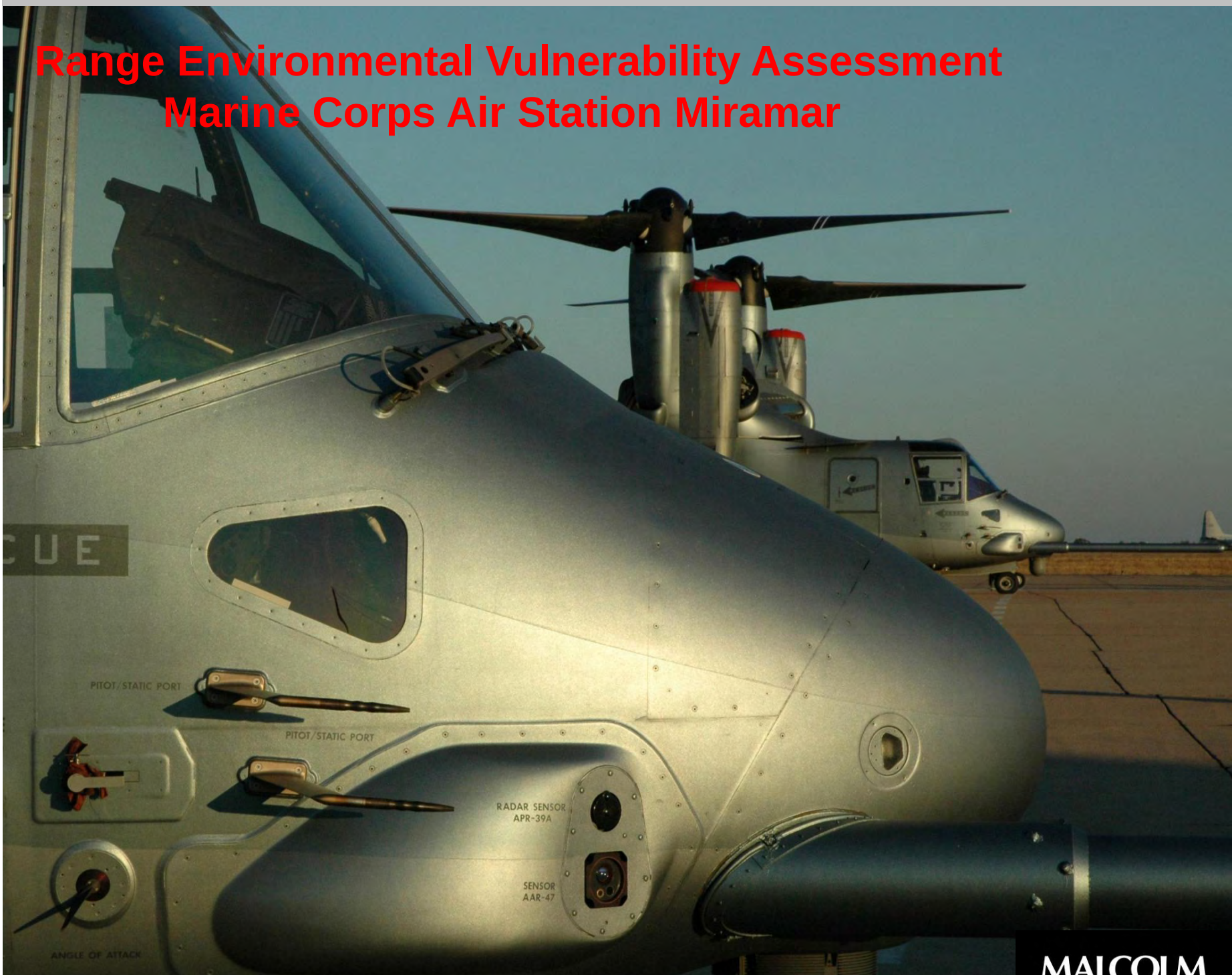
Headquarters Marine Corps

FINAL

Range Environmental Vulnerability Assessment
Marine Corps Air Station Miramar



March 2009
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INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

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Headquarters Marine Corps

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Range Environmental Vulnerability Assessment

Marine Corps Air Station Miramar

March 2009

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6285-024

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Acronym List

^{o}F	Degrees Fahrenheit
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
3rd MAW	Third Marine Aircraft Wing
amsl	Above Mean Sea Level
ASR	Archive Search Report
bgs	Below Ground Surface
CBRN	Chemical, Biological, Radiological, and Nuclear
CRWQCB	California Regional Water Quality Control Board
CSM	Conceptual Site Model
DoD	Department of Defense
DoDIC	Department of Defense Identification Code
DSWA	Defense Special Weapons Agency
EMD	Environmental Management Division
EOD	Explosive Ordnance Disposal
ESQD	Explosive Safety Quantity-Distance
FMD	Facilities Management Division
G3	Range Operations and Control
GIS	Geographic Information System
HE	High Explosive
HMX	Cyclotetramethylene tetranitramine
HQMC	Headquarters Marine Corps
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
kg/m^2	Kilograms per Square Meter
kg/m^3	Kilograms per Cubic Meter
lb	Pound
LOMAH	Location of Miss And Hit
m	Meters
m^2	Square Meters
MA	Management Area
MC	Munitions Constituents
MCAD	Marine Corps Air Depot
MCAS	Marine Corps Air Station
MIDAS	Munitions Items Disposition Action System

mg/L	Milligrams per Liter
mm	Millimeters
n/a	Not Applicable
NAAS	Naval Auxiliary Air Station
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NEW	Net Explosive Weight
NRCS	Natural Resources Conservation Service
PRA	Preliminary Range Assessment
RDX	Cyclotrimethylene trinitramine
REVA	Range Environmental Vulnerability Assessment
RUSLE	Revised Universal Soil Loss Equation
SAR	Small Arms Range
SARAP	Small Arms Range Assessment Protocol
SDZ	Surface Danger Zone
TDS	Total Dissolved Solids
TNT	Trinitrotoluene
U.S.	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UXO	Unexploded Ordnance
WWI	World War I
WWII	World War II

Executive Summary

The United States (U.S.) Marine Corps (Marine Corps) Range Environmental Vulnerability Assessment (REVA) program meets the requirements of the current Department of Defense (DoD) Directive 4715.11 *Environmental and Explosives Safety Management on Operational Ranges within the United States* and DoD Instruction 4715.14 *Operational Range Assessments*.

The purpose of the REVA program is to identify whether there is a release or substantial threat of a release of munitions constituents (MC) from the operational range or range complex areas to off-range areas. This is accomplished through a baseline assessment of operational range areas and, where applicable, the use of fate and transport modeling of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas. Indicator MC selected for the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), perchlorate, and lead.

This report presents the assessment results for the operational ranges at Marine Corps Air Station (MCAS) Miramar, San Diego, California. This report is the first comprehensive report on MC associated with the operational ranges at MCAS Miramar and serves as the baseline of environmental conditions and potential vulnerabilities of the operational ranges. Subsequent vulnerability assessments will be conducted on operational ranges at MCAS Miramar 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*.

Military Munitions Training and Operations

MCAS Miramar is the Marine Corps' primary west coast air station, comprising approximately 23,015 acres of land. The installation is located 13 miles north of downtown San Diego. Its primary mission is to provide and maintain facilities and services to support operations of the Third Marine Aircraft Wing, Marine Aircraft Group 46, Reserve Support Unit, and Combat Logistics Company 11.

The U.S. military has been operating on the land at MCAS Miramar since the early part of the twentieth century. The U.S. government initially obtained nearly 13,000 acres in the region in 1917 and established Camp Kearny, a U.S. Army National Guard infantry training area. Though the camp was closed in 1920, the government retained the property and operated it as an airfield for military and civilian use and received lighter-than-air

ships in the early 1930s (USACE, 2001a). Camp Elliott, a 32,000-acre Combat Training Area, was established in 1940. It was located in the hills east of the runways and support elements and was designated as Naval Auxiliary Air Station (NAAS) Camp Kearny in 1943. Dating to 1934, approximately 19,000 acres of Camp Elliot had been used for military training as part of a facility known as Camp Holcomb (Anteon, 2004). The camp was used extensively throughout World War II (WWII) for infantry combat training prior to deployment overseas. Following the conclusion of WWII, MCAS Miramar was converted to NAAS Miramar (1947) and then Naval Air Station (NAS) Miramar (1952). NAS Miramar absorbed a large section of Camp Elliott in 1960. The Navy operated the installation until 1997, when the Marine Corps took over the facility.

MCAS Miramar is subdivided into three general functional regions: Main Station, South/West Miramar, and East Miramar. Main Station and South/West Miramar contain the administrative and operational facilities for MCAS Miramar. East Miramar consists of approximately 15,585 acres of land, defined as all of the installation area east of Kearny Villa Road. All of East Miramar has been designated as operational range lands, with the exception of several non-contiguous tracts of land which are considered to be unavailable for training. These areas, totaling approximately 1,274 acres, have or will be put to a new use that is incompatible with range activities. The remaining East Miramar area that is available for military range training activities is comprised of approximately 14,311 acres. For the purposes of this document, the operational range lands in which training may occur will be referred to as the East Miramar Range Complex.

The East Miramar Range Complex can be divided into areas containing (1) fixed ranges/training areas and (2) other areas that are considered operational range lands but are currently not being used for training purposes. The former group consists of five designated training areas used for maneuver and land navigation training, eight small arms ranges (SARs) used for weapon proficiency training, and an explosive ordnance disposal (EOD) range used for training and emergency destruction of ordnance. The latter group represents all of the other remaining areas within the East Miramar Range Complex. These areas, while not currently being used for a specific training purpose, may be used or "activated" at any time for range/training activities.

The EOD range currently is not used for training purposes, although it is used on an infrequent basis for emergency destruction of munitions. There are no high explosive (HE) fixed ranges or impact areas currently located at MCAS Miramar. The ranges and training areas are managed by Range Operations. Because no live-fire training utilizing HE munitions currently is conducted at MCAS Miramar, expenditure data were not available to use in the MC loading process. Therefore, the Training Analysis Method was utilized, as described in the *REVA Reference Manual*, to estimate MC loading at the EOD range and at historical use MC loading areas.

Conceptual Site Model

Main Station and South/West Miramar, which contain the developed portions of the installation west of Kearny Villa Road and U.S. Highway 163, are located on the eastern edge of Kearny Mesa, part of the Pacific Coastal Plain. This area is relatively flat, gently sloping marine terrace of the Lindavista Formation (NAVFACSW, 2001; MCAS Miramar INRMP, 2006). The mesa is cut by several canyon valleys, which run laterally in an east-to-west direction. The undeveloped terrain in East Miramar, part of the Peninsular Range physiographic province, is characterized by steep, rugged hills separated by deep alluvial valleys that are typically dry throughout the majority of the year.

There are no perennial water features within MCAS Miramar, although numerous ephemeral drainages may be found throughout the installation and, in particular, in East Miramar. The installation receives an average of approximately 10 inches of precipitation per year. During a significant rainfall event, water flows into the main drainage channels of a number of subwatersheds present within MCAS Miramar. Water eventually flows off the installation to the south and southwest. Ephemeral ponding may occur in hummocky areas underlain by a shallow hardpan that restricts infiltration. This may lead to the creation of vernal pools, which are ecological habitat areas that can support rare, threatened, and endangered flora and fauna. These pools are hydrologically isolated wetlands that predominantly receive water from direct precipitation or runoff from the immediate surrounding area.

Limited information is available regarding local and regional groundwater beneath MCAS Miramar. Groundwater in the alluvial units found in the canyon bottoms is generally close to the surface. It has been measured at depths between 2 and 10.5 feet. However, this shallow groundwater exists only intermittently after heavy rainfall or after a series of wet years. Most investigations of groundwater in the older units indicate a depth to groundwater of approximately 200 feet, just above bedrock. Perched groundwater may also be found at shallow depths approximately 10 to 30 feet below ground surface where a well-cemented conglomerate layer underlies an unconsolidated layer.

Currently, live-fire training utilizing HE munitions is prohibited at MCAS Miramar due to the potential for starting wildfires in the arid terrain within the East Miramar Range Complex. Use of HE is restricted to the occasional use of the EOD range for emergency destruction of munitions. Therefore, the current EOD range is the only location where REVA indicator MC may be presently deposited. However, due to past training activities in this area during World War I (WWI) and WWII, REVA indicator MC may also have been deposited at additional locations within the East Miramar Range Complex area. While historical use ranges outside of the operational range boundarie are not assessed

under REVA (i.e., other-than-operational ranges), the potential MC loading due to historical use areas that coincide with current operational range lands is part of the scope of REVA. As such, historical training activities that previously occurred within the area now defined as the East Miramar Range Complex were evaluated in this report.

Using information collected from the installation, five locations where potential MC deposition attributed to current or historical use of HE munitions were identified within the East Miramar Range Complex:

- Current EOD Range MC loading area
- Former EOD Range / Defense Special Weapons Agency [DSWA] MC loading area
- South MC loading area
- Range C MC loading area
- Range G MC loading area

Erosion and subsequent transport of MC via surface water runoff is the primary transport mechanism at MCAS Miramar, despite the ephemeral nature of surface water at the installation. Leaching to groundwater and subsequent groundwater flow potentially could serve as another MC transport mechanism, though such transport is likely limited by relatively high evaporation rates and the depth to groundwater.

Potential receptors for MC dissolved in surface water include users of the nearby Santee Recreational Lakes and ecological receptors with habitat within or near a subwatershed where an MC loading area is located. In addition to vernal pools and potential threatened/endangered species located within them, sensitive species documented at MCAS Miramar include the threatened California gnatcatcher and the endangered least Bell's vireo, Del Mar manzanita, and willowy monardella. However, the Cedar Fire of 2003, which severely scorched most of East Miramar, adversely affected many of these sensitive species. The San Diego Region Basin Plan identifies watersheds within East Miramar as having a number of existing beneficial uses, including industrial, agricultural, recreational, and ecological uses. However, no potential human receptors from consumption of water were identified given the ephemeral nature of surface water at the installation; neither surface water nor groundwater resources near the MC loading areas are used for potable, industrial, or agricultural purposes. No ecological groundwater receptors were identified, primarily due to the depth of regional groundwater and lack of defined groundwater discharge points (CRWQCB, 1994).

Estimated MC loading rates for current and historical training activities within the operational East Miramar Range Complex were examined, along with the known migration pathways and possible receptors identified in the conceptual site model. Degradation of key MC constituents was also considered, specifically with regard to historical MC loading attributed to WWI and WWII activities. The results of this

analysis indicate that a potential exists for MC to be transported via surface runoff from the Current EOD Range MC loading area to potential ecological receptors located off the installation, as well as human receptors at the Santee Recreational Lakes.

Screening-Level Surface Water Transport Analysis

Fate and transport analysis of potential MC migration via surface water was conducted as part of the vulnerability assessment for MCAS Miramar. The fate and transport analysis was conducted through screening-level transport analysis for the Current EOD Range MC loading area. This methodology was selected to provide conservative estimates of the dissolved-phase concentrations of MC reaching the exposure endpoints for this MC loading area (i.e., Santee Recreational Lakes). MC concentrations in surface water were estimated under three scenarios:

1. At the edge of the MC loading area
2. At the edge of the operational range (East Miramar Range Complex) / installation boundary, accounting for down gradient mixing
3. At the final discharge locations (i.e., the Santee Recreational Lakes), accounting for down gradient mixing

The screening-level analysis estimated that the average annual concentration of RDX would exceed the REVA trigger value in runoff at the edge of the Current EOD Range MC loading area (Table ES-1). However, the estimated post-mixing concentrations of RDX exiting the installation and further downstream entering the Santee Recreational Lakes are predicted to be below the REVA trigger value. Edge-of-loading area and post-mixing concentrations of TNT and perchlorate were predicted to remain below their respective REVA trigger values. HMX was not included in the surface water transport analysis as it was not a component of the military munitions used in the MC loading process for this range.

Table ES-1: Estimated Concentrations of MC from Surface Water Screening-Level Analysis: Current EOD Range MC Loading Area to the Santee Recreational Lakes

MC	Trigger Value	Current EOD Range MC Loading Area		
		Edge of MC Loading Area	West Sycamore Canyon at MCAS Miramar Boundary	Post-Mixing at the Santee Recreational Lakes
RDX	0.16	**0.18**	0.002	0.0008
TNT	0.08	0.03	0.0003	0.0001
HMX	0.08	n/a	n/a	n/a
Perchlorate	0.98	0.60	0.01	0.0025

Note: All concentrations are provided in µg/L (micrograms per liter).
n/a – not applicable (HMX is not a constituent in the munitions types used in the MC loading process.)
Shading and bold indicate that the predicted concentration exceeds the REVA trigger value.

The state-approved San Diego Region Basin Plan does not include regulatory criteria for the MC associated with military munitions that might reach surface water bodies. Although the basin plan lists the intermittent drainages between MCAS Miramar and the Santee Recreational Lakes area as being suitable for various uses (agricultural supply, industrial service supply, contact and noncontact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare, threatened, or endangered species), there are no documented uses of the surface water in these areas (CRWQCB, 1994). Therefore, no further action is warranted to address potential MC releases from the Current EOD Range MC loading area.

SAR Assessments

The primary REVA MC of concern at SARs is lead because it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. Modeling parameters for lead fate and transport are contingent upon site-specific geochemical data that are generally unavailable during a baseline assessment. Therefore, SARs are qualitatively assessed under the REVA program to identify factors that influence the potential for lead migration.

Six of the eight SARs at MCAS Miramar (Ranges 5, 6, 7, B, C, and D) are adjacent to Training Area 5 and are used primarily by non-Marine units (Army, Navy, San Diego County Sheriff's Department). The two remaining SARs, Ranges 100 and 101, are located east of Training Area 4.

The analysis of the eight SARs at the installation resulted in Minimal surface water concern rankings for Ranges 100 and 101 and Moderate surface water concern rankings for Ranges 5, 6, 7, B, C, and D. Minimal groundwater concern rankings were found for all eight SARs. Generally, the Minimal and Moderate scores are primarily due to the low, intermittent precipitation rate; deep groundwater; and limited human and ecological receptors, all of which limit potential lead migration and impacts.

1. Introduction

1.1. Purpose

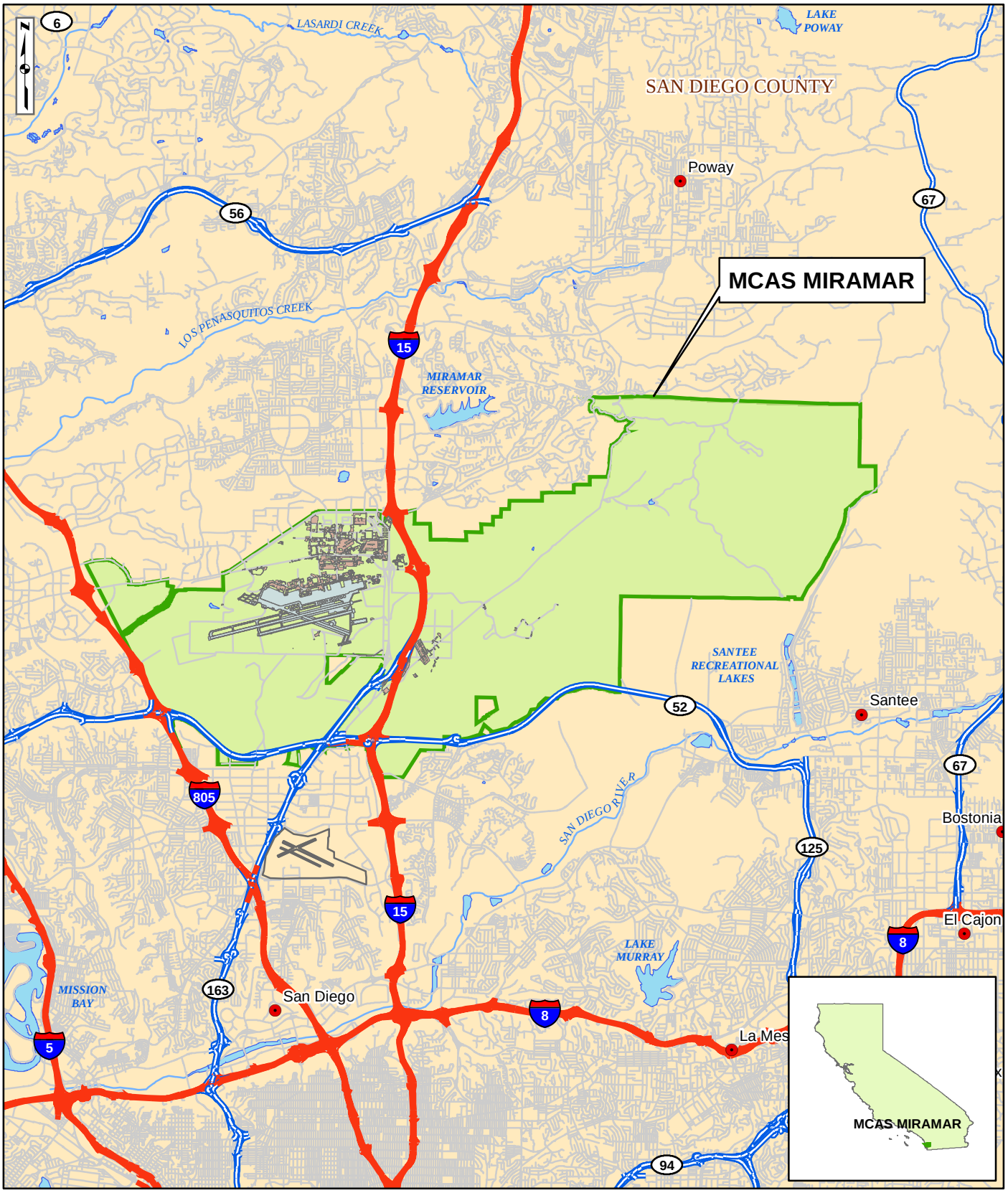
The United States (U.S.) Marine Corps (Marine Corps) Range Environmental Vulnerability Assessment (REVA) program meets the requirements of the Department of Defense (DoD) Directive 4715.11 *Environmental and Explosives Safety Management on Operational Ranges within the United States* and DoD Instruction 4715.14 *Operational Range Assessments*.

The REVA program is a proactive and comprehensive program designed to support the Marine Corps' environmental range sustainment initiative. Operational ranges across the Marine Corps are being assessed to identify areas and activities that are subject to possible impacts from external influences, as well as to determine whether a release or substantial threat of a release of munitions constituents (MC) from operational ranges to off-range areas creates an unacceptable risk to human health and/or the environment. This is accomplished through a baseline assessment of operational range areas and, where applicable, the use of fate and transport modeling of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas.

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.

The REVA program is a component of the Marine Corps Range Sustainment Program. The operational range assessments conducted through the REVA program enhance the Marine Corps' ability to prevent or respond to a release or substantial threat of a release of MC from an operational range or range complex to off-range areas. The assessments also provide information to support operational range sustainment.

This report presents the assessment results for the operational ranges and training areas at Marine Corps Air Station (MCAS) Miramar, San Diego, California (Figure 1.1-1 and Figure 1.1-2). This report is the first comprehensive report on MC associated with the operational ranges at MCAS Miramar and, as such, serves as the baseline of



REVA
FIGURE 1.1-1
SITE LOCATION MAP

MCAS MIRAMAR
MIRAMAR, CA

MALCOLM PIRNIE

LEGEND

- INSTALLATION BOUNDARY
- AIRFIELD
- LAKE
- CITY

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD

0 0.375 0.75 1.5 2.25 MILES

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007 & CASIL 2007

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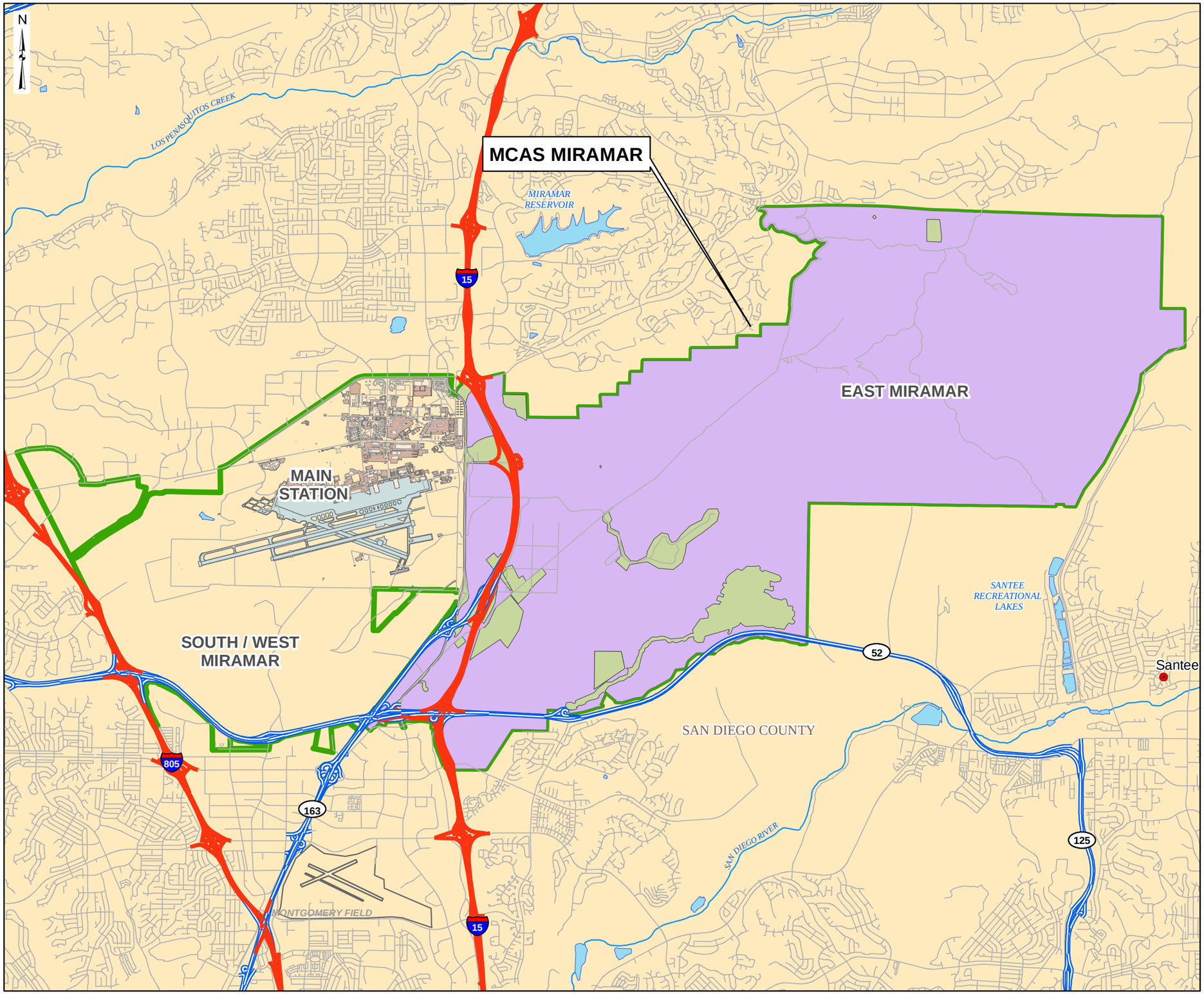


REVA
FIGURE 1.1-2
INSTALLATION LOCATION MAP

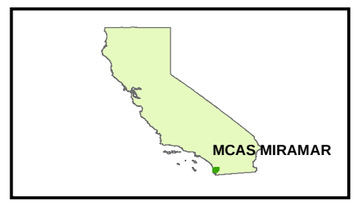
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- UNAVAILABLE FOR TRAINING
- AIRFIELD SURFACE
- BUILDINGS
- VEHICLE PARKING LOT
- LAKES
- SURFACE WATER (INTERMITTENT)

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD
- CITY



0 0.2 0.4 0.8 1.2 MILES

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

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environmental conditions and potential vulnerabilities of the ranges. Subsequent vulnerability assessments will be conducted for operational ranges at MCAS Miramar 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 to 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 fate and transport models to assess whether the potential exists for a release or substantial threat of a release of MC from an operational range or range complex area to an off-range area. Fate and transport modeling in REVA utilizes screening-level transport analyses that conservatively estimate the concentrations of MC potentially migrating to off-range exposure points. 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 (e.g., soil ingestion, incidental dermal contact, bioaccumulation and food chain exposure) currently are not considered in the REVA process.

The MC evaluated in the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), perchlorate, and lead. TNT, HMX, and RDX 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. They are common high explosives (HEs) used in a wide variety of military munitions. Perchlorate is a component of the solid propellants used in some military munitions. Perchlorate is also considered an indicator MC, as its high solubility, low sorption potential, and low natural degradation rate make the compound highly 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).

The primary MC of concern at SARs is lead because it 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 would require site-specific geochemical data that are generally unavailable during a baseline assessment. Therefore, instead of modeling lead transport, operational SARs at the installation are qualitatively reviewed and assessed 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 has also been determined.

The process and assumptions used in estimating the amount of MC deposited onto operational ranges, defined in REVA as MC loading, are discussed in **Section 3**. The fate and transport modeling and analysis methods and assumptions for surface water and groundwater are discussed in **Sections 4** and **5**, respectively.

This report presents the analysis of the data collected during site visits and the results of fate and transport modeling at MCAS Miramar. Additional details of the REVA assessment methods are outlined in the *REVA Reference Manual*, which includes a detailed description of the fate and transport models selected for the baseline range environmental vulnerability assessments, the data needed to run those models, and recommended sources for data. In addition, the *REVA Reference Manual* provides a detailed description of the REVA MC Loading Rate Calculator (HQMC, 2006).

This baseline range environmental vulnerability 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 MCAS Miramar is organized into the following sections:

Section 1 – Introduction
Section 2 – Summary of Data Collection Effort
Section 3 – Munitions Constituents Loading Rate and Assumptions
Section 4 – Surface Water Analysis Method and Assumptions
Section 5 – Groundwater Analysis Method and Assumptions
Section 6 – Conceptual Site Model (CSM)
Section 7 – Operational Range Training Areas
Section 8 – Small Arms Range Assessments
Section 9 – References

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 include various documents and reports conducted for the installation (e.g., Master Plans, Archive Search Report [ASR], Preliminary Range Assessment [PRA] and Installation Restoration Program [IRP] reports). External data sources include reports and online information from organizations such as the U.S. Geological Survey (USGS) and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

The REVA assessment team conducted a site visit on July 9–13, 2007. HQMC personnel accompanied the team during the site visit. The installation site visit involved a review of various data repositories and interviews with installation personnel from the following offices:

- Environmental Management Division (EMD)
- S-3 Operations (Range Operations)
- Explosive Ordnance Disposal (EOD)
- Facilities Management Division (FMD)
- Geographic Information System (GIS)
- Public Affairs Office

Subject matter experts were interviewed within each of these offices 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.

Site walks were performed at each of the SARs and the EOD range during the site visit. The REVA assessment team surveyed the physical condition of each range, noting firing points, impact areas, engineered controls, and other environmental factors (e.g., areas of erosion, potential migration routes).

3. Munitions Constituents Loading Rates and Assumptions

The conceptual and screening-level analyses require estimation of the amount of indicator MC deposited on operational ranges over time in order to determine if there is a release or substantial threat of a release of MC. The deposition of indicator MC which is estimated under the REVA program is referred to as MC loading. Operational range usage, boundaries, and other characteristics typically change over time; therefore, an analysis of their history was performed to map the affected areas over time and to calculate the historical and current MC loading.

Operational ranges were subdivided into one or more areas of interest when MC loading was estimated to be inconsistent across its area. This subdivision can be made both temporally (changes in training rates, historical use training) and geographically (some areas receiving greater MC loading than others). Temporally, areas of interest may include current, as well as historical, use areas within the operational ranges. The MC loading for the operational ranges was then estimated separately for each area of interest within that operational range and for each REVA indicator MC. For the purposes of REVA, the MC loading estimates are expressed as the average areal loading rate (kilograms per square meter [kg/m^2]) deposited annually in the defined area of interest for the duration that the operational range activities generating the MC loading were conducted.

Assumptions were made throughout the MC loading analysis process pertaining to the spatial distribution of the MC on the MC loading areas, as summarized in **Section 3.1** through **Section 3.4**. **Section 3.5** provides a description of the training areas and ranges at MCAS Miramar and defines the specific MC loading areas identified for the installation. The overall assumptions for MC loading on the operational ranges at MCAS Miramar are summarized in **Section 3.6**. In **Section 7**, maps are provided to depict the MC loading areas, along with the assumptions made for each MC loading area that was assessed.

3.1. MC Loading Process

The MC loading was estimated based on mass-loading principles. Studies have shown that MC are deposited on the operational range through low and high order detonations and can leach from corroded unexploded ordnance (UXO). These processes are presented in the equation below:

Total MC loading = MC (low orders) + MC (high orders) + MC (UXO)

Notes:
1) MC (low orders) is the amount of MC deposited as a result of low order detonations.
2) MC (high orders) is the amount of MC deposited as a result of high order detonations.
3) MC (UXO) is the amount of MC deposited as a result of UXO with breached casings.

Studies conducted by the DoD have shown that the MC remaining from high order detonations are much less significant than the amount of MC deposited from low order detonations. Corrosion studies conducted by the U.S. Army have shown that it can take a long time for UXO to corrode. Although MC remaining from low order detonations are the most significant contributor to MC loading, the REVA program accounts for MC from all three of these potential sources.

MC loading estimates for low order and high order detonations and UXO for the MC loading areas associated with each operational range were estimated using the equations below:

MC (low order) = (number of military munitions expended) x (low order detonation rate) x (amount of residual remaining from a low order detonation)

MC (high order) = (number of military munitions expended) x (high order detonation rate) x (amount of residual remaining from a high order detonation)

MC (UXO) = (number of military munitions expended) x (dud rate) x (amount of residual exposed as a result of damage to UXO casings)

Dud rate and low order detonation rate data for REVA were estimated based upon the July 2000 study completed by the U.S. Army Technical Center for Explosives Safety entitled *Report of Finding for Study of Ammunition Dud and Low Order Detonation Rates*. Dud and low order detonation rates for military munitions in this report were tracked, reported, and made available according to military munition DoD Identification Code (DoDIC). For the DoDICs that do not have dud or low order detonation rates available, the default values listed in the referenced report of 3.45% (dud rate) and 0.028% (low order detonation rate) were used. In addition, for the purposes of the REVA program, it was assumed that the amount of residual explosives remaining after a low order detonation and a high order detonation were 50% and 0.1%, respectively. These numbers are consistent with those used in the U.S. Navy's Range Sustainability Environmental Program Assessment.

The primary source of information on the types and amounts of energetic fillers associated with military munitions was the Defense Ammunition Center's Munitions Items Disposition Action System (MIDAS) Web site. Data were retrieved from MIDAS by performing searches for the MC, which produced a list of military munitions with

their respective amounts of MC. The list of military munitions was then evaluated, as more than one matching National Stock Number was often listed, and the highest and lowest MC quantities were captured and averaged for REVA MC loading estimate calculations.

In addition to MIDAS, other sources of MC data included the ORDDATA II software (Enhanced International Deminer's Guide to UXO Identification, Recovery and Disposal; Version 1.0, 1999) and various ordnance technical manuals. In cases where specific military munitions use data were unavailable, the military munitions types selected were based upon common military munitions used during the active time periods of the operational range.

3.2. Expenditure Data

Range Operations is responsible for the administration and oversight of the training operations conducted at MCAS Miramar. Range Operations coordinates recordkeeping for munitions expenditure at the operational ranges managed by the installation. Summaries of current munitions expenditures were based upon data produced by a variety of range managers and users, including Range Operations (Ranges 100 and 101), EOD personnel (current EOD range), Army National Guard and Navy personnel (Ranges B, C, and D), and San Diego County Sheriff's Department (Ranges 5, 6, and 7). The records vary in content as well as time period, with dates ranging from 1999 to 2007. These data were provided to the REVA assessment team in hard copy and electronic formats.

The use of documented expenditure data is preferred in the REVA program. However, there are many cases (including most historical use areas) where expenditure data were not maintained for the entire time the range was in use. In these cases, the amount of military munitions expended over time had to be estimated through use of the REVA MC Loading Rate Calculator (**Sections 3.3** and **3.4**). Generally, historical expenditures were estimated based on extrapolation of the 1999–2007 expenditure data back to applicable, documented initial use dates. In the cases of historical use areas where an extrapolation could not be made, the REVA Training Analysis Method was utilized to develop conservative estimates of expenditures. This is further discussed in **Section 3.6**.

3.3. REVA MC Loading Rate Calculator

The REVA MC Loading Rate Calculator and its Training Factor are explained in more detail in the *REVA Reference Manual* (HQMC, 2006). All known data and assumptions input into the MC Loading Rate Calculator for each operational range area assessed are

documented in **Section 7**. The following discussion provides a brief summary of the MC Loading Rate Calculator.

The REVA MC Loading Rate Calculator was used to provide an automated method to calculate the overall loading of the operational range area based upon the military munitions expenditure data obtained from the installation. The MC Loading Rate Calculator estimates an average expenditure rate that is then applied to each year the operational range area was known to be or suspected to have been operational where expenditure data are missing or incomplete.

The MC Loading Rate Calculator also applies values for the data discussed earlier (dud rate, low order and high order detonation rates, and residual amount of MC remaining) and area values (square meters [m^2]) so that the estimated MC concentrations are presented in the units needed for the fate and transport analysis (kg/m^2). Additionally, the calculator applies a training factor (discussed in **Section 3.4**) to account for fluctuations in training due to world events, such as conflicts and wars, during which there was an increase or decrease in training.

In some instances, the types of military munitions used at a given range do not contain all four of the REVA indicator MC. Under these circumstances, the MC loading rate is considered to be zero for that REVA indicator MC. This is presented in the MC loading tables as not applicable (n/a).

3.4. Training Factor

Historically, the level of military training operations has been strongly affected by conflicts and wars. This usually resulted in an increase in training prior to a conflict or war and a tapering off during it, with training increasing again toward the end of the event and then, subsequently, decreasing again to a nonconflict/nonwar level. The REVA program attempts to account for this training effect by developing a training timeline of significant military conflicts and wars from 1914 through today. This timeline accounts for the following:

- World War I (WWI)
- World War II (WWII)
- The Cold War
- The Korean War
- The Vietnam Conflict
- The Persian Gulf
- Afghanistan

- Iraq

Subject matter experts within the Marine Corps were queried to establish time periods of increased training throughout history. This inquiry resulted in the establishment of a baseline training level period, as well as the development of four periods that increase the MC loading rate by a training factor. The periods identified and their associated training factors are as follows:

- Period A: 1914–1924 (baseline + 40%)
- Period B: 1925–1937 (baseline)
- Period C: 1938–1976 (baseline + 50%)
- Period D: 1977–1988 (baseline + 20%)
- Period E: 1989–present (baseline + 50%)

The baseline expenditure rate is applied to each year an operational range was in use. The MC Loading Rate Calculator automatically applies the training factor adjustments according to the time period so that MC loading rates are estimated for each year the operational range was known or suspected to have been in use.

3.5. MC Loading at MCAS Miramar

MCAS Miramar is subdivided into three general functional regions: Main Station, South/West Miramar, and East Miramar. Main Station and South/West Miramar contain the administrative and operational facilities for MCAS Miramar and are further discussed in Section 6. Training activities are conducted within the rugged terrain in East Miramar, which consists of approximately 15,585 acres of land, defined as all of the installation area east of Kearny Villa Road and U.S. Highway 163. All of East Miramar has been designated as operational range lands [as defined by 10 U.S.C. 101(e)(3)], with the exception of several non-contiguous tracts of land which are considered to be unavailable for training. These areas have or will be put to a new use that is incompatible with range activities. These new use areas include the installation ordnance storage area/magazines (though not the explosive safety quantity-distance [ESQD] arcs), warehouses, the Navy / Marine Corps and Army Reserve centers, public transportation corridors, local school district land, an area known as "Camp Elliott" (a former WWII era camp), the future site of Military Housing Site 8 (labeled as "Future Development Area" on report figures), and various small tracts of land. The combined area of these incompatible use areas within East Miramar is 1,274 acres. Consequently, the remaining area within East Miramar that is available for military range training activities is approximately 14,311 acres. For the purposes of this document, the operational range lands in which training can occur will be referred to as the East Miramar Range Complex. This range complex contains all of

the specific range/training areas evaluated under REVA. The range complex boundary is depicted in Figure 3.5-1.

The East Miramar Range Complex itself can be divided into areas containing (1) fixed ranges/training areas and (2) other areas that are considered operational range lands but are currently not being used for training purposes. The former group consists of five training areas used for maneuver and land navigation training, eight small arms ranges (SARs) used for weapon proficiency training, and an explosive ordnance disposal (EOD) range used for training and emergency destruction of ordnance. These fixed operational ranges are described in Tables 3.5-1 and 3.5-2, respectively, and are identified in Figure 3.5-1. The latter group represents all of the other remaining area within the East Miramar Range Complex. These areas, while not currently being used for a specific training purpose, may be used or "activated" at any time for range/training activities.

Training within the East Miramar Range Complex includes land navigation training, troop maneuvers, bivouacking / overnight camping, aircraft / personnel support exercises, tactical vehicle driver training, and weapons instruction training (MCAS Miramar INRMP, 2006). The primary range users at MCAS Miramar are elements of the Third Marine Aircraft Wing (3rd MAW), the primary tenant at the installation. The mission of the 3rd MAW is to provide combat ready expeditionary aviation forces capable of short notice worldwide deployment to Marine Air Ground Task Force fleet and unified commanders (TECOM, 2004). General training categories at MCAS Miramar include (MCAS Miramar INRMP, 2006):

- Marine Corps common combat skills training,
- vehicle operations,
- Marine Wing service support, and
- Air operations training.

Table 3.5-1: Operational Ranges and Training Areas

Range Name[a]	Type	Size (1,000 m^2)	Munitions
Training Area 1	Navigation/maneuver	8,673	None
Training Area 2	Navigation/maneuver	4,140	None
Training Area 3	Navigation/maneuver	1,234	None
Training Area 4	Navigation/maneuver	3,760	None
Training Area 5	Demonstration	1,214	None
[Current] EOD Range	Ordnance disposal (emergency use only)	2,254	Various

[a] The East Miramar Range Complex, approximately 57,914,000 m^2 in size, encompasses and contains these training areas and the EOD Range.

REVA
FIGURE 3.5-1
OPERATIONAL RANGE BOUNDARIES

MCAS MIRAMAR
MIRAMAR, CA

N

SAN DIEGO COUNTY

MIRAMAR RESERVOIR

MCAS MIRAMAR

PISTOL RANGE (RANGE 101)

EOD RANGE

LOMAH RIFLE RANGE (RANGE 100)

RANGES 5,6,7; B,C,D

KEARNY VILLA ROAD

SANTEE RECREATIONAL LAKES

SAN DIEGO RIVER

Santee

15

163

52

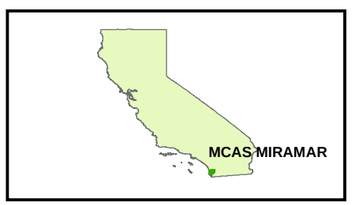
125

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- TRAINING AREAS
- UNAVAILABLE FOR TRAINING
- LAKES
- SURFACE WATER (INTERMITTENT)

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD



0 0.2 0.4 0.8 1.2 MILES

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

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Table 3.5-2: Small Arms Ranges

Range Name[a]	Type	Size (1,000 m^2)	Ammunition
Range 100 (LOMAH Rifle Range)	Rifle	4,759	Small arms ammunition
Range 101 (Pistol Range)	Pistol, shotgun	1,356	
Range B	Pistol, shotgun	1,862[b]	
Range C	Pistol, shotgun		
Range D	Pistol		
Range 5	Pistol		
Range 6	Pistol		
Range 7	Pistol, shotgun		

Notes: LOMAH – Location of Miss and Hit

[a] The East Miramar Range Complex, approximately 57,914,000 m^2 in size, encompasses and contains these small arms ranges.
[b] Area of all six adjacent ranges and their combined surface danger zones (SDZs)

Fixed wing turboprop, jet, and rotary wing aircraft from the installation utilize the Camp Pendleton Central Impact Area and the various landing areas located across the base for training purposes (TECOM, 2004).

Sections 3.5.1 through **3.5.3** further describe the current operational training profile at MCAS Miramar, including the location and general activities conducted at the training areas, EOD range, and SARs. **Section 3.5.4** describes the historical training activities conducted on the lands comprising the East Miramar Range Complex during previous military use of the MCAS Miramar property. As REVA only addresses potential MC loading on historical use areas present on an operational range area, any historical use ranges located outside of the East Miramar Range Complex are not evaluated in this report.

3.5.1. Training Areas

Of the five training areas designated within the East Miramar Range Complex, Range Operations personnel indicated that Training Area 4 receives approximately 90% of the total training activity. Training Areas 1 through 4 are field training areas for which the following tactical exercises / field training activities are approved (MCAS Miramar, 2008):

- Land navigation
- Troop maneuvers
- Vehicle driver training

- Convoy operations
- Tactical operations
- Bivouac
- Aircraft/personnel exercises

Training Area 5, located on the developed western section of the East Miramar Range Complex, is not listed as a field training area. Training at this location generally is restricted to demonstration exercises. The Chemical, Biological, Radiological, and Nuclear Readiness (CBRN) facility is located within Training Area 5, which provides individual proficiency and readiness in CBRN defense. No munitions are used at the CBRN; as such, no REVA MC of concern are expected to be present.

Due to the risk of generating wild fires in the dry, rugged areas of East Miramar, HEs and any other type of heat-producing ammunition are restricted from use on the training areas unless the Training Area Management Officer grants a special waiver. Interviews with Range Operations personnel indicate that these types of waivers are rare (approximately once/month). All potential fire-starting munitions use is completely restricted within 500 meters (m) of the installation magazines. Since live fire is not authorized, SDZs have not been established for the training areas. Given the restrictions on munitions use, significant MC loading is not anticipated to be occurring on the training areas. Additionally, a number of restrictions are enforced within the East Miramar Range Complex to minimize erosion of the area, as well as to protect sensitive ecological and cultural resources; these restrictions are described in further detail in MCAS Miramar Station Order 3500.2A (MCAS Miramar, 2008). None of these training restrictions impact the reported total operational range acreage.

3.5.2. EOD Range

The EOD range, located in the northeast corner of the East Miramar Range Complex, is the only range at MCAS Miramar that handles munitions containing HEs. The range is located at the former Sycamore Canyon Missile Test Site operated by the Air Force and the National Aeronautics and Space Administration (NASA) between 1953 and 1969 (USACE, 2001a). EOD operations, originally conducted at the Green's Farm research facility, were transferred to the current range location in October 1997. The range consists of two "shot holes" for EOD training and emergency destruction of UXO found on MCAS Miramar and surrounding areas due to past training activities during the WWI and WWII timeframes. The shot holes are located in a canyon bottom of an ephemeral drainage in West Sycamore Canyon. The net explosive weight (NEW) for this range is 5 pounds (lb). HE use consists of UXO items to be destroyed as well as donor charges. A 2,500-foot ESQD arc has been established around each shot hole for protection of personnel during EOD range operations.

The EOD range has not been used since January 2007 due to its presence in unrestricted airspace regulated by the Federal Aviation Administration. At the time of the site visit, MCAS Miramar personnel were developing plans to move the range to another location that would allow for more consistent use of the range, to include both emergency destruction and EOD training activities. However, as of June 2008, the plans to relocate the range have been abandoned; the range will remain in its current location and only be used under emergency conditions. Munitions requiring destruction that are deemed safe to move are transported to Camp Pendleton for disposal.

3.5.3. SARs

Eight SARs, located in two areas within the East Miramar Range Complex, are utilized by MCAS Miramar and other military and county personnel for annual marksmanship/proficiency training and qualification (Department of the Navy, 2001). SDZs for each of the ranges have been established based on the type of small arms ammunition used at each SAR. The sizes of the SDZs were factored into the overall acreage of each fixed range, as listed on Table 3.5-2.

Ranges 100 (LOMAH Rifle Range) and 101 (Pistol Range) were constructed in 2004 and 2007, respectively, in the north-central section of East Miramar. The SDZ for Range 100 extends to the east, while the SDZ for Range 101 extends to the southeast.

Ranges B, C, and D are located in the southwestern section of the East Miramar Range Complex, adjacent to Training Area 5. These ranges, located in parallel along a north-south trending hillside, are oriented for firing to the southeast. The ranges are separated by earthen side berms, and the natural hillside serves as the rear impact berm for all three ranges. In addition, Range B contains wood baffling above the rear firing line to reduce the vertical trajectory of bullets fired during training.

These ranges historically were utilized by the Navy and remain in operation today. The primary users of these ranges are regional Army National Guard and Navy units, which schedule range usage with Range Operations. Marine Corps units also use the range for marksmanship training. Small arms smmunition utilized at these ranges include pistol and shotgun rounds.

The San Diego County Sheriff's Department, under a lease agreement with MCAS Miramar, operates a 92-acre training facility within Training Area 5. County, state, federal, and local law enforcement agencies and military personnel use the facility for role-play scenarios and live-fire training exercises and to practice rescue-training techniques. The facility is composed of a dog training facility, an urban disaster training facility, an obstacle course, a mock town (known as Duffy's Town) used for tactical training, and administrative buildings (MCAS Miramar INRMP, 2006).

Ranges 5, 6, and 7 are operated by the county sheriff's department in an area directly north of Ranges B, C, and D and adjacent to Training Area 5. These ranges share the same hillside as Ranges B, C, and D, which also serves as the rear impact berm for Ranges 5, 6, and 7. The sheriff's department ranges are heavily used, resulting in significant lead deposition in the impact berm. The ranges are separated by concrete sidewalls. Small arms ammunition utilized at these ranges include pistoland shotgun rounds.

A combined SDZ has been established for the three Marine Corps ranges and the three San Diego County Sheriff's Department's ranges. The SDZ extends downrange beyond the impact berms and overlaps a section of land owned by the San Diego County School District that is located within the boundaries of MCAS Miramar.

Fate and transport of lead at SARs is strongly influenced by site-specific geochemical conditions that cannot be determined solely by physical observation. Therefore, MC loading and fate and transport modeling were not conducted for the SARs. Rather, the SARs were qualitatively assessed through the REVA SAR Assessment Protocol (SARAP). This assessment employs a consistent qualitative approach to identify and assess factors that influence the potential for lead migration at an operational range. Operational ranges exclusively used for small arms training at MCAS Miramar include those described in Table 3.5-2. The results of the SAR assessments are provided in **Section 8**.

3.5.4. Historical Live-Fire Ranges

The U.S. military has been operating on the land at and around MCAS Miramar since the early part of the twentieth century; training activities have varied greatly during this time period. The U.S. government initially obtained nearly 13,000 acres in the region in 1917 and established Camp Kearny. The camp was located within the current installation boundaries, in the area presently serving as the airfield (Anteon, 2004). The base served as a U.S. Army National Guard infantry training area (40th Infantry Division) to support WWI operations, including live-fire training. Historical munitions use areas within the current boundaries of the East Miramar Range Complex include a variety of HE munitions types. Though the camp was closed in 1920, the government retained the property and operated it as an airfield for military and civilian use and received lighter-than-air ships in the early 1930s (USACE, 2001a).

Camp Elliott, a 32,000-acre Combat Training Area, was established in 1940. It was located in the hills east of the runways and support elements and was designated as Naval Auxiliary Air Station (NAAS) Camp Kearny in 1943. Dating to 1934, approximately 19,000 acres of Camp Elliot had been used for various training with HE and small arms ammunition as part of a facility known as Camp Holcomb (Anteon, 2004). The camp

was used extensively throughout WWII for infantry combat training prior to deployment overseas. Camp Elliott contained 41 combat/firing ranges, four bivouac areas, and three permanent camps. All lands currently occupied by East Miramar, as well as current residential property to the south of the base, were part of Camp Elliott.

The Navy took command of Camp Elliot in June 1944. In 1946, NAAS Camp Kearny merged with Marine Corps Air Depot (MCAD) Miramar, located in the northern section of the installation, and was renamed MCAS Miramar (USACE, 2001a). Following the conclusion of WWII, MCAS Miramar was converted to NAAS Miramar (1947) and then Naval Air Station (NAS) Miramar (1952). The majority of the training within the East Miramar Range Complex during this time was for support of land patrol squadrons (URS, 2005). Following the Korean War, sections of Camp Elliott were used by several entities, including the Air Force, which conducted research and testing; the Navy, which operated the NAS Miramar magazines and a separate warehousing facility (currently Training Area 5); and the Marine Corps Reserve Training Center, which conducted non-live-fire vehicle training and maneuvers (USACE, 2001a).

NAS Miramar absorbed a large section of Camp Elliott in 1960. Nearly 2,700 acres of Camp Elliott were also transferred to the Air Force, which established the Sycamore Canyon Missile Test Site, where the operational EOD range is now located. The test site was used in the development of liquid-based propulsion systems for the Atlas and Centaur missiles (USACE, 2001a). NASA took control of the property in 1966. This property was declared excess in 1969 and was transferred to NAS Miramar in 1977. Following this, no other major live-fire training was conducted at NAS Miramar or at MCAS Miramar, which was established in October 1997.

Detailed data regarding the history of the various installations in the region, units, and historical training ranges at MCAS Miramar are provided in the Integrated Cultural Resource Management Plan (ICRMP), the ASR, and the PRA (Anteon, 2004; USACE, 2001a and 2001b). These historical ranges and activities have not all occurred within the current operational range boundary of the East Miramar Range Complex. The historical live-fire areas are summarized in Table 3.5-3 and are qualitatively organized according to spatial overlap with the East Miramar Range Complex. The general locations of these areas are presented in Figure 3.5-2.

Table 3.5-3: Historical Live-Fire Areas

Range Name	Size (1,000 m^2)	Munitions
East Miramar Range Complex		
Anti-tank range(Range I) target	225	HE, small arms ammunition
Artillery emplacements	321	HE

Range Name	Size (1,000 m^2)	Munitions
Artillery targets	139	HE
Atlas Missile Test Site	972	None
Defense Special Weapons Agency (DSWA) (Green Farm)	2,250	HE
EOD range (former)	73	HE
Gas chamber, Bldg. 77	3	CN, chlorine
Gas chamber, Bldg. 81	2	CN, chlorine
Gas chamber, Bldg. 89	1	CN, chlorine
Grenade course	175	HE
Potential impact area for chemical munitions	241	HE, small arms ammunition
Location of Bombing Target No. 31	6	Practice munitions
Machine gun range	65	small arms ammunition
Machine gun range, 6 emplacements	6	small arms ammunition
Machine gun range, 500-yard target	5	small arms ammunition
Machine gun range 600-yard target	4	small arms ammunition
Range A	2,162	small arms ammunition
Range C	1,197	small arms ammunition
Range G	3,744	HE, small arms ammunition
Range I	8,945	HE, small arms ammunition
Range J	9,257	HE, small arms ammunition
Range R	24	small arms ammunition
Range S	7	small arms ammunition
Range T	6	small arms ammunition
Range Y	2,581	small arms ammunition
Rifle range (former)	19	small arms ammunition
Trench system	265	HE, small arms ammunition
U.S. Army Reserve tank training area	4,049	Non-live-fire
Majority of Range on East Miramar		
Bomb disposal area	3,150	HE
Field target / combat range	97	HE, small arms ammunition
Range B	2,911	small arms ammunition
Range D	3,554	small arms ammunition
Majority of Range Outside East Miramar		
Range E	3,513	HE, small arms ammunition

Range Name	Size (1,000 m^2)	Munitions
Range F2	8,262	small arms ammunition
Range K	6,806	HE, small arms ammunition
Range L	7,499	HE, small arms ammunition
Range V	1,435	HE, small arms ammunition
Range N	11,948	HE
Outside of East Miramar		
Convair Range	221	HE, small arms ammunition
Range H1	559	small arms ammunition
Range H2	284	small arms ammunition
Range M	2,797	HE, small arms ammunition
Range O	45	small arms ammunition
Range P	193	None
Range Q	122	HE
Range U	1,257	HE, small arms ammunition
Range W	955	small arms ammunition
Range X	369	small arms ammunition

Note: Bldg – building;
CN – chloracetophenone

3.6. MC Loading Assumptions

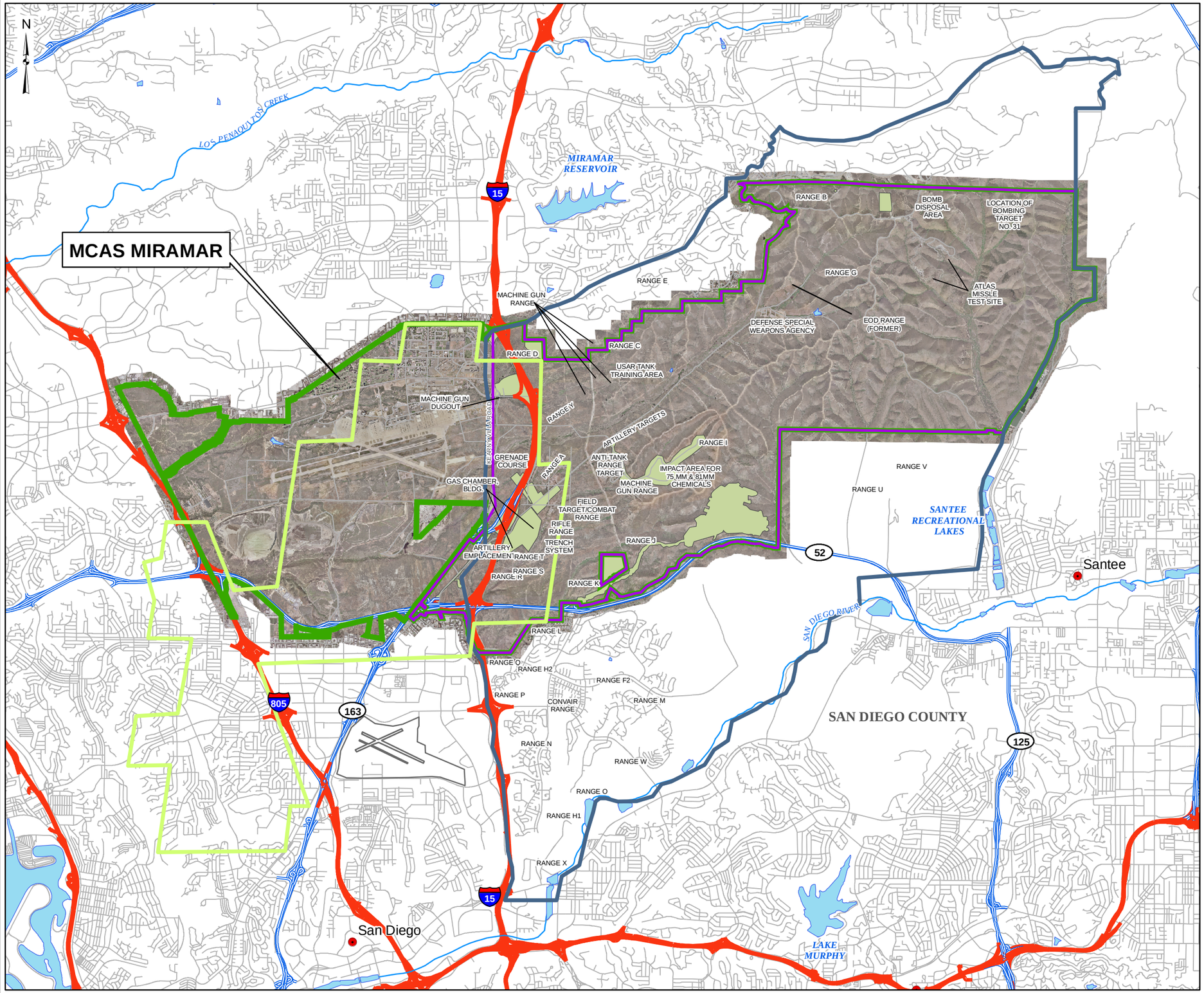
3.6.1. Selection of MC Loading Areas

The REVA assessment team reviewed existing operational ranges and training areas, as well as historical use areas, to determine the locations of MC loading areas within the East Miramar Range Complex. These areas represent the locations in which significant MC loading is occurring or suspected to have occurred as a result of training with munitions containing HE (TNT, RDX, and HMX) or munitions containing solid propellants (perchlorate). Five MC loading areas within the East Miramar Range Complex were delineated (Figure 3.6-1):

- Current EOD Range MC loading area
- Range G MC loading area
- Former EOD Range / DSWA MC loading area
- Range C MC loading area
- South MC loading area

REVA
FIGURE 3.5-2
HISTORICAL USE RANGES

MCAS MIRAMAR
MIRAMAR, CA



LEGEND

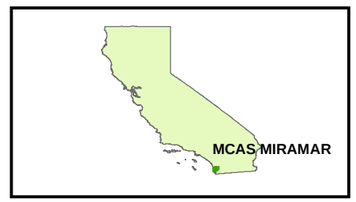
- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- UNAVAILABLE FOR TRAINING

FORMER INSTALLATIONS

- FORMER CAMP ELLIOTT
- FORMER CAMP KEARNY
- LAKES
- SURFACE WATER (INTERMITTENT)
- CITY

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD



0 0.25 0.5 1 1.5 MILES

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007
CASIL 2007
USACE 2001

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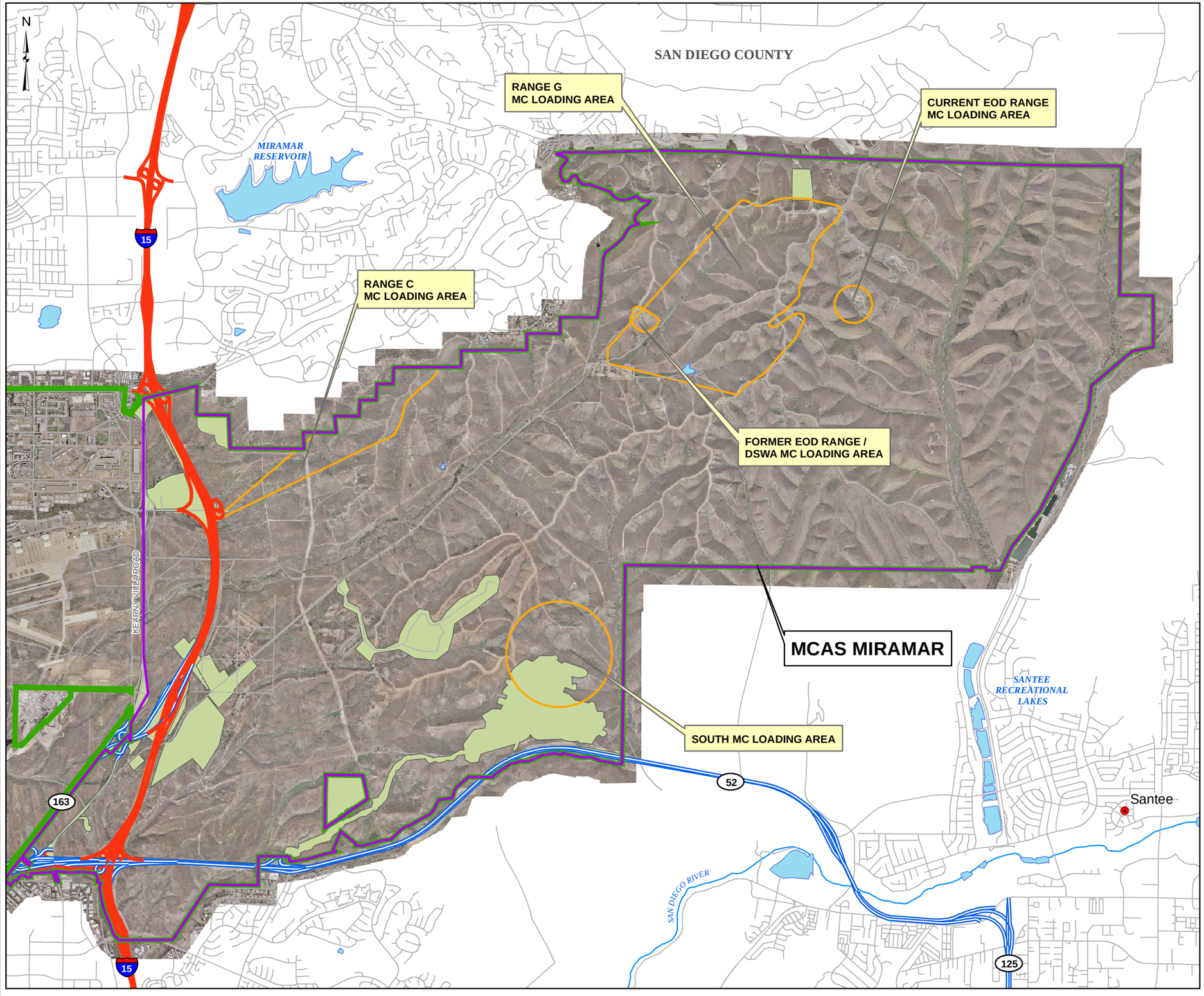


REVA
FIGURE 3.6-1
MC LOADING AREAS

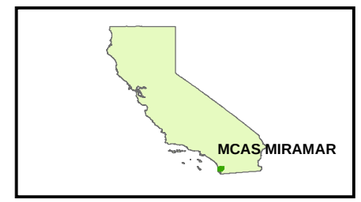
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- UNAVAILABLE FOR TRAINING
- MC LOADING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)
- CITY

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD



0 0.2 0.4 0.8 1.2
MILES

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

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The Current EOD Range MC loading area includes the only operational range currently designated for handling HE munitions at MCAS Miramar. The EOD range is located within the boundary of the former Sycamore Canyon Missile Test Site. No estimation of MC loading from historical operations of the missile test site was conducted, as only rocket motors containing liquid-based propellants were tested at this site. The missile testing operations at the former test site did not include perchlorate, or other REVA indicator MC, including TNT, RDX, and HMX. As this historical use area is located within the overall operational range boundary of the East Miramar Range Complex, any additional assessment of potential MC releases will be addressed if the range area is closed or when otherwise appropriate. A previous release of other constituents not related to munitions use was reported at the former missile test site (SCS, 1984) and has subsequently been investigated and remediated. While additional studies at this site (also known as IRP Site 10) are on-going, the release from the site is being conducted under the IRP and does not fall under the scope of this REVA assessment.

The other four MC loading areas were established to account for MC loading from historical use areas that overlapped significantly within the East Miramar Range Complex. Information primarily available in the ASR and PRA provided locations, range fans, years of use, and general types of activities and munitions associated with the historical ranges. This information allowed selection and size estimation of historical MC loading areas based on types of munitions used, location of the range(s) (e.g., proximity to off-range receptors), and duration of use. The Range C and Range G MC loading areas were based on WWII-era training ranges associated with Camp Elliott.

The Former EOD Range / DSWA MC loading area combines MC loading contributions from two separate ranges. Likewise, the South MC loading area combines MC loading contributions from one WWI and two WWII ranges in an area with extensive range fan overlap.

MC loading areas were not established for the five current training areas because HE munitions are not authorized for use in these areas. The training areas are used only for non-live-fire tactical exercises and/or field training activities. Lead loading at the eight SARs is addressed in the SARAP (**Section 8**). The five MC loading areas selected for analysis of potential migration of MC to off-range areas are evaluated further in **Section 7**.

3.6.2. Overarching Assumptions

The following assumptions are used in the REVA process for explosives and perchlorate:

- Only the main fillers and propellant components (REVA indicator MC) are included in the estimates.
- MC loading rates are estimated only for the MC on the indicator list.

- All REVA indicator MC are considered 100% pure and, therefore, are more readily transported in the environment.
- One hundred percent of residual REVA indicator MC is considered reactive within the environment.
- The U.S. Army Defense Ammunition Center study[1] dud and low order detonation rate estimates are used.
- One hundred percent of all duds result in exposed MC.
- For low order detonations, it is assumed that 50% of the total MC per item is consumed based on expert opinion.
- Training factors described in **Section 3.4** are applied to the specified periods, and the MC loading rates are adjusted accordingly.
- MC loading for a designated area is assumed to be evenly distributed throughout the area.

Explosives and perchlorate were evaluated at MC loading areas where significant HE use has been documented; lead was evaluated at operational SARs. The MC loading analysis process also required various assumptions pertaining to the quantities of expenditures due to the limited data available. As noted in **Sections 3.2** and **3.4**, conservative extrapolation of expenditure totals were made from existing data in order to account for missing years. There are also instances where ammunition descriptions were not available for reported expenditures, notably small arms ammunition. In these instances, conservative assumptions were made by examining types of ammunition appropriate for a given range in order to determine which contains the highest amount of lead per round.

With regard to historical use ranges present within the East Miramar Range Complex, very limited information was available for the MC loading process. While MC loading areas may be defined (discussed in **Section 3.5.1**), no substantive information regarding expenditure quantities was available for historical military training; with a single exception, there are no comparable, present-day loading activities that could be used to extrapolate MC loading attributable to these historical activities. To address such a data gap, two evaluations were performed, where appropriate. The Training Analysis Method, described in the *REVA Reference Manual*, was used to conservatively estimate historical MC loading by reviewing the types of training conducted on a given range, the weapon platforms used, the military munitions associated with the specific weapon platforms, and the frequency of training activities conducted at the given range. This information, combined with professional judgment, establishes conservative assumptions regarding the number of personnel trained, the number of military munitions expended per training

[1] Source: Report of Findings for Study of Ammunition Dud and Low Order Detonation Rates, July 2000.

session, and the average number of training sessions conducted annually, subsequently allowing for an estimate of munitions expended at a historical use range.

Additionally, an evaluation of historical MC loading may also take into account the influence of natural degradation of MC, especially with respect to MC loading areas that existed in the past or were used for only a relatively short period of time. Conservative assumptions regarding MC loading at these areas—based upon MC loading rate estimates developed for other historical MC loading areas—allows for calculations to demonstrate that natural degradation is a controlling factor on the presence of MC at particular areas.

The specific methodologies and assumptions used to conduct the MC loading at each loading area and the results of the loading process are detailed in **Section 7**.

4. Surface Water Analysis Method and Assumptions

Under REVA, surface water fate and transport modeling consisting of screening-level transport analysis is used to estimate the MC concentrations in surface water runoff at the edge of the MC loading areas. If this analysis predicts impacts at the edge of the loading area, then further calculations are performed to estimate the MC concentrations at a downstream receptor. Average annual surface water concentrations of the indicator MC (TNT, RDX, HMX, and perchlorate) are estimated based on the average annual MC loading of each indicator MC to each MC loading area. For MCAS Miramar, the surface water screening analysis was carried out for the Current EOD Range MC loading area for the time period 1997 to 2006. MC loading at this location prior to 1997 was believed to have been negligible, as described in **Section 7.1.1.1**. Surface water screening-level analysis was not conducted for the other MC loading areas, as described in **Sections 7.2.2, 7.3.3, 7.4,** and **7.5**. Additional details on the assumptions for MC loading for MCAS Miramar are provided in **Section 3**.

The estimation of MC concentrations in surface water assumes that a portion of the MC potentially could enter the surface water by several mechanisms: (1) erosion of particulate or adsorbed MC in soil; (2) direct dissolution of MC in surface water runoff; and (3) connectivity of groundwater and surface water. At MCAS Miramar, it was assumed that MC enter surface water through either erosion or dissolution into surface water runoff and that there is minimal discharge of groundwater into surface water. Minimal groundwater discharge was assumed because there are no known groundwater discharge points at MCAS Miramar. All surface water, including vernal pools and wetlands, is believed to originate as runoff from precipitation events. Instead, surface water flow in ephemeral canyons recharges the shallow groundwater in the underlying alluvium.

The mass loading of the indicator MC on the operational range was estimated as described in **Section 3**. Based on the procedures defined in the *REVA Reference Manual* for surface water modeling purposes, it was conservatively assumed that the entire annual MC load was uniformly mixed in the upper 6 inches of soil and was uniformly distributed across the loading area. Thus, the MC load present in the upper 6 inches of the soil was available for surface transport. A conservative, screening-level modeling approach was taken to estimate the annual average concentrations of MC in surface water runoff from the identified MC loading area. Results of the surface water screening-level analysis were compared to the REVA trigger values (Table 4.0-1) to evaluate the potential for MC

releases to off-range receptors. The REVA trigger values are applicable to all water sources (e.g., if groundwater screening-level analyses had been conducted for MCAS Miramar, the concentrations would have been compared to these REVA trigger values). The screening-level analysis method is described briefly in the following sections. Additional details on the method are provided in the *REVA Reference Manual* (HQMC, 2006).

Table 4.0-1: REVA Trigger Values for MC

MC	Trigger Value (µg/L)
RDX	0.16
TNT	0.08
HMX	0.08
Perchlorate	0.98

Note: µg/L – micrograms per liter

4.1. Losses to Surface Water in the Shot Hole Area

The primary transport mechanisms at MCAS Miramar were assumed to be erosion and direct dissolution into surface water runoff. These mechanisms are quantified in this section.

4.1.1. Erosion

The amount of soil eroded was estimated using the Revised Universal Soil Loss Equation (RUSLE), which incorporates the major factors affecting erosion to predict the rate of soil loss in mass per area per year. The RUSLE is expressed as follows:

$$A = RKLSCP$$

Where:

A = predicted soil loss, metric tons per hectare per year
R = rainfall and runoff factor
K = soil erodibility factor
LS = topographic factor (factor influenced by length and steepness of slope)
C = cover and management factor
P = erosion control practice factor

These factors were estimated for the modeled MC loading area using available information, such as soil type from the soil survey report for the San Diego area (USDA, 1973), land use / land cover, and USGS topographic data. The estimated amount of soil eroded from the MC loading area was used to calculate the mass of MC transported with the eroded soil from the MC loading area to downstream receptors. Estimation of the soil

erosion to calculate transported MC mass is especially important for MC that strongly adsorb to soil (such as TNT).

4.1.2. Surface Water Runoff

The annual surface runoff rates were estimated as the product of the average annual precipitation, the loading area, and a runoff coefficient selected from the California Transportation Highway Design manual for undeveloped areas (State of California Department of Transportation, 2006) based on soil hydrologic group, slope, and land cover of the modeled MC loading area. The average annual precipitation data were obtained from the MCAS Miramar INRMP (2006) and from MCAS Miramar weather data (2007b). The average annual precipitation was 10 inches/year.

4.1.3. Partitioning into Surface Water

A multimedia partitioning model, CalTOX, was used to estimate the mass of MC transported from surface soil to surface water runoff. This model simulates the major transport mechanisms (erosion of adsorbed MC in soil and direct dissolution in runoff and leaching to the subsurface environment) that are likely to affect MC from their point of origin in surface soils to their release into surface water runoff. The rate at which MC will partition between these media is dependent upon the chemical properties of the MC and the physical/hydrological properties of the site. CalTOX requires the input of landscape properties of the MC loading area and chemical properties of the compounds of interest. Values of landscape and chemical properties were selected based on local reports, soil surveys, mapping information, and scientific literature. Estimates of soil erosion and surface water runoff were calculated as described in previous sections and entered into CalTOX.

The CalTOX output of interest for the surface water screening-level analysis was the MC mass transferred from surface soil to surface water, which CalTOX expresses as an average daily load in grams per day. This daily mass transfer rate was divided by the daily runoff volume to estimate the MC concentration in surface water runoff at the edge of the MC loading area, prior to down gradient mixing/dilution in streams. Although CalTOX requires input of daily loading rates, the MC mass loading is available only as annual values. For this reason, the model has an effective time step of one year, and the results are interpreted as annual average concentrations in surface water runoff.

For MC that have elevated soil partition coefficient values, such as TNT and RDX, the residual mass in surface soil after each time step (one year) was calculated as the product of the MC partition coefficient, the dissolved MC concentration in runoff, and the mass of the surface soil. This provided an estimate of the mass of MC that would be sorbed to the surface soil compartment assuming sorption equilibrium. The estimated residual MC mass was added to the "new" MC loading to surface soil for the following year.

4.2. Estimation of MC Concentration in West Sycamore Canyon and the Santee Recreational Lakes

The Current EOD Range MC loading area drains to West Sycamore Canyon, which drains southward within and outside of MCAS Miramar. Drainage from West Sycamore Canyon discharges to the Santee Recreational Lakes, which are a potential receptor exposure point. To estimate the order of magnitude reduction in MC concentrations due to mixing with runoff from nonloading areas, the estimated concentrations at the edge of the MC loading area boundary were multiplied by the ratio of the loading area to:

- the total drainage area of West Sycamore Canyon upstream of the point where the canyon crosses the East Miramar Range Complex / installation boundary and
- the total drainage area upstream of the point where West Sycamore Canyon enters the Santee Recreational Lakes.

GIS data were used to delineate the boundaries and the size of the total drainage areas of Santee Recreational Lakes. MCAS Miramar provided the GIS data of the delineated watersheds encompassing West Sycamore Canyon drainage area upstream of the point where West Sycamore Canyon crosses the installation boundary (MCAS FMD, 2007). The downgradient, "mixed" concentrations at West Sycamore Canyon (where it crosses the East Miramar Range Complex / installation boundary) and the Santee Recreational Lakes were estimated as:

$$C_{mixed} = (C_{runoff} \times A_{LA})/ A_{DA}$$

Where:

C_{mixed} = post-mixed concentrations in West Sycamore Canyon at installation boundary and the Santee Recreational Lakes (µg/L)
C_{runoff} = concentration in runoff from loading area (µg/L)
A_{LA} = area receiving MC loading (m^2)
A_{DA} = total drainage area of West Sycamore Canyon and Santee Recreational Lakes (m^2)

Inherent in this method is the assumption that all areas other than the MC loading area contribute runoff that has negligible MC concentrations. In addition, these analyses assume that all MC leaving the MC loading area are deposited in the surface water receptor locations of interest (West Sycamore Canyon and the Santee Recreational Lakes) without attenuation. These are highly conservative assumptions intended to produce an upper bound estimate.

Surface water transport analysis results for the Current EOD Range MC loading area are provided in **Section 7.1.2**.

5. Groundwater Analysis Method and Assumptions

The analysis of potential groundwater impacts for MCAS Miramar was conducted following the REVA process described in the *REVA Reference Manual* (HQMC, 2006). The initial step is a qualitative analysis of the groundwater conditions based on the CSM, described in detail in **Section 6**, including the identification of potential exposure pathways, migration routes, and potential receptors (human and ecological). If this qualitative analysis indicates there is potential for MC migration from loading areas to groundwater receptors, a screening-level MC transport analysis is performed to quantitatively estimate potential concentrations of indicator MC (RDX, HMX, TNT, and perchlorate) to migrate in groundwater to a receptor or beyond the installation boundaries.

5.1. Qualitative Analysis

The qualitative groundwater analysis looked at multiple data sources, which are detailed in **Section 6**. The following key information sources were used in the qualitative assessment:

- Military munitions expenditure data
- GIS data (MCAS FMD, HQMC Geofidelis, SanGIS)
- IRP site data
- USGS topographic maps and regional groundwater resources report
- USDA NRCS soil survey

The groundwater conditions, the potential for MC migration in the vadose zone and saturated zones, and the presence of potential groundwater receptors at off-range locations are described in more detail in **Section 6.5**.

5.2. Screening-Level Analysis

Following the qualitative assessment of the groundwater at MCAS Miramar, the REVA assessment team determined that groundwater screening-level analysis at MCAS Miramar would not be beneficial. These issues and supporting justification are listed below and discussed in greater detail in the CSM (**Section 6**).

- Groundwater resources are sparse at MCAS Miramar; where they are found, they are of low quality and not used for domestic, agricultural or industrial purposes.
- Groundwater contaminated with MC may leave the installation boundary in the alluvium, which lines the canyons. Significant flow in the alluvium is only expected immediately after rainstorms or after a wet season. There are no known receptors of this groundwater.
- There is little possibility of shallow groundwater in the alluvium infiltrating to deeper groundwater, which is located more than 200 feet below ground surface (bgs) and is separated from the alluvium by several low-conductivity zones.
- There are no known human or ecological receptors associated with any potential groundwater pathways at MCAS Miramar.
- Because of the low occurrence and quality of groundwater at MCAS Miramar, few groundwater studies have been published. Thus, there are significant data gaps that make modeling results suspect.

6. Conceptual Site Model

Predicting off-range migration of MC requires the evaluation of potential exposure pathways, such as surface water and groundwater flow characteristics, and possible receptors (human and ecological) that might be affected. To this end, the REVA assessment team developed a CSM to characterize the dynamics at MCAS Miramar that can affect MC migration. The primary components of this CSM include:

- delineation of the MC loading areas;
- identification of REVA indicator MC at individual MC loading areas;
- identification of additional environmental data needs to adequately characterize affected areas; and
- a synthesis of hydrogeologic, geologic, and geomorphologic data, which will assist the identification of potential MC migration pathways and receptors.

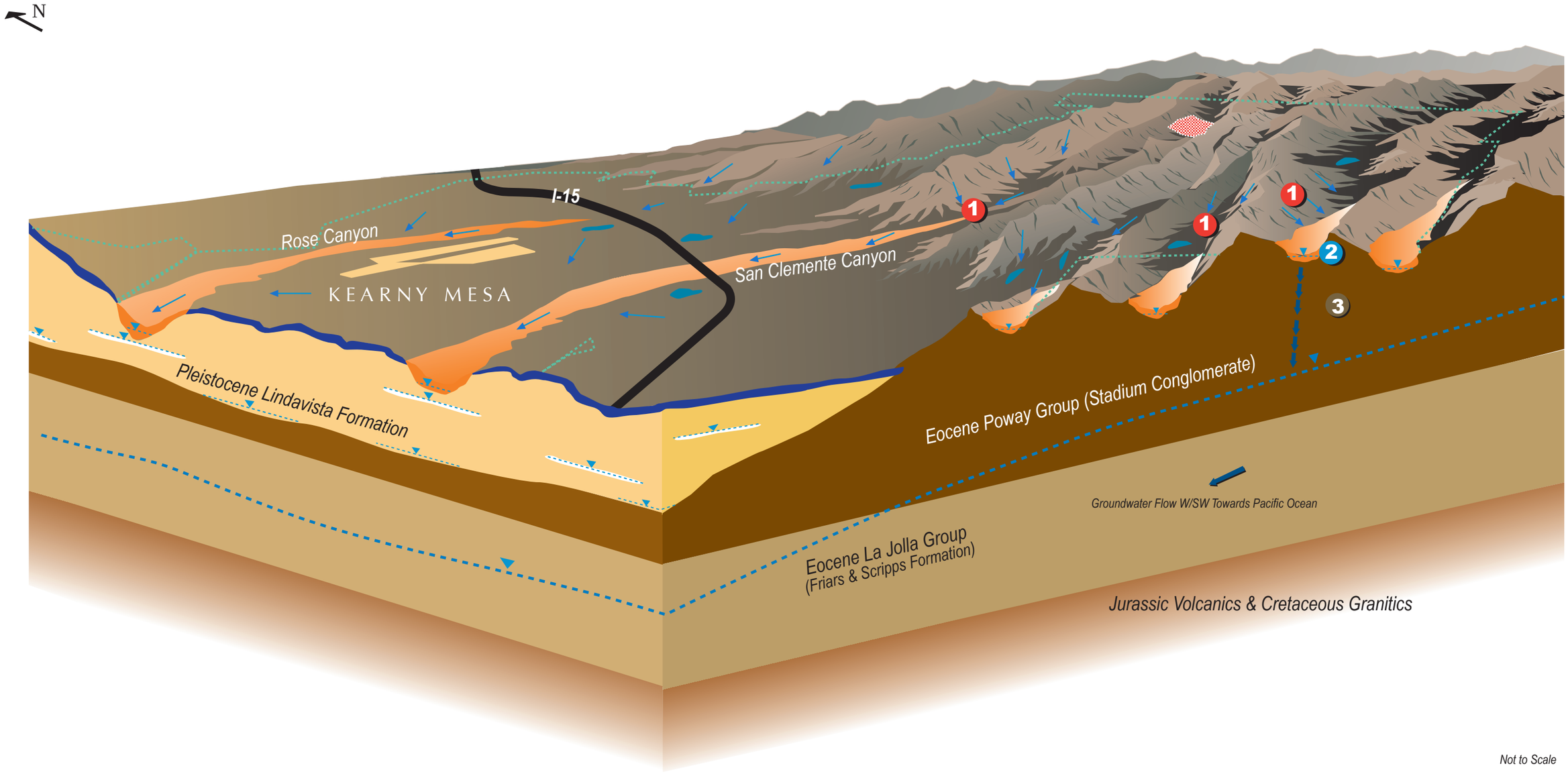
Information about the MC loading areas was combined with other environmental data in the screening-level analyses, as necessary, to predict MC migration via surface water and groundwater pathways.

The CSM was developed using information obtained during a site visit, as well as environmental documents and GIS data obtained from MCAS Miramar and publicly available references on regional and local geologic and hydrologic studies. Key information sources used in the development of the CSM included the following:

- Military munitions expenditure data
- EOD reports
- MCAS Miramar GIS data
- IRP site data
- Resource management plans
- Environmental site assessments
- USGS topographic maps and regional groundwater resources report
- USDA NRCS soil survey
- Marine Corps ASR and PRA

Where detailed information of site-specific characteristics and information did not exist, available regional information was used to estimate local characteristics.

A schematic diagram depicting the site conditions addressed in the CSM is presented in Figure 6.0-1. The geomorphology of the installation is shown relative to several generalized MC loading areas, the range boundary, and potential receptors in the alluvial plain. The following sections describe the site characteristics reviewed for the development of the CSM. The site-specific CSMs for the MC loading areas are provided in **Section 7**.



Legend

- Alluvium & Slopewash
- Beach Deposits
- Pleistocene Lindavista Formation
- Eocene Poway Group *(Stadium Conglomerate)*
- Eocene La Jolla Group *(Friars & Scripps Formation)*
- Jurassic Volcanic & Cretaceous Granitics
- Vernal Pools
- Water Table
- Groundwater Flow
- Surface Water Flow
- Installation Boundary
- MC Loading Area

NOTE:
This cross-section is based on a basic understanding of the distribution of the geologic units and features and only represents the general conceptual model for the surface and groundwater flow at MCAS Miramar. This figure is not to be considered a geologic cross-section with accurate subsurface contacts or outcrops.

Possible MC Migration Pathways:

1. *Overland runoff down canyons.*
   a. *Dissolution of MCs in the runoff water.*
   b. *Erosion of particulate or adsorbed MCs in soil.*
2. *Occasional infiltration to perched water in alluvium. Water is likely only found in the alluvium after heavy storms or several wet years. Groundwater flows down the canyons.*
3. *Possible limited infiltration to deep water table.*

Figure 6.0-1
Graphical Conceptual Site Model
Geology and Hydrogeology
MCAS Miramar
Miramar, CA

MALCOLM PIRNIE

6.1. Installation Profile

CSM Information Profiles – Installation Profile	
Information Needs	**Preliminary Information**
Installation location	San Diego, California
Date of establishment	The U.S. military has used the area in which the installation is located since 1917. The Marine Corps has been an occupant at various times; its current occupation of the installation began in October 1997 (Anteon, 2004).
Installation area and layout	MCAS Miramar, located approximately 13 miles north of downtown San Diego, encompasses over 23,000 acres; there are also over 400 acres of aviation easements (USACE, 2001a; TECOM, 2004). The air station is comprised of three general geographic and functional sectors: Main Station, South/West Miramar, and East Miramar (TECOM, 2004). Kearny Villa Road divides the installation into two sections: the South/West Miramar and Main Station area (with the airfield, administration, maintenance, supply, housing, and recreation functions) and East Miramar (training, warehousing, and magazine storage). East Miramar, comprising approximately 15,585 acres, is largely undeveloped since it lies beneath the flight path (Anteon, 2004).
Installation mission	The mission of MCAS Miramar is to provide facilities and services to support operations of the 3rd MAW, Marine Aircraft Group 46, Reserve Support Unit, and Combat Logistics Company 11 (MCAS Miramar, 2007a).
Installation history	The history of the installation involves many changes in names, ownership, missions, and activities. The Army established Camp Kearny in 1917 within the confines of the present-day installation boundaries, accommodating training and maneuvering activities during WWI (MCAS Miramar INRMP, 2006). Live-fire training included the use of HE and small arms ammunition (USACE, 2001a and 2001b). Although a permanent airfield was not established, parade grounds were used for military aircraft in 1918. Camp Kearny was closed in 1920, but the airfield was retained. The Navy placed a mooring mast at the facility and accommodated dirigibles during the early 1930s; another portion of the facility was used as an aircraft target bombing area (URS, 2005). In June 1940, eastern portions of the installation were designated as Camp Elliot, used by the Marine Corps for combat training (Mactec, 2006; URS, 2005). Live-fire training at Camp Elliot included the use of HE and small arms ammunition (USACE, 2001a and 2001b). Following improvements and expansions of the runways, the southern portion of the installation was commissioned as NAAS Camp Kearny in February 1943. The Marine Corps established Marine Corps Aviation Base Camp Kearny in March 1943 on the northern portion of the installation, which was redesignated

CSM Information Profiles – Installation Profile	
Information Needs	**Preliminary Information**
Installation history (cont.)	MCAD Miramar in September 1943. The NAAS was utilized primarily for multiengine aircraft training, while the MCAD was used for warehousing, processing, and quarters. The Navy took command of Camp Elliot in June 1944, utilizing it as a training and distribution center during the remainder of WWII. On May 1946, MCAD Miramar was deactivated and combined with NAAS Camp Kearny to become MCAS Miramar, only to be redesignated as NAAS Miramar in June 1947, when Marine air units moved to another installation. Its primary mission involved supporting operation of land patrol squadrons (URS, 2005). By April 1952, the installation was designated NAS Miramar when it became the Master Jet Station for the Pacific Fleet (MCAS Miramar INRMP, 2006). Following the Korean War, portions of Camp Elliot were used by various entities: the Air Force for research and testing; NAS Miramar for magazines; Navy Supply Center for warehousing; and Marine Corps Reserve Training Center for non-live-fire vehicle training and maneuvers. In 1960, the military no longer needed Camp Elliot and transferred separate portions to NAS Miramar and the Air Force. The Air Force transferred its portion to NASA in 1966. NASA declared it excess and transferred it to the General Services Administration in 1972, which then transferred it to NAS Miramar in 1977. Since then, no major change occurred until decisions by the Base Realignment and Closure Commission resulted in the Marine Corps assuming command of the installation under the designation of MCAS Miramar in October 1997 (URS, 2005).

6.2. Operational Range Profile

CSM Information Profiles – Operational Range Profile	
Information Needs	**Preliminary Information**
Range complex location	The East Miramar Range Complex is located on the eastern half of the installation, bounded on the west by Kearny Villa Road and U.S. Highway 163; its remaining boundaries follow the installation boundaries on the south, east, and north sides. The complex is approximately 14,311 acres. Approximately 1,274 acres of land located within East Miramar have been removed from the range complex due to incompatible uses.
Range names	The installation has administratively designated five training areas within East Miramar for various training purposes. Training Areas 1 through 4 are used primarily for maneuver and field exercises, while Training Area 5 primarily serves as a demonstration exercise area. CBRN training occurs within Training Area 5. In addition, there are eight operational SARs located within East Miramar. They include a rifle range and a pistol range utilized by the Marines (Range 100 and Range 101, respectively); three ranges primarily utilized by the Army National Guard (designated Ranges B, C, and D); and three ranges primarily utilized by the San Diego County Sheriff's Department (designated Ranges 5, 6, and 7). An EOD range is also located within the complex.
Military munitions usage	Initial military use of the area during WWI supported infantry training and maneuvering activities (MCAS Miramar INRMP, 2006). Many of the ranges were SARs, although several ranges were also present that accommodated the use of a variety of HE munitions (USACE, 2001a and 2001b). Up through WWII, military munitions use varied to accommodate a wider range of training activities. By the mid-1950s, types of munitions used at the installation were generally similar to those used today, as most ranges were SARs and maneuver areas; EOD activities were also conducted. Missile and weapon testing facilities were also present at East Miramar for significant portions of this time period, but no longer exist at the installation.
MC loading areas	The REVA assessment team delineated five MC loading areas within the East Miramar Range Complex: ■ Current EOD Range MC loading area ■ Range G MC loading area ■ Former EOD Range / DSWA MC loading area ■ Range C MC loading area ■ South MC loading area The loading areas were selected based upon a review of existing operational ranges and contributions from historical use areas located within the East Miramar Range Complex. Only the Current EOD Range

CSM Information Profiles – Operational Range Profile	
Information Needs	**Preliminary Information**
MC loading areas (cont.)	MC loading area contains an operational range that utilizes HE munitions. The remaining MC loading areas were identified based on historical use areas located within the East Miramar Range Complex.
Date of establishment	Historically, East Miramar has been used for training in various configurations, with different exercises and munitions. Training activities date to the beginning of WWI (see Installation Profile).
Range area	East Miramar consists of approximately 15,585 acres; of this area, a small portion (approximately 1,274 acres) is dedicated to uses not compatible with training activities (see below and Human Land Use and Exposure Profile). Consequently, the East Miramar Range Complex designated as operational range area is approximately 14,311 acres.
Other features	A substation operated by San Diego Gas & Electric is located on the northern end of East Miramar; a number of electric and gas lines also traverse the area. The San Diego Community College Fire Academy has a facility near Training Area 5. A weather station operated by the National Weather Service is located along the northern edge of East Miramar. The San Diego County Water Authority has a series of pipelines within a 78-acre easement that runs south and north through the western portion of East Miramar. The San Diego Unified School District has a small, undeveloped parcel of land within the southern portion of East Miramar. A 978.3-acre Research Natural Area is present between Training Areas 2 and 3. Designated in 1987, it is used to provide education and research opportunities for scientists. The Marine Corps does not consider this to be a permanent preserve; a small portion of it recently was redesignated for future development for a military family housing site (see Human Land Use and Exposure Profile; MCAS Miramar INRMP, 2006).
Range security	The main entry point into East Miramar is the Camp Elliot Gate off of Kearny Villa Road. The perimeters of the installation and range complex are fenced, with the exception of the eastern side. Occasional patrols, sometimes concurrent with maneuver exercises, are performed at the range complex. Trespassers have been documented in the eastern portions of East Miramar, specifically on the EOD range and within the Range 100 SDZ. Trespassers typically consist of bikers and joggers who enter the installation without permission.
Potential release mechanisms	The primary mechanism for potential release of MC at ranges at MCAS Miramar is erosion of soil where MC were deposited and subsequent downstream transport in surface runoff. Limited infiltration of MC may occur, but substantial releases to groundwater are not expected. Specific release/transport mechanisms are discussed in **Section 7**.

6.3. Physical Profile

CSM Information Profiles – Physical Profile	
Information Needs	**Preliminary Information**
Climate	MCAS Miramar has a semi-arid Mediterranean climate, with warm, dry summers and mild, wet winters. The average annual temperature is 63 degrees Fahrenheit (°F); the average daily high is 71°F, and the average daily low is 53°F (Anteon, 2004). Daily high temperatures in the summer can exceed 90ºF, while lows in the winter can drop to 40ºF. Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Most of the precipitation occurs in the winter months, between November and April (URS, 2005). Infrequent thunderstorms may occur during the year (SCS, 1984; Bechtel Environmental, 2005a), resulting in a large amount of precipitation in a short period of time. Because of the hot, arid climate, evaporation is high. One report (SCS, 1984) indicates the net pan evaporation south of Miramar Reservoir is 70.2 inches per year. Strong winds are not frequent. Prevailing winds average approximately 6 miles per hour and are from the west-northwest (SCS, 1984; MCAS Miramar, 2007b).
Elevation	Elevations at the installation range from 240 to 1,112 feet above mean sea level (amsl) (MCAS FMD, 2007). Main Station and South/West Miramar is set on Kearny Mesa. This broad, sloping land mass has an elevation of about 400–450 feet amsl. The mesa is cut by several canyon valleys, with valley bottoms as much as 100 feet below the mesa elevation. The two main canyons are Rose Canyon and San Clemente Canyon. The canyons slope gently toward the coast at a gradient of about 0.009 feet/foot in Rose Canyon and around 0.01 feet/foot in San Clemente Canyon (Bechtel Environmental, 2005b; SCS, 1984). The terrain in East Miramar is quite different, characterized by steep, rugged hills and valleys. Ground surface elevations near Interstate 15 are about 450 feet amsl, but the mountain peaks climb as high as 1,000 feet amsl in the northeastern portion of MCAS Miramar (Bechtel Environmental, 2005b; SCS, 1984).

CSM Information Profiles – Physical Profile	
Information Needs	**Preliminary Information**
Topography and geologic features	The developed portion of MCAS Miramar is located mostly on the eastern edge of Kearny Mesa (part of the Pacific Coastal Plain), a relatively flat, gently sloping marine terrace of the Lindavista Formation (NAVFACSW, 2001; MCAS Miramar INRMP, 2006). The mesa is cut by a few canyon valleys, including Rose Canyon and San Clemente Canyon (Izbicki, 1985; SCS, 1984). East Miramar is part of the Peninsular Range physiographic province and largely consists of steep, eroded, gravelly or cobbly terraces dissected with numerous divides and ephemeral drainages. The rugged hills are separated by deep alluvial valleys, which are normally dry, filling with water only occasionally after heavy rain (Izbicki, 1985; SCS, 1984). Notable canyons in East Miramar include the southwesterly draining San Clemente Canyon and the southerly draining West Sycamore Canyon (MCAS Miramar INRMP, 2006). Several other smaller drainages—including Murphy, Oak, and Spring Canyons—are located in the southern portion of East Miramar. Although this region is considered to be seismically active, there are no known faults within the boundaries of MCAS Miramar. Faulting, landslides, and liquefaction have the potential to occur in varying degrees throughout the installation (NAVFACSW, 2001). The Rose Canyon fault zone is located about 4 miles southwest of the installation and consists of several northwest-trending faults parallel to Interstate 5 (URS, 2005). The Torrey Pines fault is located near the northwest corner of MCAS Miramar and trends northeast to east (SCS, 1984).
Stratigraphy	The information on stratigraphy was obtained from a variety of sources, including SulTech (2005), Environmental Associates (1995), Evenson (1989), SCS Engineers (1984), Woodward-Clyde (1991), Foster Wheeler (2000), and URS (2005). The basement bedrock units at MCAS Miramar include Santiago Peak Volcanics of Jurassic age and granitic rocks of Cretaceous age. The Santiago Peak Volcanics are metamorphosed lava flows and breccias. The depth to these basement rocks is approximately 1,000 feet at MCAS Miramar. The bedrock units are overlain by two formations of the La Jolla Group of Eocene age: the Friars Formation and the Scripps Formation. The Friars Formation is found mostly in the southern regions of MCAS Miramar. It is approximately 300 feet thick and made up of olive-gray, well-consolidated, marine and lagoonal claystone and sandstone with localized cobble layers. The Scripps Formation is found in the western sections of the installation and is a yellow-brown, medium-grain sandstone with occasional cobble conglomerate interbeds.

CSM Information Profiles – Physical Profile	
Information Needs	**Preliminary Information**
Stratigraphy (cont.)	The La Jolla Group is overlain by the Stadium Conglomerate unit of the Poway Group of Eocene age. The thickness of this unit is estimated at 80–120 feet. The unit consists of a well-consolidated cobble conglomerate with dark yellow-brown, coarse-grained sandstone with interbeds of well-indurated, dark greenish-gray claystone. The Poway Group is exposed at the surface throughout most of East Miramar. In West Miramar, Kearny Mesa is capped with the Lindavista (or Linda Vista) Formation of Pleistocene age. This is an interbedded sandstone, siltstone, and cobble conglomerate with a reddish-brown color caused by the cementation with iron oxides. The formation is about 100 feet thick and resistant to erosion. Unconsolidated to poorly consolidated sand, silt, and gravel alluvium and slope wash cover the bottoms of the canyons to varying thicknesses. The tops of the mesas are covered with beach deposits of similar composition.
Aquifers	The potential water-bearing units in the MCAS Miramar region include the alluvium and beach deposits, the Lindavista Formation, and parts of the Poway and La Jolla groups. The alluvium and beach deposits are unconsolidated or poorly consolidated mixtures of gravel, sand, silt, and varying amounts of clay. The beach deposits are thin units located on top of the mesas and are not likely to be saturated. The alluvium, which lies along the canyon bottoms, may transmit groundwater under unconfined conditions when saturated. The lower portions of the alluvium probably are only saturated after winter rains or a series of wet years. Runoff in the canyons can rapidly recharge the fill materials in the valley. Annual recharge may cause rapid downstream migration of any contaminants in the alluvium (SCS, 1984). The Lindavista Formation potentially can transmit groundwater, but its permeability is low because of consolidation and cementation. Like the beach deposits, it is located mainly on the mesa tops, so it has little potential for saturation except seasonally or after several wet years. Groundwater in this formation would generally be unconfined (SCS, 1984). The well-cemented Stadium Conglomerate, which underlies the Lindavista Formation, is relatively impermeable in West Miramar and can restrict infiltration, resulting in vernal pools when surface water runoff collects in topographic depressions (OHM, 1997). When water is able to infiltrate the Lindavista Formation, perched conditions may form when it reaches the more impermeable conglomerate layer.

CSM Information Profiles – Physical Profile	
Information Needs	**Preliminary Information**
Aquifers (cont.)	In East Miramar, the Stadium Conglomerate may hold groundwater in its coarser-grained conglomerate units. Where this formation is exposed on the surface or overlain by only a thin layer, it has a high recharge potential, and sand lenses may store and yield significant water volumes (SCS, 1984). The water table is generally considered to occur within this layer in East Miramar (Woodward-Clyde, 1991). The La Jolla Group is expected to have more limited water-bearing capacity, but very few data on the hydrologic characteristics of this unit are available (SCS, 1984). The water table probably occurs in the Friars Formation of the La Jolla Group (Woodward-Clyde, 1991).
Soil and vadose zone characteristics	More than three-quarters of the area of MCAS Miramar is covered by soils of the Redding Group, composed of shallow, well-drained, cobbly or gravelly loams. Soils of this group normally are underlain by hardpan, resulting in slow infiltration and low permeability (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989). The far west section of MCAS Miramar is covered by small areas of different soil types, including the Chesterton, Carlsbad, and Altamount groups. The Chesterton Group consists of fine sandy loam or loamy sand with 10%–30% iron content; the Carlsbad Group is a gravelly loamy sand; and the Altamount Group is clay. Unlike the Redding Group, these soil types are appropriate for growing irrigated crops (MCAS Miramar INRMP, 2006). The canyon bottoms in both East and South/West Miramar are covered with alluvium or riverwash sediments. These stream deposits consist of silt, sand, and cobble. Their thicknesses vary. Alluvial thickness in Soledad Canyon (northwest of MCAS Miramar) has been measured at 100 feet. Thicknesses within the boundaries of MCAS Miramar are not expected to be as high (Evenson, 1989). This alluvium is very permeable and allows for rapid infiltration (SCS, 1984). Because of the high erodibility of both the Redding Group and the alluvial sediments, the underlying rock is often exposed on the sides of the canyons, where the slopes are steepest (MCAS Miramar INRMP, 2006).
Erosion potential	According to the NRCS, most of the soil types at MCAS Miramar are severely erodible. This is because the soils are located on a steep topographic slope, have shallow depth to rock, have shallow depth to a hardpan, or have excessive silt in surface texture composition. Loss of plant cover in some parts of MCAS Miramar has resulted in severe erosion, causing a loss of topsoil and potential streambed siltation (MCAS Miramar INRMP, 2006). However, there are smaller areas of clay-texture

CSM Information Profiles – Physical Profile	
Information Needs	**Preliminary Information**
Erosion potential (cont.)	type soils that have a low erodibility. In addition, the numerous soil cobbles found in many areas reduce erodibility by self-sealing gullies or channels (MCAS Miramar INRMP, 2006). Rainfall can impact soil erosion, especially at range areas in East Miramar, where there is a steeper topographic slope, sparse vegetation, and general land disturbance due to military activity. Stream bank erosion problems along San Clemente and Rose canyons have been identified. These stream banks are a height of typically 10–12 feet, though may be as tall as 200 feet (Woodward-Clyde, 1986).

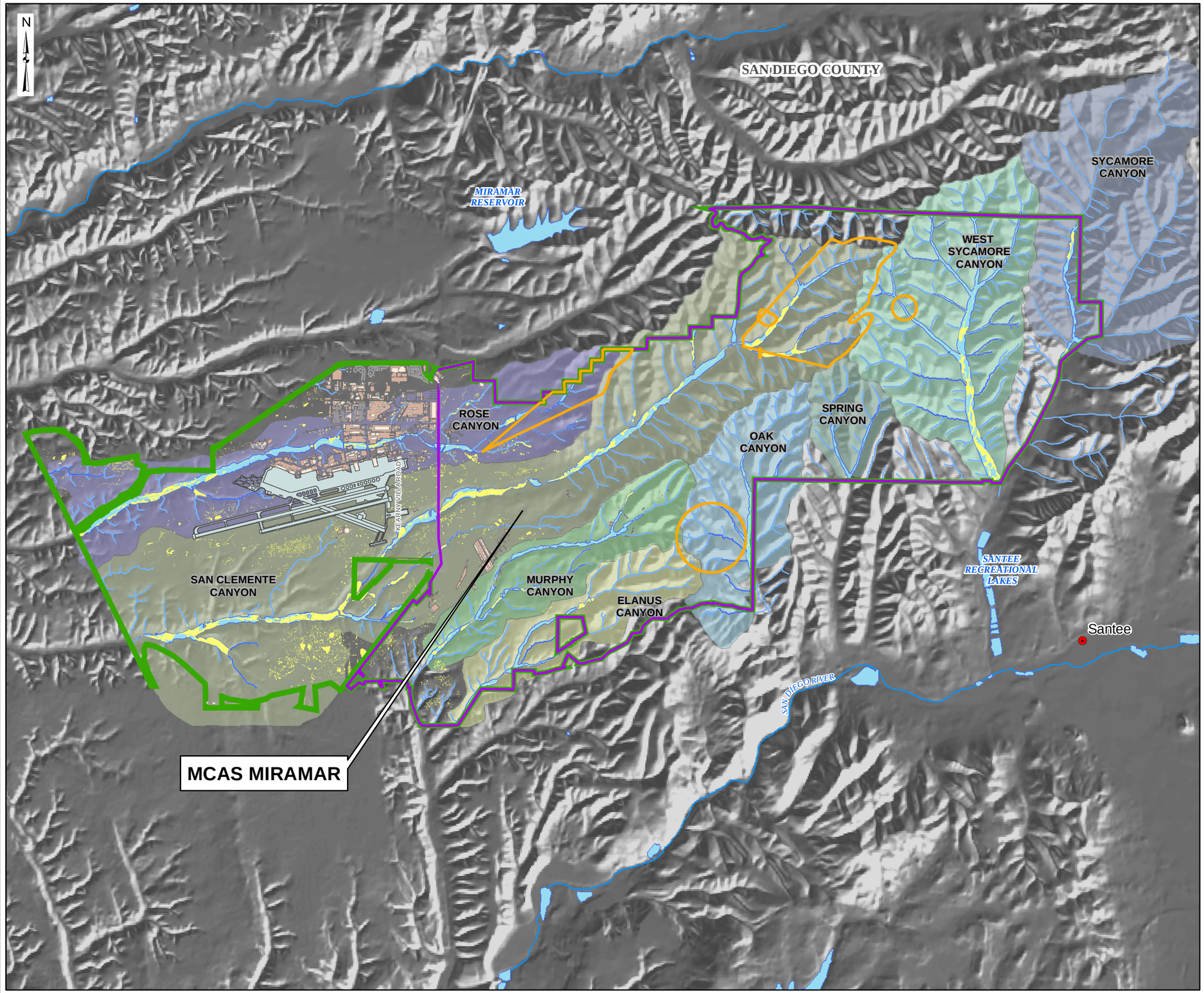
6.4. Surface Water Profile

CSM Information Profiles – Surface Water Profile	
Information Needs	**Preliminary Information**
Surface water drainage	Drainage in canyons and tributaries at MCAS Miramar is ephemeral or intermittent in nature. There are no natural perennial surface water bodies within the base; however, during rainy periods, ephemeral ponding may occur in hummocky areas underlain by a shallow hardpan that restricts infiltration, creating vernal pools (Bechtel Environmental, 2002). Vernal pools are ecological habitat areas that support rare, threatened, or endangered plant and animal species. The pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. However, vernal pools that are located adjacent to streams can possibly exhibit hydrological connectivity with streams. Water remains in the pools for several weeks to months, depending on the size of the pool, rainfall, and temperature (Bechtel Environmental, 2007). In addition, man-made water bodies exist at MCAS Miramar, including a golf course pond and several ephemeral ponds that are remnants from pre-military homesteading. Rose and San Clemente canyons drain a large portion of the base. These canyons are as large as 100 feet deep and 300 feet wide (Bechtel Environmental, 2007). In accordance with a 100-year return period floodplain, areas of potential flooding are narrow because of canyon topography, but the potential for high water flooding at the narrow canyons does exist (MCAS Miramar INRMP, 2006).
Hydrological units and sub-watershed areas	The installation is located within the Penasquitos (Unit 6) and San Diego (Unit 7) hydrologic units, both within the San Diego hydrological region. According to GIS data obtained from MCAS Miramar personnel, there are eight subwatersheds located within MCAS Miramar (MCAS FMD, 2007). The subwatershed delineations obtained from the installation include drainage areas of canyons upstream of the installation boundary, but do not include drainage areas of canyons downstream of the installation boundary. Of these eight subwatersheds, only three are located completely within the installation boundary. The other five subwatersheds extend beyond the installation boundary and consist of ephemeral stream systems that drain to the south or southwest and ultimately discharge into the Pacific Ocean. The watersheds within MCAS Miramar range in size from 582 to 9,680 acres (Figure 6.4-1).

CSM Information Profiles – Surface Water Profile	
Information Needs	**Preliminary Information**
Hydrological units and sub-watershed areas (cont.)	MC loading areas that have been identified are located within five of the subwatershed areas within MCAS Miramar: San Clemente Canyon, Rose Canyon, West Sycamore Canyon, Oak Canyon, and Elanus Canyon. Moreover, existing training areas that are used for infantry maneuver and bivouac are located in six of the subwatershed areas: San Clemente Canyon, Sycamore Canyon, Rose Canyon, West Sycamore Canyon, Murphy Canyon, and Spring Canyon. Locations of watersheds, streams, and MC loading areas are shown in Figure 6.4-1.
San Clemente Canyon sub-watershed area	The San Clemente Canyon subwatershed is the largest drainage area within MCAS Miramar. This 9,680-acre subbasin contains the longest stream network within MCAS Miramar. San Clemente Canyon has a dendritic drainage pattern and drains southwesterly from the north-central section of East Miramar through all of South/West Miramar and Main Station. The canyon comes to a confluence with Rose Canyon approximately 3 miles west of the installation boundary. Rose Canyon continues to flow from the confluence and discharges into Mission Bay. Wetlands exist along the main drainage of San Clemente Canyon and some of its tributaries. Wetlands also exist in areas set away from streams throughout the western portion of the watershed. Vernal pool habitats are found in the western portion of the watershed.
Sycamore Canyon sub-watershed area	The 3,932-acre Sycamore Canyon subwatershed is located on the northeastern corner of MCAS Miramar. A large portion of this subwatershed lies outside of the MCAS Miramar installation boundary. Sycamore Canyon originates outside of the installation, northeast from the installation boundary, and drains south within MCAS Miramar. After leaving the installation boundary, the drainage flows past the Padre Dam Municipal Water District water recycling facility and the Santee Recreational Lakes. It drains into the San Diego River approximately 4 miles south of the installation boundary and then westward to the Pacific Ocean. Wetlands exist along a short segment of the main drainage of Sycamore Canyon.
Rose Canyon subwatershed area	The Rose Canyon subwatershed is located in the northern section of MCAS Miramar. Most of the watershed area is located within MCAS Miramar, but some northeastern and northwestern portions lie outside of the installation boundary. This 3,863-acre subwatershed consists of the second largest stream network within MCAS Miramar. Rose Canyon has a dendritic drainage pattern and drains southwesterly across the entire length of West Miramar. It originates about a mile east of Interstate 15 in the northwest corner of East Miramar and flows southwest through South/West Miramar and Main Station then flows off the installation boundary to discharge into Mission Bay. Wetlands are located throughout the main drainage of Rose Canyon and its tributaries. Vernal pools are scattered throughout the subwatershed, but are more common in the northwestern and southern parts of the watershed.

CSM Information Profiles – Surface Water Profile	
Information Needs	**Preliminary Information**
West Sycamore Canyon sub-watershed area	The West Sycamore Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 3,323-acre subwatershed is located almost entirely within the MCAS Miramar boundary. The predominant feature is West Sycamore Canyon, which drains south within the eastern section of East Miramar. It continues draining south off the installation and joins with Sycamore Canyon, which ultimately flows into San Diego River and later the Pacific Ocean. Wetlands exist along the main drainage of West Sycamore Canyon.
Oak Canyon subwatershed area	The Oak Canyon subwatershed is located on the southeastern corner of MCAS Miramar. This 1,780-acre subwatershed is located predominantly within the boundaries of the installation. Oak Canyon originates on MCAS Miramar and drains southward within the installation. Oak Canyon continues draining south off the installation and discharges into the San Diego River approximately 1.5 miles southeast of the installation boundary. Wetlands exist along the entire main drainage of Oak Canyon within MCAS Miramar.
Murphy Canyon sub-watershed area	The Murphy Canyon subwatershed is located on the southern portion of MCAS Miramar, north of the Elanus Canyon subwatershed. This 1,546-acre subwatershed is located entirely within the installation boundary. Murphy Canyon originates on MCAS Miramar and drains southwesterly within the installation. It drains south off the installation and discharges into the San Diego River south of the installation boundary. Wetlands exist throughout the subwatershed, but are predominantly located along the main drainage of Murphy Canyon and its tributaries. Vernal pools also exist along the main drainage of Murphy Canyon and some of its tributaries.
Elanus Canyon sub-watershed area	The Elanus Canyon subwatershed is located on the southern portion of MCAS Miramar, bordering the installation boundary. This 1,309-acre subwatershed is located almost entirely within the installation. A small portion of the southeastern part lies outside of the installation. Elanus Canyon originates on MCAS Miramar and drains southwesterly within the installation. Down gradient of the installation, it joins Murphy Canyon, which discharges into the San Diego River. Wetlands exist within the Elanus Canyon subwatershed, predominantly along the main drainage of Elanus Canyon.
Spring Canyon sub-watershed area	The Spring Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 582-acre subwatershed is the smallest drainage area within MCAS Miramar and is located entirely within the installation. Spring Canyon is the shortest ephemeral stream system within MCAS Miramar. Spring Canyon originates on MCAS Miramar and drains southward within the installation. It discharges into San Diego River approximately 2 miles south of the installation boundary.
Designated beneficial uses	Most surface waters at MCAS Miramar (including major canyons) have been designated by the California Regional Water Quality Control Board's

CSM Information Profiles – Surface Water Profile	
Information Needs	**Preliminary Information**
Designated beneficial uses (cont.)	(CRWQCB's) San Diego Region Basin Plan (1994) to have existing and potential beneficial uses for agricultural supply, industrial service supply, contact and non-contact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare, threatened, or endangered species. In accordance with the Basin Plan, all waters at MCAS Miramar have been exempted from municipal use. Drinking water at MCAS Miramar is supplied by the City of San Diego. The City of San Diego gets its water from the Colorado River, the State Water Projects California Aqueduct, and other distant sources (MCAS Miramar INRMP, 2006).
Supported habitats/ ecosystems	A variety of wildlife species, including amphibians, reptiles, mammals, and birds, inhabit MCAS Miramar (MCAS Miramar INRMP, 2006). A wide range of vegetation types is also found within MCAS Miramar. The intermittently flowing canyons within MCAS Miramar support the majority of the wildlife and vegetation species. Federally listed threatened and endangered species are described in the Natural Resources Profile. Seasonal wetlands exist within MCAS Miramar. These include vernal marsh wetlands, freshwater marshes, and vernal pools. Vernal marshes typically occur in main drainages, including Rose Canyon, San Clemente Canyon, Murphy Canyon, Elanus Canyon, West Sycamore Canyon, and Sycamore Canyon. There are approximately 90 acres of this type of wetland on base. Approximately 30 acres of freshwater marsh wetland exist on base (MCAS Miramar INRMP, 2006). Vernal pools exist throughout MCAS Miramar, but are found predominantly in western and central Miramar.
Gaining or losing streams	Surface water flows through canyons and other main drainages resulting from seasonal and long-term direct precipitation is recharged to the underlying alluvium that is relatively coarse grained and permeable; this recharge may contribute to shallow, ephemeral groundwater. Some soil types along San Clemente Canyon are estimated to have a permeability value that ranges from 2 to 6.3 inches/hour at a depth of 3 feet (SCS, 1984).
Surface water collection points	There are no actively used potable water storage reservoirs within MCAS Miramar. However, according to the Initial Assessment Study report, there are four inactive reservoirs that currently are not used for potable water supply (SCS, 1984). The Miramar Reservoir, located approximately 2 miles north of MCAS Miramar, is a major water storage facility; it contains imported water from the Colorado River. It is one of the primary water supply sources for the base. However, the Miramar Reservoir does not receive drainage from the installation.



REVA
FIGURE 6.4-1
SURFACE WATER FEATURES

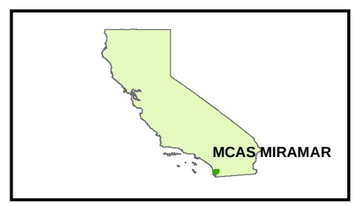
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- AIRFIELD SURFACE
- BUILDINGS
- CITY
- WETLANDS
- SURFACE WATER COURSE AREA
- SURFACE WATER (INTERMITTENT)

SUB-WATERSHEDS

- ELANUS CANYON
- MURPHY CANYON
- OAK CANYON
- ROSE CANYON
- SAN CELEMENTE CANYON
- SPRING CANYON
- SYCAMORE CANYON
- SYCAMORE WEST CANYON



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SOURCE: MCAS EMD GIS 2007
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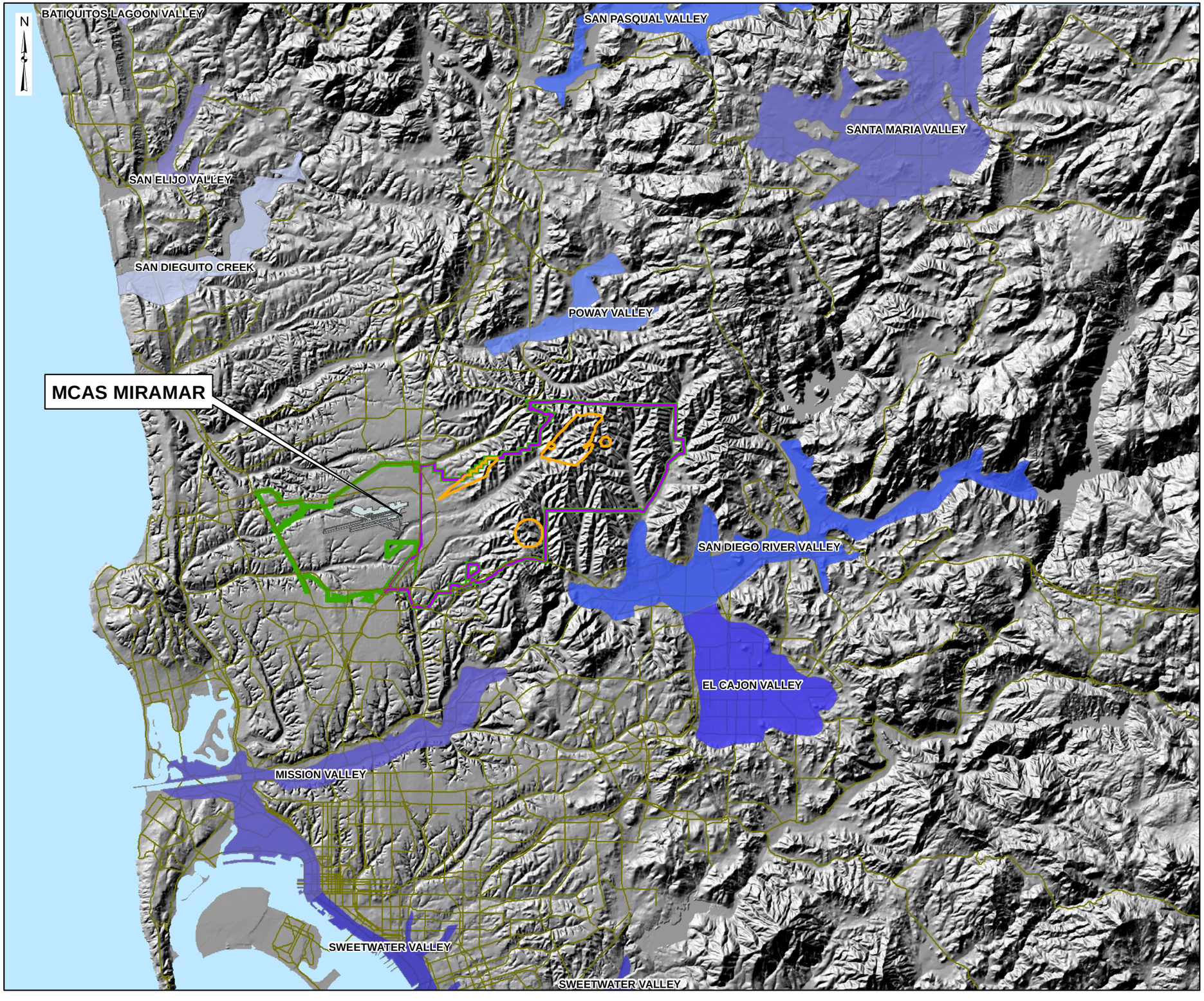
6.5. Groundwater Profile

CSM Information Profiles – Groundwater Profile	
Information Needs	**Preliminary Information**
Groundwater basin(s)	The California Department of Water Resources (2003) does not designate a groundwater basin covering MCAS Miramar. A review of literature sources for groundwater in the region indicates that few studies exist for the region surrounding MCAS Miramar and that very limited groundwater data exist for the installation. The groundwater basins in the San Diego region that have been delineated are indicated in Figure 6.5-1.
Designated beneficial uses	The San Diego Region Basin Plan identifies the groundwater in the Mission San Diego hydrologic subarea, which covers the south-central section of East Miramar, as beneficial for agriculture, industrial process, and industrial service. The groundwater is also designated with a potential beneficial use for municipal and domestic supply. The Santee subarea, which covers the far east portion of MCAS Miramar, is designated as having existing beneficial uses for municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply (CRWQRB, 1994). There are no existing beneficial uses for groundwater in the Miramar hydrographic subarea, which covers West Miramar and parts of the north-central section of East Miramar; however, this area is listed as having a potential industrial service supply use (CRWQRB, 1994). The shallow groundwater is known to be of low quality and is unsuitable for domestic use (Woodward-Clyde, 1991; Environmental Associates, 1995; SCS, 1984).
Groundwater supply wells	Twenty-four wells have been drilled in the vicinity of MCAS Miramar, but none of them are currently active. Usage included irrigation, stock watering, industrial usage, and domestic supply for homes and ranches (SCS, 1984). According to installation personnel, none of the water used at MCAS Miramar comes from wells on the installation. Potable water is provided by the City of San Diego (SCS, 1984).
Recharge source(s)	Historically, the primary sources of recharge near MCAS Miramar were the streamflow in the San Diego River and San Vicente Creek. With the construction of the El Capitan Dam in 1935 and the San Vicente Dam in 1943, these recharge sources were removed. Today, direct precipitation and municipal wastewater treatment discharges are more important recharge sources (Izbicki, 1985). A study in the Escondido area approximately 17 miles north of MCAS Miramar indicates that only 7% of precipitation recharges groundwater (Heaton and Giesick, 2002). Recharge can also occur as groundwater flow from surrounding formations (Evenson, 1989).

CSM Information Profiles – Groundwater Profile	
Information Needs	**Preliminary Information**
Porous or fracture flow	Some precipitation and the associated runoff may infiltrate to the alluvial aquifers along the bottoms of the canyons. It is unlikely that the alluvium remains saturated long after the precipitation event because of the high potential for evaporation caused by high temperatures and low humidity. The possibility that some of this water may be able to infiltrate to deeper geologic units cannot be eliminated based on the available information, but the infiltrating volume would be small due to some areas of lower permeability separating the alluvium from the deeper groundwater (Izbicki, 1985). Groundwater in the alluvium and in porous geologic units is expected to move west or southwest across MCAS Miramar toward the ocean (Izbicki, 1985). The Rose Canyon fault zone near Interstate 5 is a groundwater barrier, but few data exist to analyze the effect of this barrier on flow or water quality (SCS, 1984). None of the geologic reports indicate significant fracture flow in the area of MCAS Miramar, and most make no mention of it.
Depth to groundwater	Groundwater when present in the alluvial units found in the canyon bottoms is generally close to the surface. It has been measured at depths between 2 and 10.5 feet. However, this groundwater exists only intermittently after heavy rainfall or after a series of wet years (Bechtel Environmental, 2005b; SCS, 1984; Evenson, 1989; URS, 2005). Most investigations of groundwater in the older units indicate a depth to groundwater of approximately 200 feet. This groundwater collects at the base of the Friars Formation just above the bedrock (URS, 2005; Bechtel Environmental, 2005a; Foster Wheeler, 2000). Perched groundwater is often found at shallower depths, up to 10 to 30 feet bgs. This normally occurs in the Lindavista or Stadium Conglomerate formations where an unconsolidated layer is directly underlain by a well-cemented conglomerate layer (SulTech, 2005; Foster Wheeler, 2000; URS, 2005).
Gradient and flow velocity	Groundwater flow directions in shallow groundwater are expected to be to the west and southwest, parallel to the canyons. In the northeast portion of MCAS Miramar, groundwater flow is to the northwest. Deeper groundwater flow directions have not been determined, but one report (SCS, 1984) indicates that the gradient should roughly conform to the westerly dip of the bedding in the Poway and La Jolla formations (URS, 2005; Foster Wheeler, 2000; SulTech, 2005; Bechtel Environmental, 2005a). Average groundwater flow velocities are estimated between 0.006 and 0.27 feet/day (SCS, 1984; Foster Wheeler, 2000; Bechtel Environmental,

CSM Information Profiles – Groundwater Profile	
Information Needs	**Preliminary Information**
Gradient and flow velocity (cont.)	2002). The hydraulic gradients in the alluvium are probably similar to the ground surface gradients, which are 0.009 feet/foot in Rose Canyon and 0.01 feet/foot in San Clemente Canyon. In the Poway and La Jolla groups, the bedding dips to the west at 3 to 4 degrees, corresponding to a hydraulic gradient of 0.05 feet/foot (SCS, 1984).
Known water quality characteristics	The quality of groundwater in the vicinity of MCAS Miramar is described as "poor" or "marginal" by most sources. It has high total dissolved solids (TDS) (1,000 milligrams per liter or more) and has high levels of calcium sulfite and sodium chloride. There are no known active water supply wells in the vicinity of MCAS Miramar, and the groundwater would require treatment before domestic use (Woodward-Clyde, 1991; Environmental Associates, 1995; SCS, 1984). Available groundwater pH measurements in various wells (e.g., monitoring, exploratory, etc.) near MCAS Miramar ranged from 6.5 to 7.6 (Woodward-Clyde, 1991; Evenson, 1989; CDWR, 1967).
Discharge location(s)	There are no known groundwater discharge locations near MCAS Miramar. It is not believed that groundwater significantly contributes to surface water on the installation; all surface water, including vernal pools and wetlands, is believed to originate primarily as runoff from precipitation events.



REVA
FIGURE 6.5-1
GROUNDWATER FEATURES

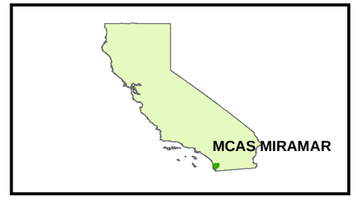
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- AIRFIELD SURFACE

GROUNDWATER BASINS

- BATIQUITOS LAGOON VALLEY
- EL CAJON VALLEY
- MISSION VALLEY
- POWAY VALLEY
- SAN DIEGO RIVER VALLEY
- SAN DIEGUITO CREEK
- SAN ELIJO VALLEY
- SAN PASQUAL VALLEY
- SANTA MARIA VALLEY
- SWEETWATER VALLEY



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DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
CDWR, 2003
USGS, 2007

MALCOLM PIRNIE

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6.6. Human Land Use and Exposure Profile

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Preliminary Information**
Land use	East Miramar is used primarily for small arms, infantry, and maneuver training exercises. Specific activities include navigation training, troop maneuvers, bivouacking / overnight camping, aircraft/personnel support exercises, tactical vehicle driver training, and weapons instruction training (MCAS Miramar INRMP, 2006). Much of East Miramar is undeveloped because it serves as the approach corridor for military aircraft. Portions of the undeveloped areas are also designated as SDZs for operational ranges and ESQD arcs for magazine storage and the EOD range. Warehouses and a vehicle maintenance and storage area are also present within East Miramar. Much of East Miramar has been surveyed for cultural resources, with the exception of the area encompassed by the Range 100 and 101 SDZs; a number of prehistoric and historic resources have been identified. Sycamore Canyon, running north-south on the eastern edge of the installation, is utilized by the public for recreation; the installation has a tentative plan to formally transfer a portion of the canyon to the local government. Because no fencing exists along the eastern edge of the installation, unauthorized recreational use farther west into East Miramar occasionally occurs. An area in the south-central portion of East Miramar is the proposed future location of a military family housing development (Military Family Housing Site 8). A natural gas electric generating plant is also proposed for construction in East Miramar near the southern end of West Sycamore Canyon. The land immediately surrounding MCAS Miramar represents a mix of residential, commercial, industrial, and recreational uses. A major transportation corridor, Interstate 15, runs north-south and cuts through the center of the installation. The north and south sides of East Miramar are bordered by residential homes and undeveloped areas; the eastern side is bordered by artificial lakes serving as a public recreation area (Santee Recreational Lakes) and the Padre Dam Municipal Water District water recycling facility.
Current human receptors	Potential human receptors may include installation personnel and contractors, primarily located in non-operational areas to the west of Kearny Villa Road, and users of the Santee Recreational Lakes recreational area southeast of the installation. The CRWQCB San Diego Region Basin Plan (1994) has designated major canyons within MCAS Miramar to have existing beneficial uses for contact and non-contact water recreation. In addition, there is a fishpond along the lower tributary of Rose Canyon in West Miramar that is used for fishing by station personnel. The water recycling facility is not considered to be impacted by MC migration because it is located north of the West Sycamore Canyon subwatershed discharge

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Preliminary Information**
Current human receptors (cont.)	point and there are no other MC loading areas defined within the Sycamore Canyon subwatershed, which discharges near the facility. Potential exposure of any MC from operational ranges to these receptors is anticipated to be limited. There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within a 1-mile radius of the installation. Current HE use is limited to the Current EOD range and active small arms use is limited to the eight SARs at East Miramar; no munitions use is associated with maneuver or other exercises that occur throughout East Miramar. MC potentially deposited on historical use HE ranges are expected to have degraded over the approximately 60 years since the ranges were last used. Although soils tend to be erodible, precipitation is limited, thereby limiting opportunities for transport of MC.
Land use restrictions	Much of the installation's perimeter is fenced, with the exception of its easternmost reaches. Use of certain maneuver and field training areas is limited by season. Vehicles are restricted to paved and unpaved roads (no off-road travel). Construction of fighting holes is limited to previously disturbed areas. While use of explosive devices is approved within the EOD range for disposal and training purposes, the use of heat-producing devices in the training areas is severely limited due to fire dangers (MCAS Miramar, 2008). The Record of Decision selecting Site 8 for military family housing effectively closed that area of the East Miramar Range Complex, and munitions response planning is underway for that area. The ESQDs surrounding ordnance magazines, a San Diego Gas & Electric substation, and warehousing represent other areas within East Miramar that restrict or are closed to training activities. Other land use constraints in East Miramar include aircraft accident potential zones, noise zones, and areas of electromagnetic interference (MCAS Miramar INRMP, 2006). Some actions, including construction and maintenance activities, may require certain special regulatory review. The ephemeral drainages at Miramar meet the federal classification of "waters of the United States" and, therefore, are subject to U.S. Army Corps of Engineers (USACE) regulation. The CRWQCB may also have regulatory jurisdiction when wetlands may be involved. The presence of threatened and endangered species and their critical habitat (see below) may create a need for consultation with the U.S. Fish and Wildlife Service (USFWS). Presence of cultural resources at East Miramar may also necessitate consultation with the State Historic Preservation Officer.

6.7. Natural Resources Profile

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Preliminary Information**
Ecosystems	MCAS Miramar is located within an arid, Mediterranean-type ecosystem. The land varies from marine terrace on the coastal plain (West Miramar) to coastal foothills and canyons with moderate to steep slopes (East Miramar).
Vegetation	Three major plant communities have been identified at MCAS Miramar: ■ Chaparral (9,642 acres) – community subtypes, including chamise, southern mixed chaparral, Nuttal's scrub oak (*Quercus dumosa*), and ceanothus (*Ceanothus tomentosus* and *C. verrucosus*) with mixed and disturbed versions of each ■ Coastal sage scrub (4,614 acres) – drought-hardy deciduous shrubs typically associated with southern facing slopes and ridges ■ Grasslands (2,049 acres) – native needlegrasses and/or nonnative species dominant ground cover associated with disturbed or undisturbed areas
Fauna	MCAS Miramar supports 7 species of amphibians, 30 species of reptiles, and 39 species of mammals that are adapted for chaparral / coastal sage scrub habitat. Additionally, over 200 species of birds have been observed on the station. Habitat linkages and wildlife corridors are important natural areas that provide essential connectivity for fauna to habitat patches among developed areas. The entire eastern portion of MCAS Miramar functions as an important habitat linkage with adjacent off-installation open spaces. The construction of State Route 52 south of MCAS Miramar fragmented the open habitat linkage with the Mission Trails Regional Park located to the south. Two large bridges of State Route 52, spanning Oak and Spring canyons, now provide connectivity between MCAS Miramar and Mission Trails Regional Park. Wildlife corridors generally follow major drainages and open ridgelines. Primary east-west corridors on MCAS Miramar are Rose and San Clemente canyons. North-south wildlife movement in East Miramar oriented with Oak, Spring, West Sycamore, and Sycamore canyons is relatively unconstrained, where the area functions more like a large habitat linkage than narrower corridors (MCAS Miramar INRMP, 2006).
Special status species	Federally listed species found on MCAS Miramar include the following (MCAS Miramar INRMP, 2006): ■ Coastal California gnatcatcher (*Polioptila californica*) – threatened; obligate resident of coastal sage scrub communities ■ Least Bell's vireo (*Vireo bellii pusillus*) – endangered; rare sightings

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Preliminary Information**
Special status species (cont.)	in the southeast portion of installation ■ Del Mar manzanita (*Arctostaphylos glandulosa* ssp. *crassifolia*) – endangered; occurs in chaparral communities with eroding sandstone substrate ■ Willowy monardella (*Monardella linoides* ssp. *viminea*; *Monardella viminea*) – endangered; occurs in riverwash cobbly loams of ephemeral drainages and floodplains ■ Golden eagle (*Aquila chrysaetos*) – fully protected; requires large, undeveloped open areas for foraging and nesting ■ Six species are associated with vernal pool habitat: o San Diego mesa mint (*Pogogyne abramsii*) – endangered; occurs in vernal pool habitat in chaparral, coastal sage scrub and grassland habitats o San Diego fairy shrimp (*Branchinecta sandiegonensis*) – endangered; spread easily into puddle depressions and vehicle tracks o San Diego button-celery (*Eryngium aristulatum* var. *parishii*) – endangered; prefers gravelly loam soils o California Orcutt grass (*Orcuttia californica*) – endangered; usually in wetter portions as pools are drying o Riverside fairy shrimp (*Streptocephalus woottoni*) – endangered; found in deep vernal pool and wetland habitat o Spreading navarretia (*Navarretia fossalis*) – threatened; occurs in shallow pool habitat Endangered vernal pools and other vernal pool habitat (157.3 acres) at MCAS Miramar are the largest and most contiguous in Southern California. These habitats represent the most important and least disturbed examples of vernal pool habitat in the region and support various endangered and sensitive species that are dependent on these environs. The USFWS considered but determined not to designate or propose to designate critical habitat at MCAS Miramar for the San Diego fairy shrimp, Riverside fairy shrimp, coastal California gnatcatcher, spreading navarretia, and willowy monardella. The USFWS made this determination because the installation's INRMP, as implemented, is a legally operative plan that "provides a benefit to the species for which critical habitat [was] proposed for designation," per section 218 of the 2004 National Defense Authorization Act.

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Preliminary Information**
Management areas	The MCAS Miramar strategy for conservation and management is to (1) limit activities, minimize development, and mitigate actions in areas supporting high densities of vernal pool habitat, threatened or endangered species, and other wetlands and (2) manage activities and development in areas of low densities, or no regulated resources, with site-specific measures and programmatic instructions. Management areas (MAs) were identified primarily to support the conservation and management of special status species, wetlands, and other areas warranting special attention. ■ Level I MAs (2,676.9 acres) support nearly all vernal pool habitat basins and watersheds and some closely associated coastal California gnatcatcher territories. ■ Conservation needs in Level II MAs (5,516.3 acres) focus on non–vernal pool federally listed species. ■ Level III MAs (2,016.9 acres) support riparian vegetation and habitat linkages not contained within Level I and II MAs. ■ Remaining undeveloped areas not in Level I, II, or III MAs have been delineated as Level IV MAs (7,813.6 acres). ■ Level V MAs (5,037.2 acres) are developed areas that support few unaltered natural landscapes and, therefore, almost no high value natural resources.
Potential ecological exposure pathways	Flora receptors, including the willowy monardella and Del Mar manzanita, may be exposed to intermittent surface water via direct contact to plant tissue or uptake by the roots. Due to the foraging habits of the coastal California gnatcatcher and the least Bell's vireo, the primary source of water for these species is their diet (e.g., insects, fruit). Direct exposure and consumption of intermittent surface water is anticipated to be limited. Sensitive species within vernal pools rely on periodic exposure to surface water. In vernal pools, the San Diego fairy shrimp and Riverside fairy shrimp may absorb water for respiration purposes. However, the hydrologically isolated nature of the habitat inherently precludes continuous exposure to MC-impacted surface water.

6.8. Potential Pathways and Receptors

MC accumulated in the MC loading areas can migrate to potential receptors via the following exposure pathways:

- Surface water runoff
- Leaching to groundwater and subsequent groundwater flow

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 (e.g., soil ingestion, incidental dermal contact, bioaccumulation and food chain exposure) are not currently considered in the REVA process. The potential points of exposure for receptors of MC at MCAS Miramar include the following:

- Water bodies used in association with recreational activities, including the Santee Recreational Lakes, an on-installation fishpond in the western reaches of Rose Canyon, and a pond at an installation golf course
- Intermittent water bodies / drainages that leave the installation/range boundary and may contain special status ecological receptors

6.8.1. Surface Water Pathway

Surface water runoff is the primary MC transport mechanism at the East Miramar Range Complex. Although rainstorms are infrequent, the surface runoff may be high during significant storm events. The predominant surface water drainage direction is to the southwest. Slopes range from gently sloping at eroded plateaus or mesas to steep at the dissected hills or canyons (MCAS Miramar INRMP, 2006).

Most soils at the range complex are severely erodible with few exceptions, such as the clayey types of soils found in hummocky areas underlain by bedrock or hardpan. Following rainstorm events, surface drainage occurs by way of natural topographic gradients and drainage directly into canyons. Such drainage systems can transport MC to canyons from soil through dissolution in runoff water or erosion of soil and sediments. MC transported through canyons can be recharged to the underlying alluvium, as the alluvium in these canyons is comprised of shallow, well-drained sandy or gravelly soils (SCS, 1984). By way of surface drainage, dissolved and soil-associated MC potentially can be transported to habitats containing ecological receptors (e.g., vernal pools) located off of the MCAS Miramar operational range or installation. Vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area; however, vernal pools that are located adjacent to streams possibly can exhibit hydrological connectivity with streams. Such vernal pools can receive water from streams, typically during high water flows, and possibly can also discharge water to streams. Overall, the hydrology of vernal pools is

highly site-specific. In addition, MC potentially can be transported to potential human receptors in canyons (through contact recreational use) within and outside MCAS Miramar and to human receptors in other areas outside the installation, such as the Santee Recreational Lakes.

As discussed in **Section 6.4**, MC loading areas are located in five of the eight subwatershed areas within MCAS Miramar, including San Clemente Canyon, Rose Canyon, West Sycamore Canyon, Oak Canyon, and Elanus Canyon. All of the canyons within the five subwatershed areas where the MC loading areas are located flow off range to areas that have been documented to be associated with potential threatened and endangered ecological species. Rose, San Clemente, West Sycamore, and Oak canyons have potential human receptors, as they are designated to have existing beneficial use for contact and non-contact water recreation (CRWQCB, 1994). However, because these streams are intermittent, the canyons infrequently have surface waters that could come into contact with recreational users. West Sycamore Canyon drains off the installation into areas with human receptors (Santee Recreational Lakes). These lakes are perennial man-made water bodies used for recreational purposes.

None of the surface waters within MCAS Miramar are used as a source of drinking water. The West Sycamore Canyon subwatershed contains the only operational range utilizing HE munitions (the Current EOD Range MC loading area). Locations of the watershed, stream, and impact areas that may potentially receive MC are shown in Figure 6.4-1.

6.8.2. Groundwater Pathway

All of the MC loading areas are located in the East Miramar Range Complex, and most cover mountainous areas and canyon areas. Impacts to deep groundwater are highly unlikely because of the great depths to groundwater and the presence of hardpan below most surficial soil layers.

Impacts to shallow groundwater are possible if the MC loading occurs in canyons where the surficial material is alluvial. Groundwater in these areas has been measured at 2 to 10.5 feet bgs and is expected to be present at this depth only after heavy rainfall or after a series of wet years. Subsurface flow through these aquifers may be rapid after rainfall and could quickly carry MC down the canyons. Most of these canyons lead south toward the installation boundary or west toward West Miramar.

There are no known human receptors of the shallow groundwater. The shallow groundwater is known to be of low quality and is unsuitable for domestic use (SCS, 1984; Woodward-Clyde, 1991; Environmental Associates, 1995). Ecological receptors may use the water if it discharges to the surface. However, there are no known points of groundwater discharge except for interflow following precipitation events.

7. Operational Range Training Areas

MC loading areas were defined in **Section 3.6** as those areas within the East Miramar Range Complex in which significant MC loading is occurring or suspected to have occurred as a result of training with munitions containing REVA indicator MC. These MC loading areas were assessed qualitatively through the development of site-specific CSMs, and, if necessary, quantitatively, through screening-level transport assessments. The assessments for the MC loading areas identified within the East Miramar Range Complex at MCAS Miramar, both current and historical as identified on Table 7.0-1, are presented in the following sections:

- Current EOD Range MC loading area (**Section 7.1**)
- Historical Use MC loading areas (**Sections 7.2–7.5)**

The areas were selected for assessment based upon discussions with Range Operations and EMD personnel at MCAS Miramar and the data presented in the Training Range Sustainment Planning and Training Range Inventory, 2004 National Defense Authorization Act Section 366 Report (TECOM, 2004).

The section for each MC loading area contains discussions on the operational range background, the site-specific CSM, MC deposition estimates, screening-level modeling results (if applicable), and additional range information. The site-specific CSMs developed for the MC loading areas include the following:

- MC loading estimates (detailed in **Section 3**)
- Geography, topography, and climate
- Surface water features
- Soil characteristics and land cover
- Erosion potential
- Hydrogeology and groundwater characteristics
- Potential surface water and groundwater pathways
- Potential receptors

Table 7.0-1: Current and Historical MC Loading Areas

MC Loading Area	Size of MC Loading Area	
	Acres	1,000 m^2
ACTIVE MC LOADING AREA		
Current EOD Range	40.0	162
HISTORICAL MC LOADING AREAS		
Former EOD Range / DSWA	17.7	71.8
South	323.7	1,310
Range C	249.6	1,010
Range G	921.7	3,730

Surface Water Analysis Summary

Surface water fate and transport modeling through screening-level analysis was conducted for one MC loading area, the Current EOD MC loading area. This MC loading area was determined to be the most likely to show a potential off-range MC release, as it is the only operational range area that currently utilizes HE. Analysis of the four historical MC loading areas was not conducted based on considerations for the quantity and relatively short duration of munitions use at each area, as well as decay calculations for relevant MC. The results of the surface water screening-level modeling are discussed in detail in **Section 7.1.2**. MC decay calculations are discussed in **Section 7.3.2**.

Groundwater Analysis Summary

A qualitative groundwater analysis was performed by analyzing the source media, migration mechanisms, and exposure pathways documented in the MCAS Miramar CSM. Based on the results of the qualitative analysis of the groundwater information, limited potential exists for MC migration to groundwater, and no groundwater receptors associated with the indicator MC are present. Therefore, a groundwater screening-level analysis was not conducted. Discussions of the qualitative analysis and screening-level analysis are presented in **Section 5**.

7.1. Current EOD Range

The EOD range is constructed on a portion of the former Sycamore Canyon Missile Test Site, located in the northeast portion of East Miramar (Figure 7.1-1). Its MC loading area is estimated to be approximately 40 acres, located within a circular area around the range. The range consists of two "shot holes" for EOD training and emergency destruction of UXO found on MCAS Miramar and surrounding areas due to past training activities during the WWI and WWII timeframes. The NEW limit for the range is 5 lb per demolition shot. The shot holes are lined blast pits depressed into the ground surface within a dry drainage. The natural topography of this area provides added containment of any potential fragmentation generated during disposal operations. The ESQD arc for the EOD range slightly overlaps Training Area 1. The EOD range was activated in 1997. It has not been used since January 2007 because it is located in Class B airspace, which prevents consistent training and disposal operations at the range. It is currently only available for emergency EOD activities. Munitions that are deemed safe to move are transported to Camp Pendleton for disposal.

Prior to the establishment of the EOD range, the former Sycamore Canyon Missile Test Site operated at this location from 1956 to the late 1960s. The test site was used in the development of liquid-based propulsion systems for the Atlas and Centaur missiles (USACE, 2001a). NASA took control of the property in 1966. This property was declared excess in 1969 and was transferred to NAS Miramar in 1977. Following this, no other major HE live-fire training was conducted at NAS Miramar or at MCAS Miramar until the establishment of the EOD range.

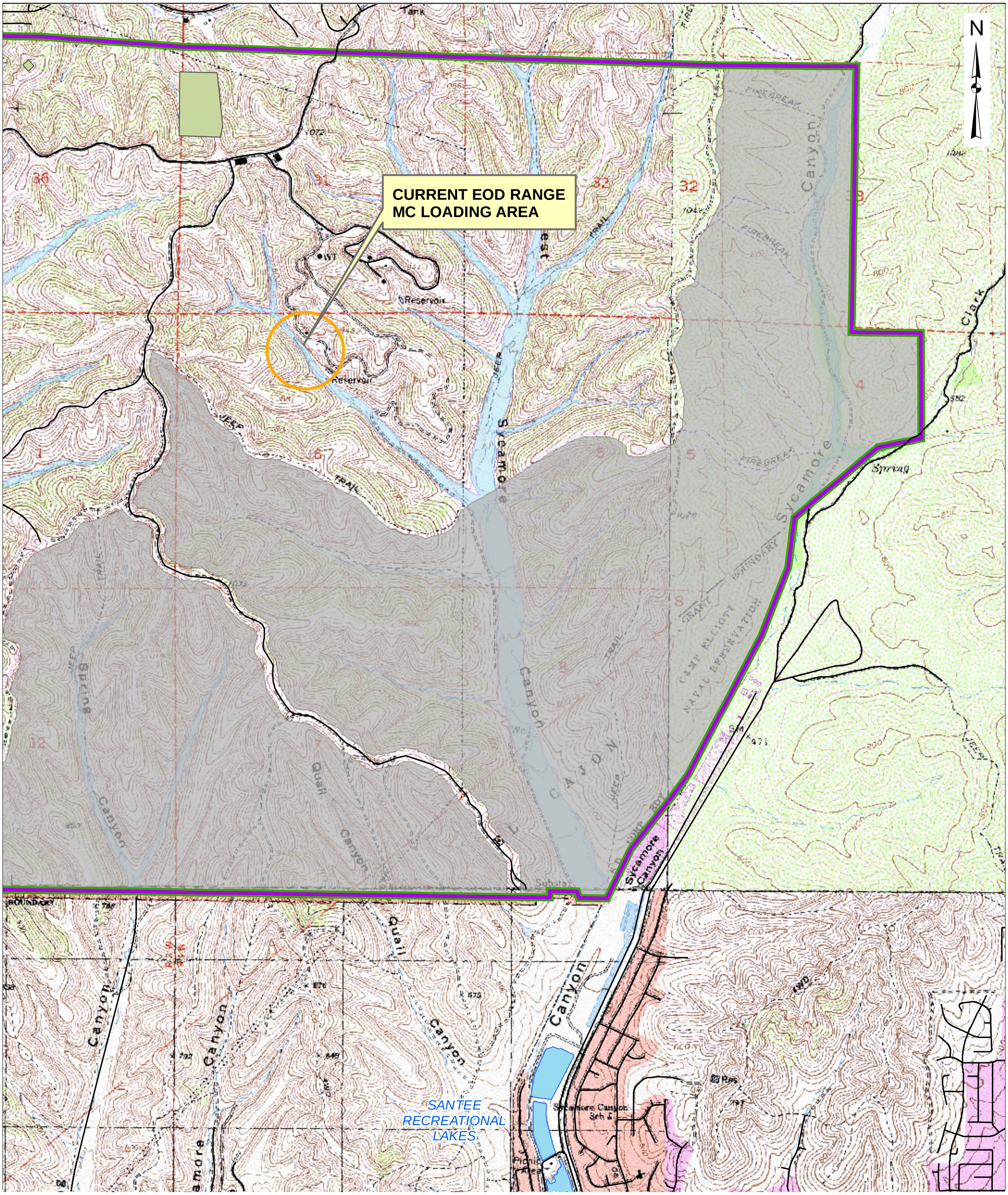
Military Munitions

The general classes of military munitions utilized at this range include donor charges and associated blasting material as well as a variety of unserviceable munitions or UXO ranging from small arms to small- and medium-sized HE munitions. When the range is active, use of the range generally occurs one to three times per month. Detailed assumptions for the determination of MC loading rates are provided in **Section 3** and the *REVA Reference Manual* (HQMC, 2006).

7.1.1. CSM

7.1.1.1. Estimated MC Loading

The MC loading area for the EOD range is shown in Figure 7.1-1. The MC Loading Rate Calculator was used to estimate the amount of MC loaded to this primary MC loading area over time (Table 7.1-1). Expenditure and demolition records were available for the years 1999, 2000, 2004, and 2006. Data for 1999 and 2000 consist of the exact same types and quantities. The REVA assessment team could not verify whether the EOD



0 700 1,400 2,800 4,200
FEET

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- UNAVAILABLE FOR TRAINING
- MC LOADING AREAS
- TRAINING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)
- MINOR ROAD

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

MALCOLM PIRNIE

MCAS MIRAMAR
MIRAMAR, CALIFORNIA
RANGE ENVIRONMENTAL
VULNERABILITY ASSESSMENT

CURRENT EOD RANGE
MC LOADING AREA

MALCOLM PIRNIE, INC.
OCTOBER 2008
FIGURE 7.1-1

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range use was exactly the same for 1999 and 2000; it was presumed that the data are representative of only one year. In addition, the data for 2004 lacked information regarding the types of munitions destroyed and included only the types of charges used for demolition activities. Consequently, the data for 1999/2000 and 2006 served as the basis for munitions expenditure analysis at this range. Expenditure data were extrapolated for time periods when expenditure data were not available. To achieve representative annual values of expenditures for this time period, the reported totals for each yearly period were averaged together by DoDIC, with all fractional values conservatively rounded up to the nearest whole number. Some munitions lacked an identifiable DoDIC; appropriate surrogate values were selected to incorporate the expenditures into the loading estimates. No loading from historical operations of the missile test site was conducted, as REVA indicator MC were not used in these tests (see **Section 3.6.1**).

Table 7.1-1: Estimated Annual MC Loading for the Current EOD Range MC Loading Area

MC Loading Area	Period	Begin Use	End Use	HMX (kg/m^2)	RDX (kg/m^2)	TNT (kg/m^2)	Perchlorate (kg/m^2)
Current EOD Range	E (1989–Present)	1997	2007	0.00E-00	2.22E-07	5.32E-08	1.05E-07

The estimated perchlorate loading in Table 7.1-1 is primarily attributed to destruction of two types of ordnance in 1999/2000, one of the two years used to develop average annual expenditures at the EOD range. Information regarding pertinent MC loading factors was not available for one of the HE munitions items destroyed at the range during that timeframe. In order to perform the MC loading estimate, a surrogate munition item was selected that was similar in use and structure to the one noted in the expenditure record. The surrogate munition contains perchlorate, whereas some of its analogs do not contain this REVA indicator MC. The other munition item, which is not routinely destroyed at this range, also contains perchlorate. Given this assumption, these two types of munitions contain the highest perchlorate content per expenditure relative to other munitions destroyed at the EOD range in 1999/2000 and 2006. Perchlorate-containing munitions destroyed at the EOD range in 2006 were limited in number and were of a variety that contained significantly less perchlorate per round than the two munitions items used in the estimated loading from 1999/2000. Based on this information, the perchlorate loading presented in Table 7.1-1 is believed to be very conservative, as current perchlorate loading based solely upon 2006 expenditure data is expected to be significantly lower. The MC loading process is dependent upon extrapolation of assumed DoDICs; in addition, the analysis is based only on two years of expenditure data, and may not represent actual munitions destroyed in previous years. Consequently, true perchlorate loading at the EOD range is not likely occurring on an annual basis and is

presented here as a result of limited expenditure data, which are sensitive to the reported use of a few munitions types not routinely used at this range.

7.1.1.2. Geography and Topography

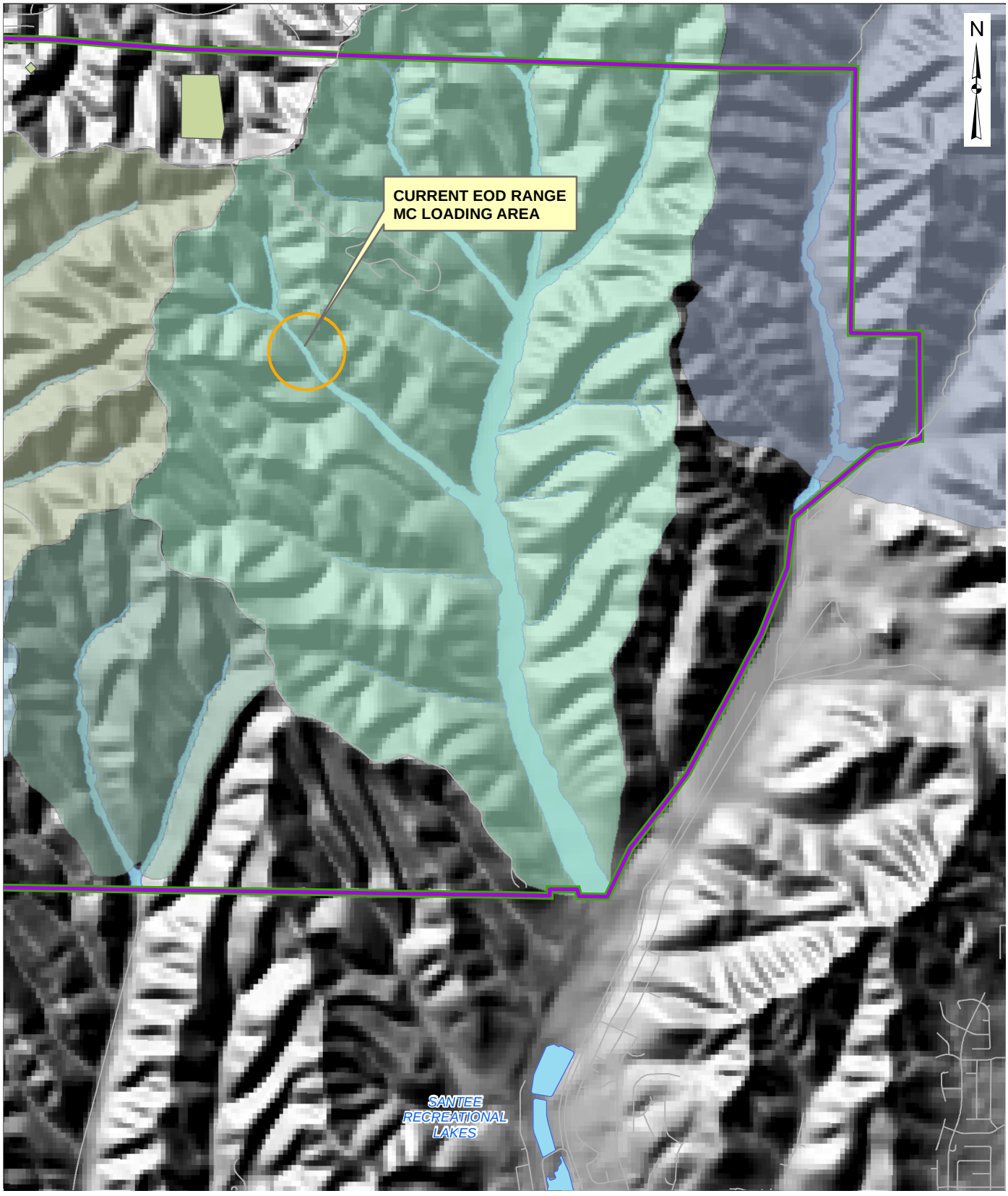
The EOD range is located in the eastern portion of the East Miramar Range Complex. Based on available GIS data (MCAS FMD, 2007), it straddles a canyon with bottom elevations as low as 650 feet amsl and surrounding walls up to an elevation of 950 feet amsl. The facility consists of a handful of structures that sit upon a relatively level, paved area cut into the northeast side of a drainage trending northwest to southeast. An access road runs through this range, bending around the local topography. The two shot holes sit on the edges of the drainage channel, which varies from approximately 90 to 145 feet in width within the Current EOD MC loading area. The natural topography on both sides of the drainage channel quickly elevates, thereby providing some confinement of EOD activities and training from the area surrounding the MC loading area. Based on available elevation contour data, the average slope of the MC loading area is approximately 18.4%. The EOD range and structures associated with the former missile test site represent the only developed areas within the MC loading area; the remainder of the area is undeveloped.

7.1.1.3. Surface Water Features

The EOD range is located within a branch of the West Sycamore Canyon subwatershed, located within the eastern reaches of MCAS Miramar (Figure 7.1-2). There are no permanent surface water features in this subwatershed; surface water consists of intermittent drainage generated during precipitation events. Drainage from the location of the Current EOD Range MC loading area is anticipated to flow approximately 0.7 miles to the southeast where it meets the main ephemeral drainage of the subwatershed. The drainage continues to the south within MCAS Miramar, eventually combining with drainage from the adjacent Sycamore Canyon subwatershed. This intersection occurs at the southern end of the installation boundary. The confluence continues to flow southward, eventually reaching the Santee Recreational Lakes, approximately 0.6 miles south of the installation boundary. These are perennial, man-made lakes used for recreation.

7.1.1.4. Soil Characteristics and Land Cover

The EOD range is located at the bottom of a tributary in West Sycamore Canyon subwatershed. As noted in **Section 6.3**, the bottoms of canyons in East Miramar are typically covered with alluvium or riverwash sediments. The predominant soil type within the MC loading area is dissected Redding cobbly loam (85.9%), with Stony land located on and around the tributary draining into the main channel of West Sycamore Canyon (14.1%) (Figure 7.1-3). Redding series is moderately well to well drained with



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE BOUNDARY
- UNAVAILABLE FOR TRAINING
- MC LOADING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)

SUB-WATERSHEDS

- OAK CANYON
- SAN CELEMENTE CANYON
- SPRING CANYON
- SYCAMORE CANYON
- SYCAMORE WEST CANYON

0 750 1,500 3,000 4,500 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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MCAS MIRAMAR
MIRAMAR, CALIFORNIA

RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

SURFACE WATER DRAINAGE BASINS - CURRENT EOD RANGE MC LOADING AREA

MALCOLM PIRNIE, INC.

OCTOBER 2008

FIGURE 7.1-2

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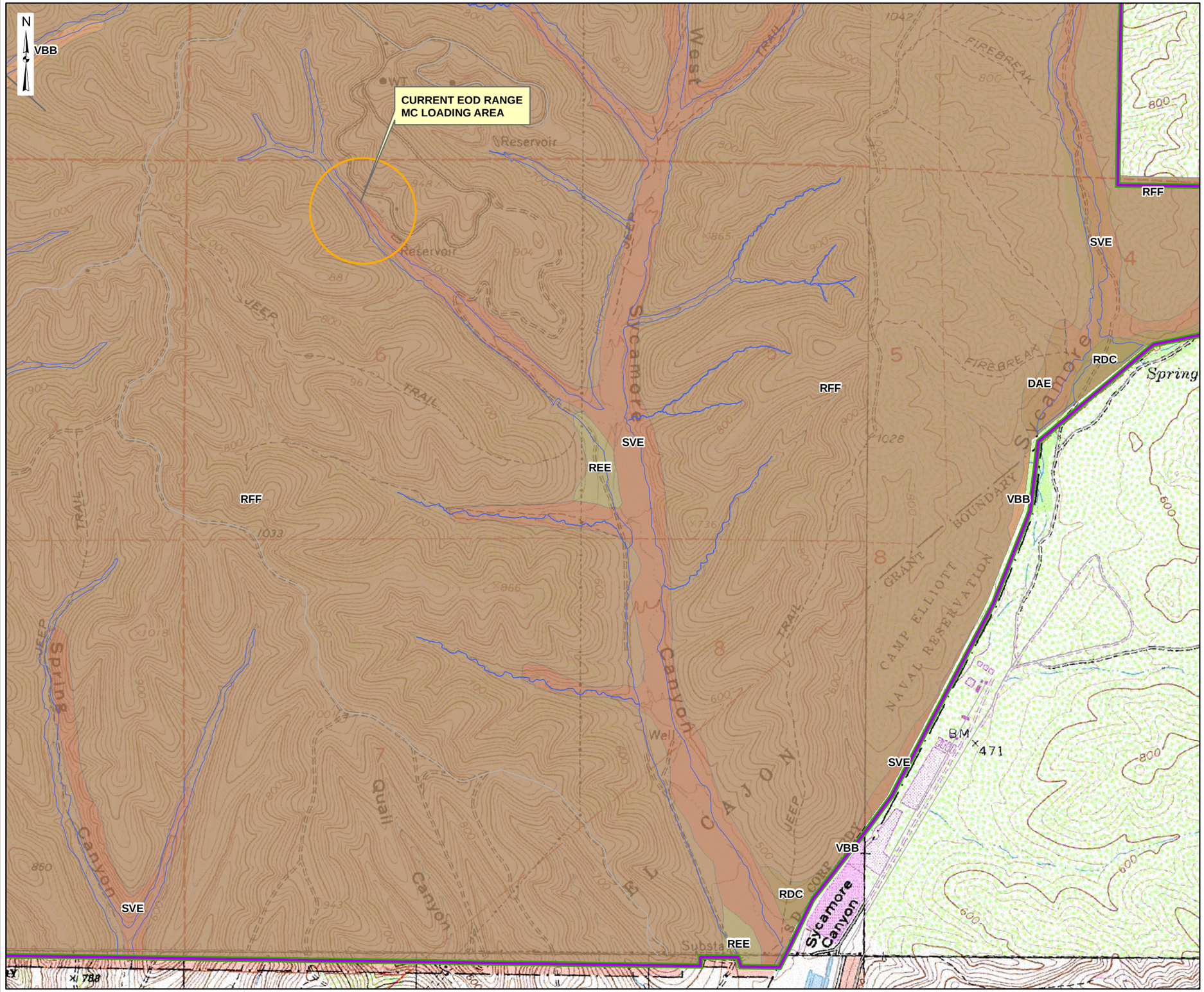


REVA
FIGURE 7.1-3
SOIL MAP - CURRENT EOD RANGE MC LOADING AREA

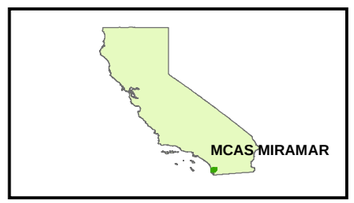
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- LAKES
- ROADS
- SURFACE WATER (INTERMITTENT)

PRIMARY SOIL TYPES:

RFF - REDDING COBBLY LOAM, 15-30%
SVE - STONY LAND



0 355 710 1,420 2,130
Feet

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MALCOLM PIRNIE

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very slow to slow permeability. The ground cover is generally bare, sparsely vegetated with chapparal and coastal sage scrub.

7.1.1.5. Erosion Potential

The estimated erosion potential of soils at the Current EOD Range MC loading area is high, mainly due to the steep topography (approximately 18.4%) and sparse vegetative cover within the area. The detonation pits at the EOD range are unlined. A moderate soil erodibility factor of 0.58 was selected for the MC loading area for use in surface water transport analysis (**Section 7.1.2**).

7.1.1.6. Groundwater Characteristics

Limited information exists on groundwater occurrence and flow characteristics in this area. Very little of the rainfall is expected to infiltrate to the groundwater, especially on the steep mountain walls. Some infiltration may occur in the alluvium-filled canyon bottoms, though this may be limited due to the slow permeability of the soils. Subsurface water in the alluvium is normally found only after rainfall events or wetter-than-normal seasons. Most of it is expected to be removed by evapotranspiration before significant downgradient movement of the water occurs. The presence of hardpan under most of the installation is likely to prevent the movement of shallow groundwater to the deeper aquifers in the area.

7.1.1.7. Potential Surface Water and Groundwater Pathways

Surface Water Pathways

Surface water runoff is the primary pathway of interest for MC transport at MCAS Miramar, though there are no perennial water bodies within the West Sycamore Canyon subwatershed where the Current EOD Range MC loading area is located; all surface water flow is ephemeral. Regional precipitation is typically episodic and is approximately 10 inches total per year. Because of the hot, arid climate, regional evaporation is relatively high. Additionally, coarse-grained and permeable alluvium is typically limited to the main drainages, thereby limiting recharge to the shallow subsurface. Consequently, potential MC migration is most likely to occur with precipitation events where a notable amount of rainfall occurs over a short period of time. During such episodes, MC have the potential to migrate downstream via two pathways: (1) transportation of MC adhered to eroded soil particles within the surface water and (2) dissolution of MC into surface water runoff. As noted in **Section 7.1.1.3**, this MC loading area may be flushed by infrequent precipitation events, eventually traveling to the south through West Sycamore Canyon and moving off installation toward the Santee Recreational Lakes.

Groundwater Pathways

As previously described, infrequent rainfall could dissolve MC before infiltrating to the subsurface. This water is not expected to reach deep groundwater. Shallow groundwater is generally only found in the alluvium at the bottom of the canyon immediately after rainfall events or after an especially wet period. This shallow groundwater is anticipated to flow along the gradient of the watershed and eventually be removed by evapotranspiration. It is possible that there may be limited instances where this shallow, ephemeral groundwater resurfaces. In such circumstances, the groundwater is anticipated to represent a small volume of water relative to the surface water drainage generated during precipitation events. However, no groundwater seeps have been noted on MCAS Miramar. As the drainage path from the MC loading area to the installation boundary is approximately 2.25 miles, migration of MC in groundwater to off-range and off-installation receptors is not anticipated.

7.1.1.8. Potential Surface Water and Groundwater Receptors

Surface Water Receptors

West Sycamore Canyon has been designated by San Diego Region Basin Plan to have existing beneficial uses for agriculture, industrial service supply, contact and non-contact recreation, and warm freshwater and wildlife habitat (CRWQCB, 1994). Designation of an "existing beneficial use" signifies such use has occurred since November 28, 1975, or that water quality and quantity is suitable to allow the use to be obtained. The drainage is ephemeral within and outside the installation; consequently, the potential for actual recreational users is considered remote.

As noted in **Section 7.1.1.7**, discharge from West Sycamore Canyon may eventually travel off-installation to the Santee Recreational Lakes, which accommodates public recreational use, including camping, boating, and fishing. Although trespassers engaged in recreation (biking or jogging) have been noted in West Sycamore Canyon, the nature and rare occurrence of such incidents suggest that trespassers do not constitute a potentially significant receptor.

Seasonal wetland areas, including vernal marsh, are present in the main reach of the subwatershed as well as several of its tributaries, including the one where the Current EOD Range MC loading area is present. No vernal pools have been identified within the area of West Sycamore Canyon that is present within East Miramar, though it is possible they may be present beyond the installation boundary. Riparian areas have also been identified toward the lower end of West Sycamore Canyon. California gnatcatchers, a federally listed threatened species, recently have been sighted near the southern end of the main drainage, across the installation boundary. Rare sightings of the federally listed

endangered least Bell's vireo have only been noted in the adjacent Sycamore Canyon. The endangered willowy monardella has also been observed throughout much of the West Sycamore Canyon. West Sycamore Canyon, along with Sycamore, Spring, and Oak Canyons, serves as an open north-south wildlife corridor and habitat linkage for the surrounding areas. However, West Sycamore Canyon, along with all of East Miramar, was badly burned during the Cedar Fire of 2003. No post-fire sightings of the California gnatcatcher in West Sycamore Canyon are noted in the latest INRMP (2006), and most of the willowy monardella across MCAS Miramar was lost during the fire. Due to the limited data available for species located off the installation, additional ecological receptors may exist within West Sycamore Canyon. Regardless, as noted in **Sections 6.7** and **7.1.2**, the significance of MC exposure to these special status species is considered to be limited given potential for uptake or consumption of adversely impacted runoff.

Groundwater Receptors

There are no known human or ecological receptors for the shallow groundwater leaving the EOD range. The groundwater at MCAS Miramar is generally of low quality with high TDS and is not used for drinking water. There are no known active wells in the vicinity, although the San Diego Region Basin Plan designates some of the groundwater around MCAS Miramar for agricultural or industrial uses (CRWQCB, 1994). The EOD range is located in the Santee hydrologic subarea, as designated in the San Diego Region Basin Plan, though its ESQD may extend into the Miramar hydrologic area. The ephemeral nature of shallow groundwater in the alluvium makes it unlikely to be used for any purpose.

7.1.2. Surface Water Analysis Results

A screening-level analysis was used to obtain conservative estimates of MC concentrations in surface water from the Current EOD Range MC loading area. This MC loading area was selected for quantitative transport analysis based on its current use of munitions containing HE, the presence of surface drainages that extend off the installation boundary, and the proximity of a potential surface water exposure points with documented human and ecological presence. The screening-level analysis for surface water was conducted as described in **Section 4**.

The Current EOD Range MC loading area is located several miles upstream of the operational range / installation boundary. Consequently, the locations of interest for determining REVA MC concentrations in surface water were the edge of the MC loading area, the downstream point of West Sycamore Canyon drainage at the East Miramar Range Complex / MCAS Miramar boundary (representing the point at which an off-range release may occur), and the Santee Recreational Lakes (representing the most likely downstream human receptor interaction point). Additionally, although vernal pools have not been identified in this area of the installation, they may be present beyond the

installation boundary near West Sycamore Canyon. Figure 7.1-4 and Figure 7.1-5 depict the locations where the REVA MC concentrations were estimated.

The surface water screening analysis was carried out for a time period matching the estimated MC loading period (1997–2006) for the Current EOD Range MC loading area. The surface water transport analysis methodology employed by REVA takes into account any MC loading areas that might be present upstream (or downstream) of the subject MC loading area to account for the actual estimated amount of REVA MC that might be migrating through the surface water pathway. For this analysis, it was determined that a small portion of the former Range G MC loading area (discussed further in **Section 7.5**), drains into West Sycamore Canyon and follows the same drainage pattern as the Current EOD Range MC loading area (Figure 7.1-2). However, as MC loading at this historical use area occurred for only a limited time (1941–1944), and because REVA MC have likely attenuated over the six decades since the range was last used, MC contribution from this MC loading area is believed to be negligible (**Section 7.5**); therefore, MC contributions from this area to the surface water transport analysis were not considered. Table 7.1-2 presents the estimated annual average edge-of-loading area concentrations in runoff from the Current EOD Range MC loading area.

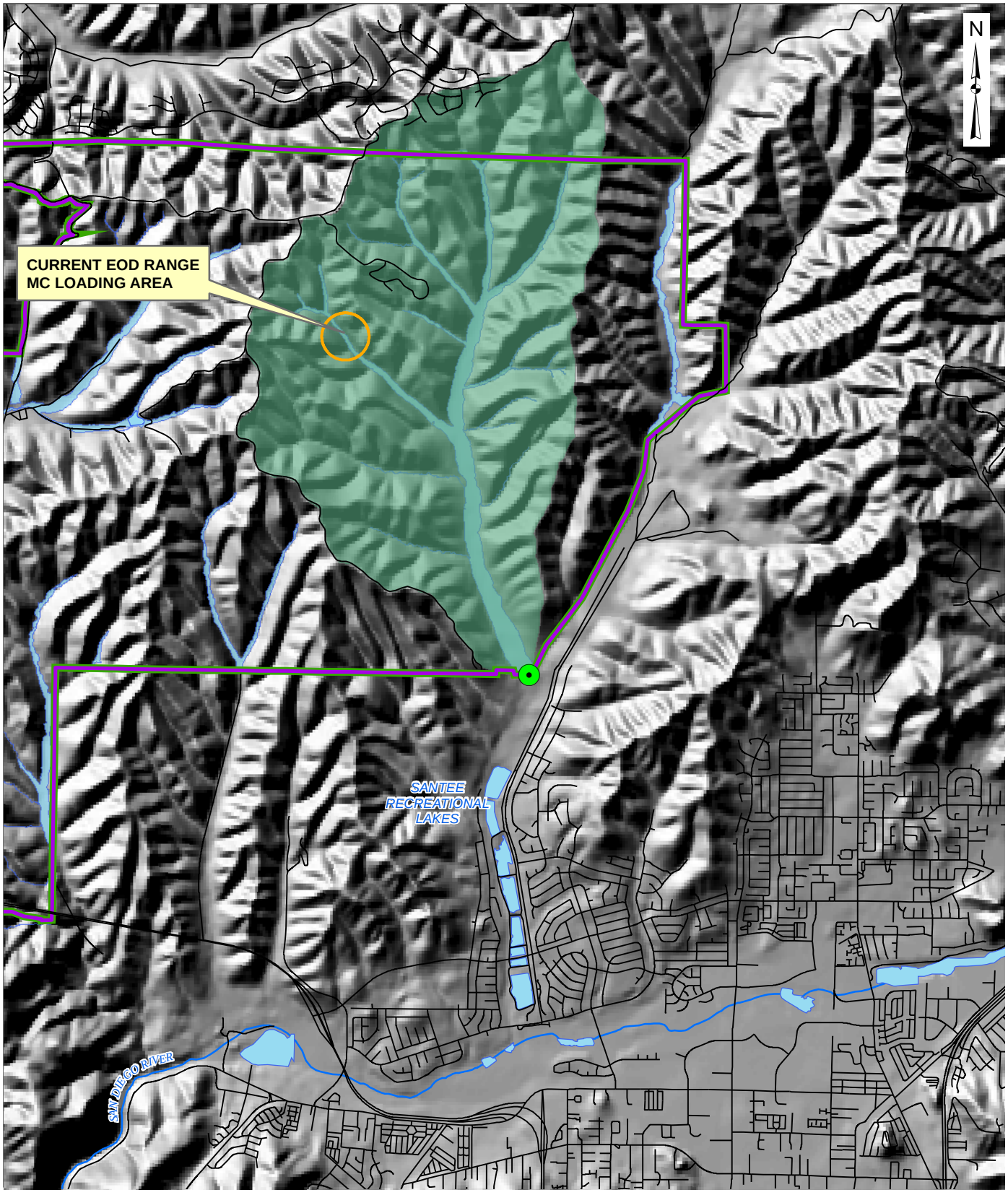
Table 7.1-2: Screening-Level Estimates of Annual Average Edge-of-Loading-Area MC Concentrations in Runoff

MC Loading Area	MC Concentration (µg/L)			
	RDX	TNT	HMX	Perchlorate
Current EOD Range	**0.18**	0.03	0	0.60

Note: **Shading and bold** indicate that the predicted concentration exceeds the REVA trigger value.

Based on surface water screening-level calculations, the average annual concentrations of TNT and perchlorate were estimated to be below detection limits (i.e., below REVA trigger values) in runoff at the edge of the Current EOD Range MC loading area. However, RDX was estimated to be just above the REVA trigger value in runoff at the edge of the Current EOD Range MC loading area. There was no HMX loading associated with munitions use at the Current EOD Range MC loading area. As a result, there is no potential for HMX to be present in the runoff at the edge of the MC loading area or at surface water receptor locations (West Sycamore Canyon at the operational range / installation boundary and the Santee Recreational Lakes).

Table 7.1-3 presents the annual average MC concentrations (post-mixed concentrations) in West Sycamore Canyon at the edge of the East Miramar Range Complex / MCAS Miramar boundary and the final discharge location at the Santee Recreational Lakes. Post-mixing concentrations of all REVA MC were predicted to be below REVA trigger values in West Sycamore Canyon at the East Miramar Range Complex / installation



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- WATERSHED
- LAKES
- SURFACE WATER (INTERMITTENT)
- MINOR ROAD
- POTENTIAL MC DISCHARGE LOCATION

0 1,200 2,400 4,800 7,200 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

SURFACE WATER TRANSPORT ANALYSIS - OPERATIONAL RANGE BOUNDARY

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FIGURE 7.1-4

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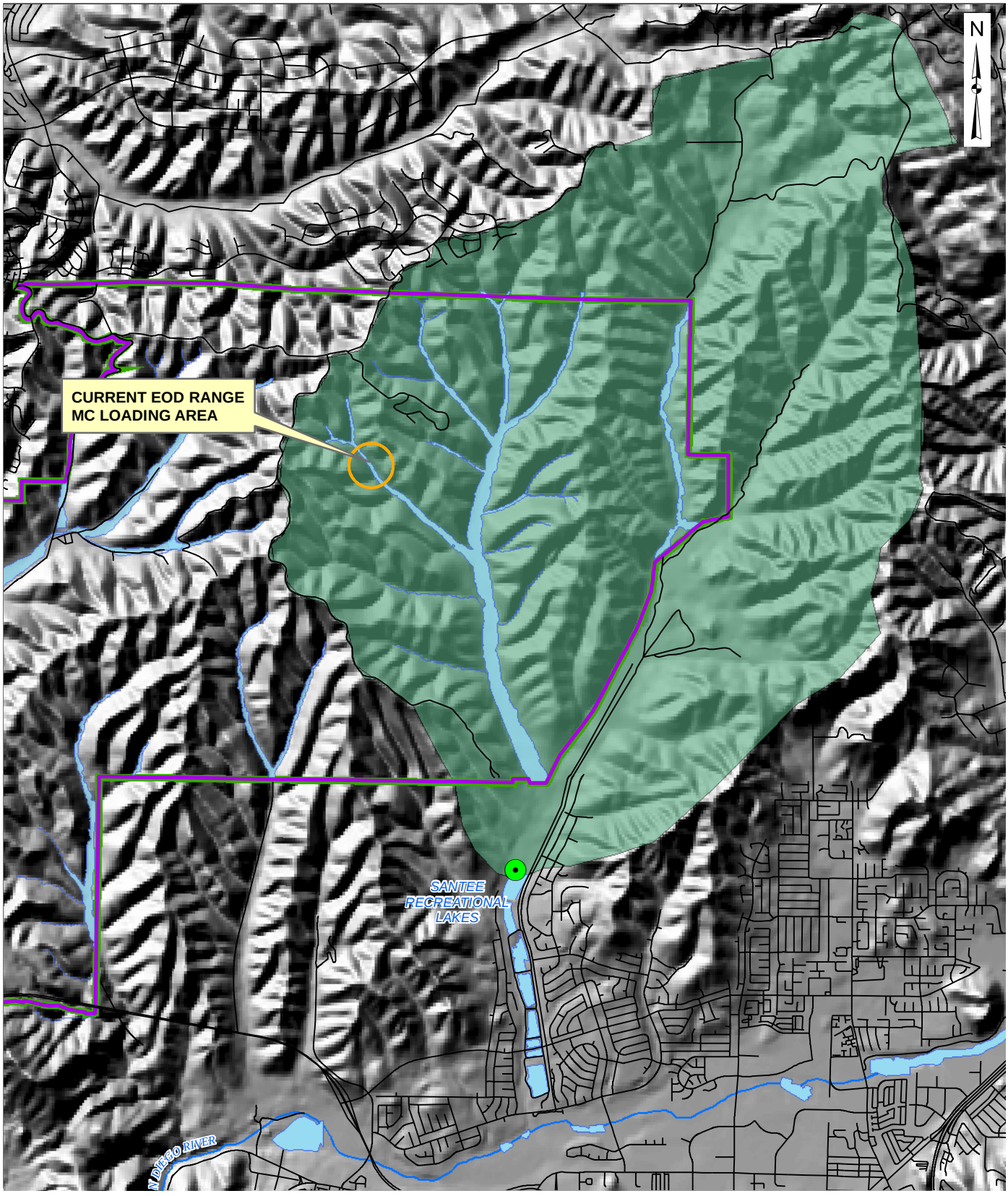

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE BOUNDARY
- MC LOADING AREAS
- WATERSHED
- LAKES
- SURFACE WATER (INTERMITTENT)
- MINOR ROAD
- POTENTIAL HUMAN RECEPTOR LOCATION

0 1,250 2,500 5,000 7,500 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

SURFACE WATER TRANSPORT ANALYSIS - SANTEE RECREATIONAL LAKES

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FIGURE 7.1-5

Map Document: (P:\6285024\MCAS Miramar\GIS\Projects\PRD\Figure7.1-5.mxd)
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boundary and the discharge point at the Santee Recreational Lakes. Overall, the REVA surface water screening-level analysis estimates a very low potential for MC to exceed trigger values beyond the MCAS Miramar operational range boundary in surface water from MC originating from the current EOD range.

Table 7.1-3: Screening-Level Estimates of Annual Average MC Concentrations in West Sycamore Canyon at MCAS Miramar Installation Boundary and Entering the Santee Recreational Lakes

MC	Concentration in West Sycamore Canyon at MCAS Miramar Installation Boundary (µg/L)	Concentration Entering Santee Recreational Lakes (µg/L)
RDX	0.002	0.0008
TNT	0.0003	0.0001
HMX	0	0
Perchlorate	0.01	0.0025

Note: **Shading and bold** indicate that the predicted concentration exceeds the REVA trigger value.

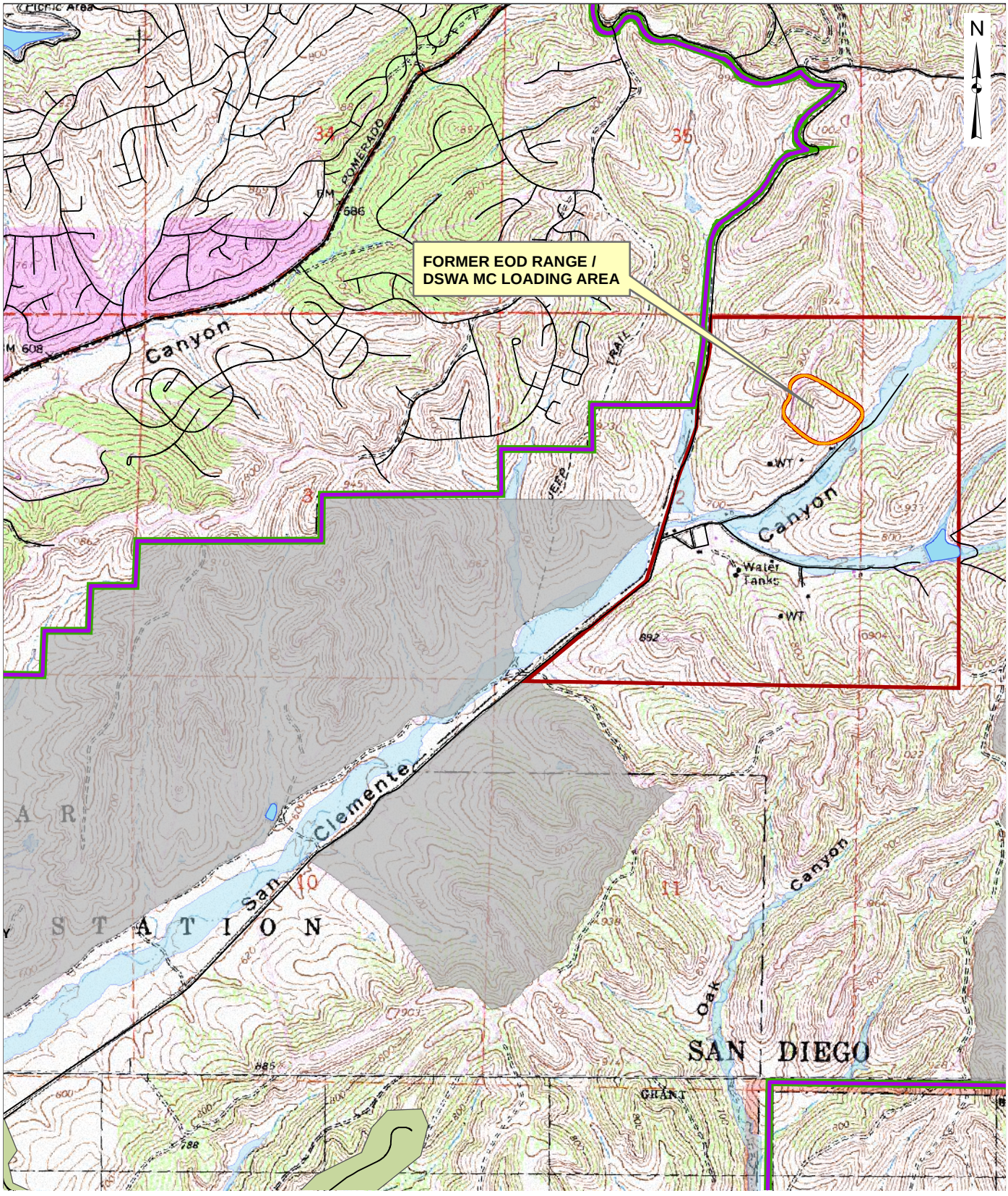
7.1.3. Groundwater Analysis Results

A qualitative groundwater analysis was performed by analyzing the source media, migration mechanisms, and exposure pathways documented in the MCAS Miramar CSM. Based on the results of the qualitative analysis of the groundwater information, limited potential exists for MC migration to groundwater and no potential receptors of groundwater were identified. Therefore, a groundwater screening-level analysis was not conducted. Discussions of the qualitative analysis and screening-level analysis are presented in **Section 5**.

7.2. Former EOD Range / DSWA

The former EOD range is located at the former DSWA Green Farm facility attached to the former Camp Elliott, near the north-central boundary of East Miramar (Figure 7.2-1). The MC loading area is an irregular shape covering approximately 17.7 acres; most of it falls within the boundaries of the former Range G (**Section 7.5**). Use of the area as an EOD range began in 1972 by the Navy; the use is described as "minimally every few months" in the PRA (USACE, 2001b).

The former EOD range was located within the boundaries of the DSWA Green Farm, a gun research facility initially operated in 1960. Gulf Atomic operated the facility from 1960 to 1972, and Maxwell Technologies operated it from 1972 until its closure. Munitions usage at the facility did not result in the firing of rounds into a downrange impact area; rounds were fired into long tunnels and stopped within 50 m of the firing



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- UNAVAILABLE FOR TRAINING
- HISTORICAL HE RANGE
- MC LOADING AREAS
- TRAINING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)
- MINOR ROAD

0 500 1,000 2,000 3,000 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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MCAS MIRAMAR
MIRAMAR, CALIFORNIA
RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

FORMER EOD RANGE / DSWA
MC LOADING AREA

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FIGURE 7.2-1

Map Document: (P:\6285024\MCAS Miramar\GIS\Projects\PRD\Figure7.2-1.mxd)
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point. The specific method for containment of rounds was not indicated in the ASR, though some type of berm likely was used. The NEW during Gulf Atomic's presence was 500 lb (USACE, 2001b); the NEW during the tenure of Maxwell Technologies is not known. However, it is reported that demolition shots used during the tenure of Maxwell Technologies ranged from 0.25 grams to 600 lb of explosives (USACE, 1996), though typically only 5–10 lb of explosives reportedly was used at a time (USACE, 2001b). The facility was closed sometime after the ASR and PRA were conducted in 1998.

Military Munitions

No specific information is available regarding the types of munitions utilized at the DSWA Green Farm facility or the munitions items used or destroyed at the former EOD range. The EOD range reportedly was used for disposal of all types of parts and munitions, including small arms, HE munitions and aircraft components. The research facility was used for test firing a variety of vehicle-mounted guns. These particular tests only involved inert rounds and their associated propellants; rounds containing HE were not used. Both operators of the facility utilized HEs, though the ASR and PRA do not fully indicate the types of explosives used (USACE, 2001a and 2001b).

7.2.1. CSM

7.2.1.1. Estimated MC Loading

The estimated MC loading area for the former EOD range / DSWA facility is shown in Figure 7.2-1. Available information regarding historical expenditures rates is general and not specific enough to develop MC loading estimates. The former EOD range is described as being used "minimally every few months" by various military units and government agencies. The test fire of guns at the DSWA facility involved approximately 50 rounds per year; no expenditure information is available for these events (USACE, 2001a and 2001b).

Given the lack of specific expenditure data, existing expenditure data collected for the current EOD range (**Section 7.1.1.1**) were used to estimate MC loading across the estimated time period of use and acreage of this area through application of the REVA MC Loading Rate Calculator. It is noted that explosives and demolitions used for training by the Scout and Sniper School associated with Range G may have been used in this MC loading area, likely beginning in 1943 and ending in 1944, though this historical loading is addressed as part of the Range G MC loading area (**Section 7.5**).

The estimated perchlorate loading in Table 7.2-1 may be attributed primarily to the use of expenditure data from the Current EOD Range MC loading area. Based on discussion presented in **Section 7.1.1**, actual perchlorate loading at the Former EOD Range / DSWA MC loading area is not anticipated and is presented here due to the use of surrogate

expenditure data, which are sensitive to the reported use of a few munitions types not routinely used at such a range.

Table 7.2-1: Estimated Annual MC Loading for Former EOD Range / DSWA MC Loading Area

MC Loading Area	Period	Begin Use	End Use	HMX (kg/m^2)	RDX (kg/m^2)	TNT (kg/m^2)	Perchlorate (kg/m^2)
Former EOD / DSWA	C (1938–1976)	1972	1976	0.00E-00	5.01E-07	1.20E-07	2.37E-07
	D (1977–1988)	1977	1988	0.00E-00	4.01E-07	9.60E-08	1.90E-07
	E (1989–Present)	1989	1997	0.00E-00	5.01E-07	1.20E-07	2.37E-07

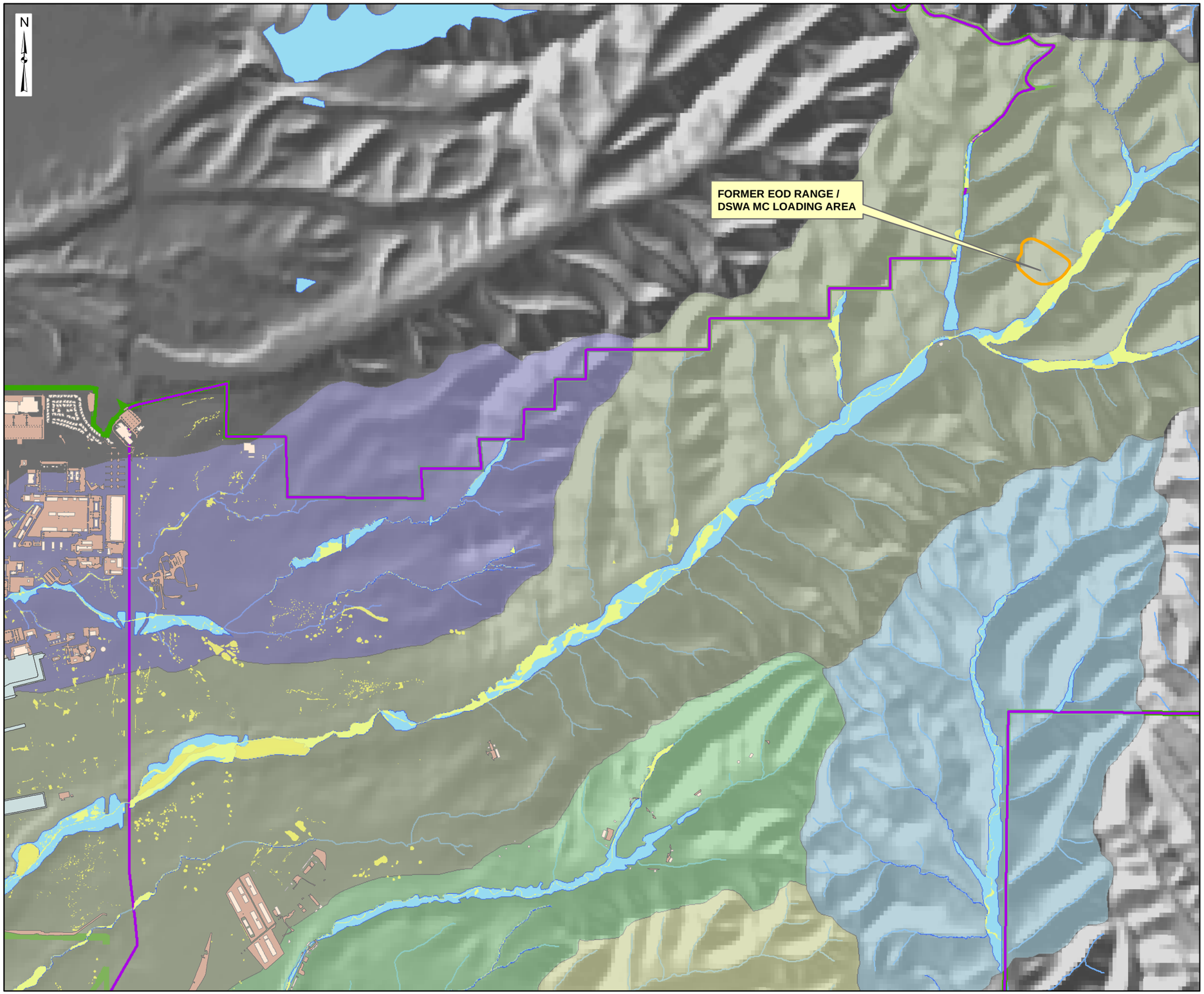
7.2.1.2. Geography and Topography

The Former EOD Range / DSWA MC loading area is located near the north-central boundary of East Miramar. It falls on a small drainage, varying between approximately 35 and 100 feet in width, which slopes downward from the northwest to the southeast towards a larger drainage immediately adjacent to the MC loading area. An unpaved access road runs southwest-northeast just inside the northwest boundary of the MC loading area; the area is presently undeveloped. Based on available GIS data, it sits on the side of a canyon and has elevations ranging from 730 to 900 feet amsl (MCAS FMD, 2007). Based on available elevation contour data, the average slope of the MC loading area is approximately 14.8%.

7.2.1.3. Surface Water Features

The Former EOD Range / DSWA MC loading area is located within the San Clemente Canyon subwatershed (Figure 7.2-2). As noted in **Section 6.4**, this is the largest drainage area within East Miramar, as well as the entire installation. Surface water in this subwatershed is primarily intermittent drainage generated during precipitation events. There are no permanent surface water features in this subwatershed, though small, ephemeral ponds attributed to pre-military homesteading are present in the undeveloped reaches in East Miramar. Additionally, many of the vernal pools at MCAS Miramar are present in this subwatershed; however, all of the identified vernal pools are located west of the MC loading area.

The Former EOD Range / DSWA MC loading area is located within a small tributary of San Clemente Canyon subwatershed and is immediately adjacent to the primary drainage of the subwatershed. Drainage from this point travels almost 8.5 miles to the southwest, crossing the western boundary of the East Miramar Range Complex before reaching the western installation boundary of MCAS Miramar. As noted in **Section 6.4**, the canyon



REVA
FIGURE 7.2-2
SURFACE DRAINAGE BASINS - FORMER EOD RANGE / DSWA MC LOADING AREA

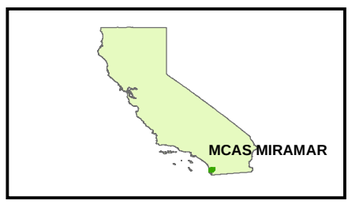
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- BUILDINGS
- VEHICLE PARKING LOT

SUB-WATERSHEDS

- ELANUS CANYON
- MURPHY CANYON
- OAK CANYON
- ROSE CANYON
- SAN CELEMENTE CANYON
- LAKES
- SURFACE WATER (INTERMITTENT)
- WETLANDS



0 500 1,000 2,000 3,000 FEET

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
LIDAR, SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

Map Document: (P:\16285024\MCAS Miramar\GIS\Projects\PRD\Figure7.2-2.mxd)
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comes to a confluence with Rose Canyon approximately 3 miles west of the installation boundary. Rose Canyon continues to flow from the confluence and discharges into Mission Bay.

7.2.1.4. Soil Characteristics and Land Cover

The Former EOD Range / DSWA MC loading area is located on a tributary immediately adjacent to the main drainage of the San Clemente Canyon subwatershed. As noted in **Section 6.3**, the bottoms of canyons in East Miramar typically are covered with alluvium or riverwash sediments. Dissected Redding cobbly loam is the only soil type present within this MC loading area (Figure 7.2-3). Redding series are moderately well to well drained soils, with very slow to slow permeability. The ground cover is generally bare, sparsely vegetated with chapparal.

7.2.1.5. Erosion Potential

The estimated erosion potential of the Former EOD Range / DSWA MC loading area is moderate to high due to its steep topography (14.8% slope) and sparse vegetative cover.

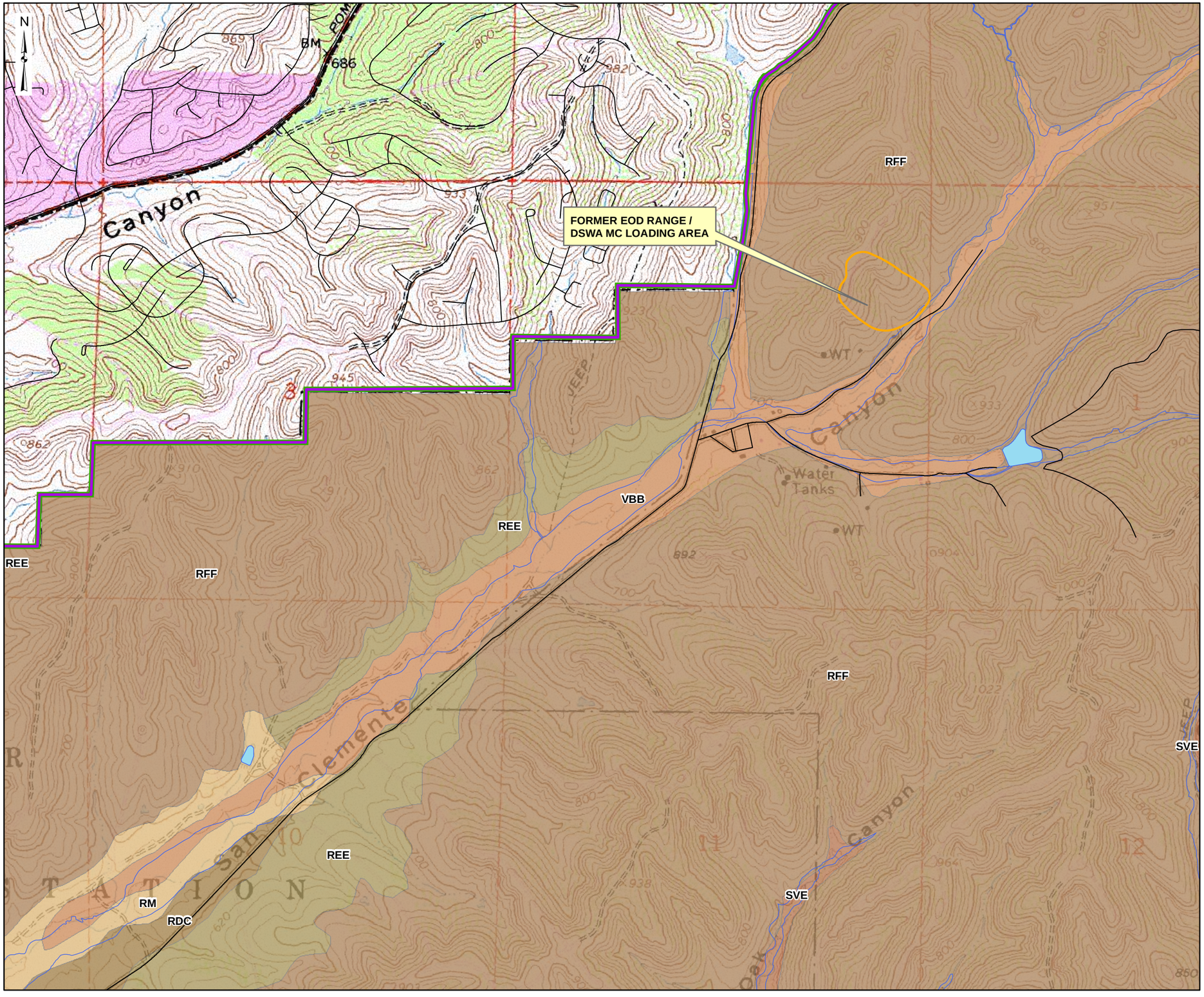
7.2.1.6. Groundwater Characteristics

Groundwater characteristics are similar to those described for the Current EOD Range MC loading area. Limited information exists on groundwater occurrence and flow characteristics in this area. Very little of the rainfall is expected to infiltrate to the groundwater, especially on the steep mountain walls. Some infiltration may occur in the alluvium-filled canyon bottoms. Subsurface water in the alluvium is normally found only after rainfall events or wetter-than-normal seasons. Most of it is expected to be removed by evapotranspiration before traveling far. The presence of hardpan under most of the installation is likely to prevent the movement of shallow groundwater to the deeper aquifers in the area.

7.2.1.7. Potential Groundwater and Surface Water Pathways

Surface Water Pathways

Similar to the Current EOD Range MC loading area, surface water runoff is the dominant pathway for MC transport at the Former EOD Range / DSWA MC loading area. MC potentially migrate downstream via transportation of MC adhered to eroded soil particles within the surface water and dissolution of MC into surface water runoff. As noted in **Section 7.2.1.3**, this MC loading area may be flushed by infrequent precipitation events, eventually traveling to the southwest through the relatively long primary drainage of San Clemente Canyon and moving off installation.



REVA
FIGURE 7.2-3
SOIL MAP - FORMER EOD RANGE / DSWA MC LOADING AREA

MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)
- ROADS

PRIMARY SOIL TYPES:

RFF - REDDING COBBLY LOAM, 15-50%
REE - REDDING COBBLY LOAM, 9-30%
SVE - STONY LAND
VBB - VISALIA GRAVELLY SANDY LOAM, 2-5%

0 340 680 1,360 2,040 Feet

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007
CASIL 2007

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Groundwater Pathways

As previously described in **Section 7.1.1.6**, the potential for subsurface migration of MC into groundwater is limited by infrequent rainfall and high evapotranspiration rates. The limited infiltrating water is not expected to reach deeper groundwater. MC reaching the shallow groundwater in the canyon/drainage alluvium could be transported down the canyon; however, the distance to the installation boundary is approximately 8.5 miles.

7.2.1.8. Potential Groundwater and Surface Water Receptors

Surface Water Receptors

San Clemente Canyon has been designated by the San Diego Region Basin Plan to have existing beneficial uses for contact and non-contact recreation; warm freshwater, cold freshwater, and wildlife habitat; rare, threatened, or endangered species; and spawning, reproduction, and/or early development (CRWQCB, 1994). There is also a potential beneficial use has been designated for industrial service supply. Designation of an "existing beneficial use" signifies such use has occurred since November 28, 1975, or that water quality and quantity is suitable to allow the use to be obtained. Designation of a "potential beneficial use" occurs for a variety of reasons, including the existence of known future plans for such use or existence of regional water quality goals. The drainage is ephemeral within and outside the installation; consequently, the potential for actual recreational and industrial users is considered remote.

As noted in **Section 7.2.1.3**, surface runoff from San Clemente Canyon may eventually travel off-installation and reach Mission Bay, a large marine water body used by a variety of human receptors for various recreational purposes.

Seasonal wetland areas, including vernal marsh, are present in the main reach of the subwatershed and several of its tributaries; such habitat has been identified in the main drainage channel adjacent to the Former EOD Range / DSWA MC loading area. Additionally, vernal pools that support rare, threatened, or endangered plant and animal species have been documented in this subwatershed, predominantly near West Miramar; some pools have been identified along portions of the main drainage of San Clemente Canyon. The California gnatcatcher, a federally listed threatened species, has been sighted a number of times throughout much of the San Clemente Canyon. The endangered willowy monardella and Del Mar manzanita have also been documented in this subwatershed. The former has been noted adjacent to the MC loading area and along the primary drainage, while the latter has been observed on the opposite slope of the canyon. However, much of San Clemente Canyon was badly burned during the Cedar Fire of 2003. In the latest INRMP (2006), post-fire sightings of the California gnatcatcher in this canyon are only noted in the westernmost reaches of the main

drainage. Additionally, most of the willowy monardella across MCAS Miramar and all of the Del Mar manzanita were lost during the fire. As noted in **Section 6.7**, the significance of MC exposure to these special status species is considered to be limited given potential for uptake or consumption of adversely impacted runoff.

Groundwater Receptors

There are no known human or ecological receptors for the shallow groundwater leaving the Former EOD Range / DSWA MC loading area. Groundwater characteristics and pathways at the Former EOD Range / DSWA MC loading area are generally the same as those previously described for the Current EOD Range MC loading area.

7.2.2. Surface Water Analysis Results

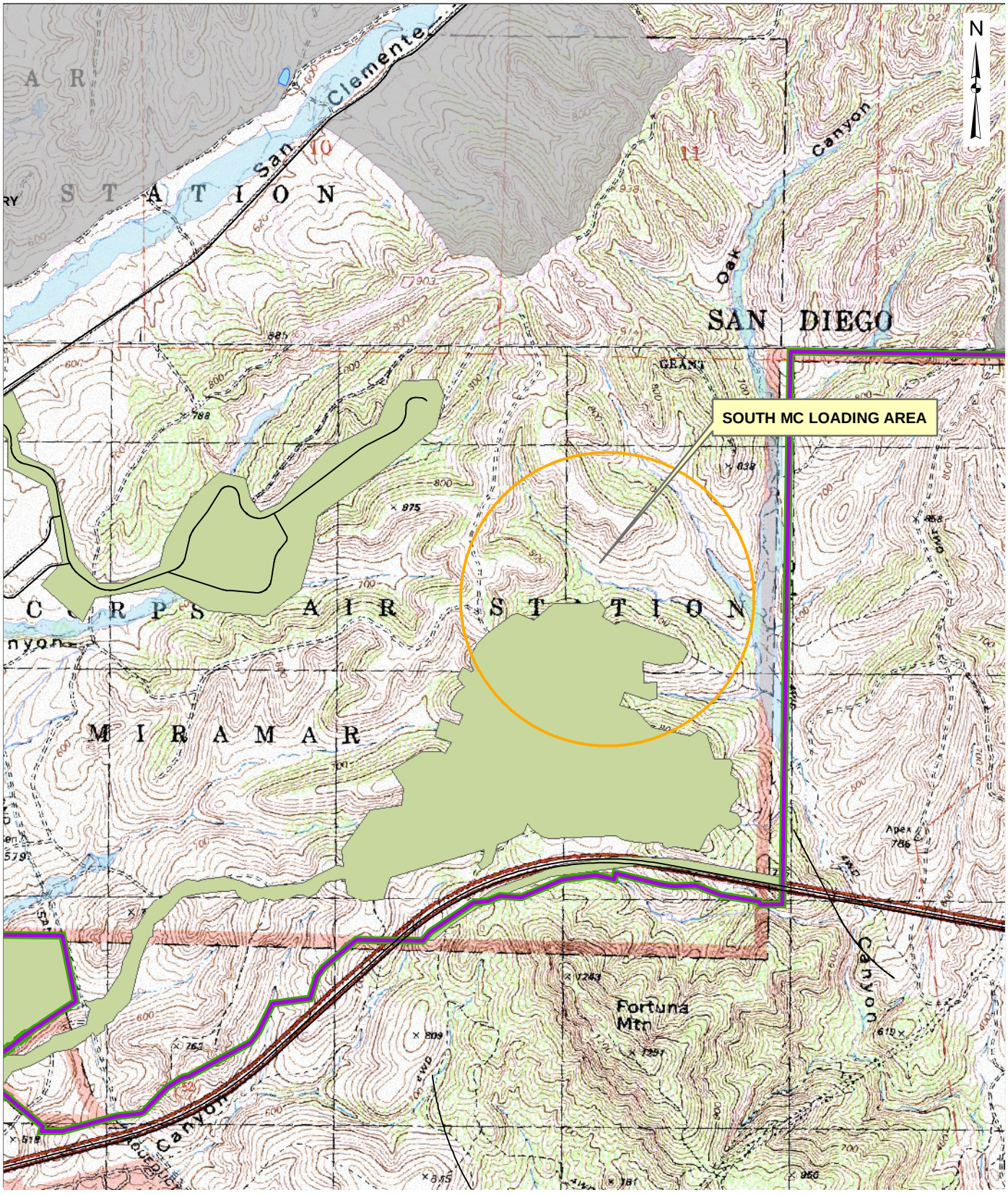
The Former EOD Range / DSWA MC loading area represents historical MC loading that occurred during Navy administration of the installation. No significant, active MC loading occurs at this location. The generally low MC loading rates estimated for the range, combined with the infrequent use and long distance of the MC loading area to the off-range boundary, suggest that off-range releases from the historical use MC loading area are likely not to have occurred. Additionally, conservative calculations provided in **Section 7.3.2** demonstrate that MC attributed to historical range use likely has degraded/attenuated since cessation of the historical munitions usage at this former range. Consequently, MC transport through the surface drainages of San Clemente Canyon was not modeled under the screening analysis method utilized for the Current EOD Range MC loading area (**Section 7.1**).

7.2.3. Groundwater Analysis Results

A qualitative groundwater analysis was performed by analyzing the source media, migration mechanisms, and exposure pathways documented in the MCAS Miramar CSM. Based on the results of the qualitative analysis of the groundwater information, limited potential exists for MC migration to groundwater, and no potential receptors of groundwater were identified. Therefore, a groundwater screening-level analysis was not conducted. Discussions of the qualitative analysis and screening-level analysis are presented in **Section 5**.

7.3. South

The South MC loading area is a conservatively estimated composite of overlapping firing fans associated with one WWI-era range and two WWII-era ranges. It is located at south-central boundary of the East Miramar Range Complex (Figure 7.3-1), covering approximately 323.7 acres. No training areas or fixed ranges that are currently in use overlap with this MC loading area. A notable fraction of the South MC loading area



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- TRAINING AREAS
- UNAVAILABLE FOR TRAINING
- LAKES
- SURFACE WATER (INTERMITTENT)

0 500 1,000 2,000 3,000 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

MALCOLM PIRNIE

MCAS MIRAMAR
MIRAMAR, CALIFORNIA
RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

SOUTH MC LOADING AREA

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OCTOBER 2008
FIGURE 7.3-1

Map Document: (P:\6285024\MCAS Miramar\GIS\Projects\PRD\Figure7.3-1.mxd)
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overlaps with the proposed location of the Military Family Housing Site 8. Once constructed, this housing will represent a use incompatible with training activities conducted within in the East Miramar Range Complex and will exclude use of the area as part of operational training activities. Full site investigation and remediation activities addressing any explosive and chemical constituent hazards will be conducted prior to any future developmentof this site.

The historical ranges included within the South MC loading area include artillery targets (associated with Camp Kearny), a mortar impact area (associated with Camp Holcomb), and the Range I Anti-Tank Range (associated with Camp Elliott). The WWI artillery targets were used from 1917 to 1920; the mortar impact area was used from 1934 to 1941; and Range I was used from 1941 to 1950. Limited additional information is available regarding these ranges; the ASR and PRA identified these ranges primarily based upon historical maps and photographs (USACE, 2001a and 2001b).

Military Munitions

HE munitions and small arms ammunition were utilized at the former ranges comprising the South MC Loading area. However, detailed military munitions use data (e.g., total expenditures, DoDICs, frequency of training) are not available for these historical use ranges.

7.3.1. CSM

7.3.1.1. Estimated MC Loading

Because little information is available that directly addresses quantities of expenditures utilized at the historical ranges contributing to the South MC loading area, the Training Analysis Method discussed in **Section 3.6** was used to conservatively estimate historical MC loading at this area. Assumptions were developed using information available in historical documents. The most significant information was available for Camp Elliott, established to train Marines for combat in WWII. It can be assumed that the training tempo was extremely elevated during this time. A document titled *A Training Center Chronicle*[2] by Second Lieutenant Frederick Jones dated August 1943 provides some information on the Anti-Tank School at Camp Elliott and, correspondingly, the use of Range I.

The document states that the Anti-Tank School operated "on a concentrated eight-week schedule that consumes 337 training hours. Its classes, begun every other week, are comparatively small—not usually over 15 or 16 men." From this observation, it is conservatively estimated that 26 classes were held per year with 20 Marines in each class.

[2] Document found as Appendix E-2 in a USACE report (1996).

This provides a total of 520 Marines trained per year. Jones also states that the Anti-Tank School was divided evenly between classroom and field training. According to the document, "when the men are thoroughly familiar with the anti-tank guns and their use, they spend the balance of their training time in the field, undergoing hardships, conducting intricate maneuvers, and firing on Elliott's various anti-tank combat ranges. The $100,000 electronically controlled moveable target anti-tank range … is one phase of the student's advanced training in the field." Using a conservative assumption that units in addition to the Anti-Tank School may have used the ranges, the number of Marines trained per year is conservatively estimated at 1,000.

During training, Marines fired a variety of anti-tank munitions. However, no information regarding numbers of munitions per school session or individual is available. Based on the description of the school, it is conservatively estimated that every individual fired four rounds of five different types of anti-tank munitions anticpated to be used at this range.

Similar assumptions were utilized in estimating expenditures from the other two ranges, as limited information was available. The latest ICRMP indicates that a total of over 60,000 men trained at Camp Kearny (Anteon, 2004); no other notable information is provided regarding munitions use between 1917 and 1920. Given that artillery represents a specialized function within combat training, it is presumed that not every trainee at Camp Kearny fired munitions listed for the artillery range. Assuming a total of 66,000 men trained at Camp Kearny and 20% of these individuals engaged in artillery training over the three-year period, it is conservatively estimated that 4,400 men engaged in artillery training exercises on an annual basis. Additionally, as with Range I and given the lack of pertinent information regarding artillery training at the installation, it is assumed that every individual fired four rounds of five different types of artillery rounds anticpated to be used on the artillery range.

According to the ICRMP, only two Marine battalions were "intermittently" stationed at the installation from 1934 until 1941, when the installation was expanded (Anteon, 2004); the aforementioned *A Training Center Chronicle* notes that the area only operated "six or eight months out of the year—during the dry season." No other notable information regarding training levels or exercises during this period has been identified. Typically, a battalion consists of approximately 324 Marines. Assuming two battalions were stationed at Camp Holcomb simultaneously, it may be estimated that 648 Marines were present at the installation at any moment. Again, it is likely that only a portion of the Marines stationed utilized the mortar range present during this time period. However, because of the lack of information, it is conservatively assumed that 648 Marines trained annually during this time period and that every individual fired four rounds of four different types of mortar rounds likely to have been used on the range.

Collectively, this information was used in the REVA MC Loading Rate Calculator to estimate loading attributed to the designated common impact area utilized by these three historical ranges (Table 7.3-1). It was assumed all munitions fired from these three ranges landed within the South MC loading area. Information regarding indicator MC content in relevant munitions was gathered from installation-specific USACE documents (1996; 2001a; 2001b). TNT is one of the more common fillers associated with the identified munitions. HMX was not fully developed until late WWII. RDX was identified as an explosive after WWI, though this explosive did not receive extensive study until WWII, where its use in a limited number of munitions (including Composition B, mines, and warheads) is documented (Fedoroff and Sheffield, 1974). Perchlorate was not incorporated into munitions (as a component of solid-based propellants) until well after WWII (Bedard, 2007). Given HMX, RDX, and perchlorate were nonexistent or in limited use through WWII, potential loading of these REVA indicator MC on this historical use area is considered to be negligible. Other parameters necessary to complete the analysis are obtained under the guidelines of the *REVA Reference Manual*. It is indicated that a mix of WWI and WWII munitions may have been utilized by Marines stationed at Camp Holcomb (USACE, 1996); MC values associated with WWII munitions, as presented in the ASR, were selected when estimating loading associated with the time period between 1934 and 1941.

Table 7.3-1: Estimated Annual MC Loading for the South MC Loading Area

MC Loading Area	Period	Begin Use	End Use	HMX (kg/m^2)	RDX (kg/m^2)	TNT (kg/m^2)	Perchlorate (kg/m^2)
South	A (1914–1924)	1917	1920	0.00E-00	0.00E-00	2.37E-04	0.00E-00
	B (1925–1937)	1934	1937	0.00E-00	0.00E-00	4.79E-06	0.00E-00
	C (1938–1976)	1938	1950	0.00E-00	0.00E-00	9.37E-06*	0.00E-00

* This estimated TNT loading rate presented for Period C is the higher of two rates estimated from physically and temporally separate loading activities that occurred within the timeframe defined as Period C. Between 1938 and 1941, TNT loading rate is estimated to be 7.18E-06 kg/m^2; between 1941 and 1950, TNT loading rate is estimated to be 9.37E-06 kg/m^2.

7.3.1.2. Geography and Topography

The South MC loading area is located near the south-central boundary of the East Miramar Range Complex. It is largely undeveloped and spans across three small, narrow tributaries that slope from west to east and southeast, all arriving at a common, larger drainage. Its western edge, less than 10% of its total 323.7 acres, just overlaps tributaries that generally slope down to the west and are part of separate subwatersheds. Unpaved firebreak / access roads bend through the MC loading area along the top of ridges separating drainages. Based on available GIS data, the elevations range from

approximately 560 to 890 feet amsl (MCAS FMD, 2007). Based on available elevation contour data, the average slope of the MC loading area is approximately 9.3%.

7.3.1.3. Surface Water Features

The South MC loading area is almost fully contained within the Oak Canyon subwatershed; its western edge overlaps slightly with the boundaries of the Elanus Canyon and Murphy Canyon subwatersheds (Figure 7.3-2). There are no permanent surface water features in these subwatersheds; surface water consists of intermittent drainage generated during precipitation events. Small clusters of vernal pools have been noted near the southwest end of Murphy Canyon and the southern edge of the Elanus Canyon subwatershed. As noted in **Section 6.4**, Oak Canyon drains to the south, while Murphy and Elanus Canyons drain to the southwest. Almost the entire area of the South MC loading area drains within Oak Canyon; drainage leaving the area travels along the main drainage approximately 0.38 miles until it reaches the southern installation boundary. Oak Canyon continues draining south off the installation through an undeveloped area and discharges into the San Diego River approximately 1.5 miles southeast of the installation boundary.

7.3.1.4. Soil Characteristics and Land Cover

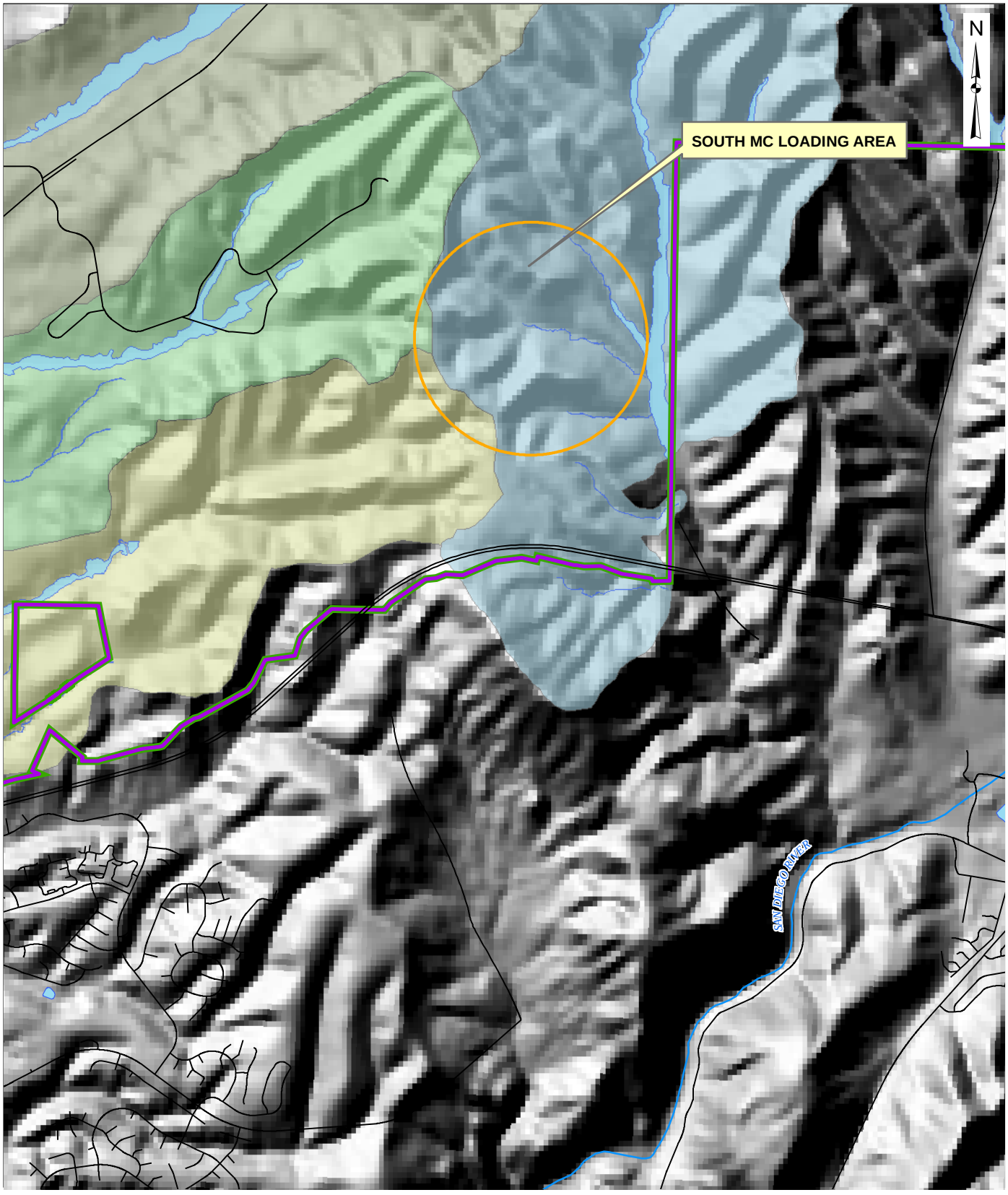
The South MC loading area is located on a number of tributaries of the Oak Canyon subwatershed; its eastern edge is immediately adjacent to the main drainage of the subwatershed. The predominant soil type within the MC loading area is dissected Redding cobbly loam (94.3%); Friant rocky fine sandy loam is present in its southern reaches (4.5%), while stony land is located within the lower ends of the some of the Oak Canyon tributaries (1.2%) (Figure 7.3-3). The dissected Redding cobbly loam is the predominant soil type for the tributaries within the South MC loading area, though stony land appears to the dominant soil type with the primary drainage of Oak Canyon. Redding series are moderately well to well drained soils, with very slow to slow permeability. Friant series are well drained soils, with moderately rapid permeability. The ground cover is generally bare with very sparse chapparal vegetation.

7.3.1.5. Erosion Potential

The estimated erosion potential of the South MC loading area is moderate to high due to its steep topography (9.3% slope) and sparse vegetative cover.

7.3.1.6. Groundwater Characteristics

Groundwater characteristics are similar to those previously described for the Current EOD Range and Former EOD Range / DSWA MC loading areas.



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- LAKES
- SURFACE WATER (INTERMITTENT)

SUB-WATERSHEDS

- ELANUS CANYON
- MURPHY CANYON
- OAK CANYON
- SAN CELEMENTE CANYON
- MINOR ROAD

0 700 1,400 2,800 4,200 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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SURFACE WATER DRAINAGE BASINS - SOUTH MC LOADING AREA

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FIGURE 7.3-2

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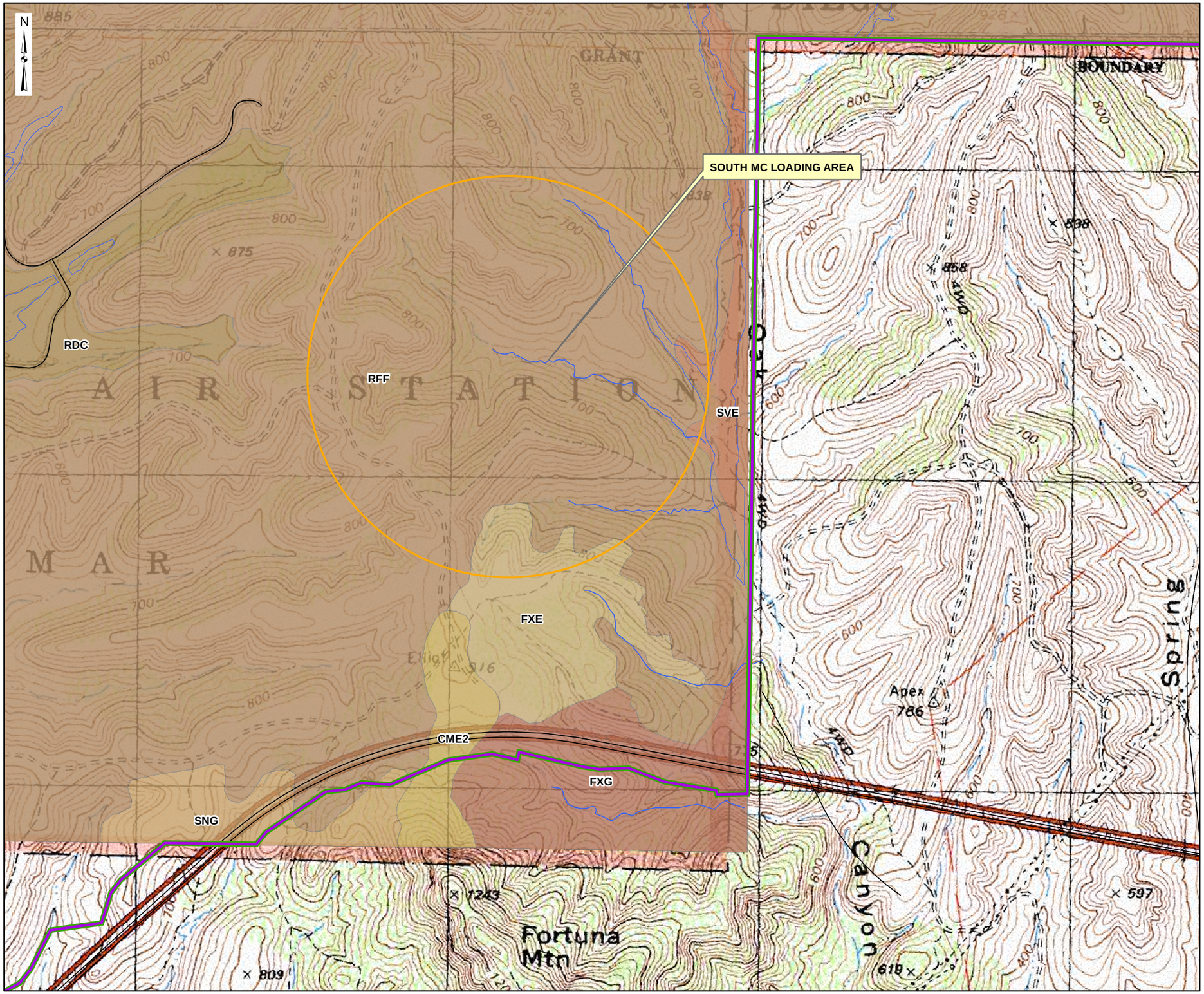


REVA
FIGURE 7.3-3
SOIL MAP - SOUTH MC LOADING AREA

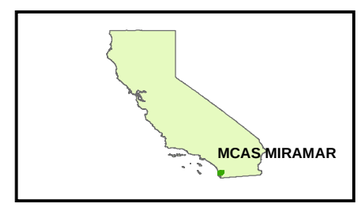
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- LAKES
- ROADS
- SURFACE WATER (INTERMITTENT)

PRIMARY SOIL TYPES:

RFF - REDDING COBBLY LOAM, 15-50%
SVE - STONY LAND
FXE - FRIANT ROCKY FINE SANDY LOAM, 9-30%
FXG - FRIANT ROCKY FINE SANDY LOAM, 30-70%



0 275 550 1,100 1,650
Feet

DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
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MALCOLM PIRNIE

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7.3.1.7. Potential Surface Water and Groundwater Pathways

Surface Water Pathways

Similar to the other MC loading areas previously described, surface water runoff is the dominant pathway for MC transport at MCAS Miramar, though there are no perennial water bodies within the Oak Canyon, Elanus Canyon, or Murphy Canyon subwatersheds where the South MC loading area is located; surface water flow is ephemeral. MC potentially migrate downstream via transportation of MC adhered to eroded soil particles within the surface water and dissolution of MC into surface water runoff. As noted in **Section 7.3.1.3**, this MC loading area may be flushed by infrequent precipitation events, largely draining to the south through Oak Canyon and moving off installation toward the San Diego River.

Groundwater Pathways

As previously described for the other MC loading areas, infrequent rainfall and high evapotranspiration rates limit the potential for subsurface migration of MC into groundwater. The limited infiltrating water is not expected to reach deep groundwater. MC reaching the shallow groundwater in the Oak Canyon alluvium could be transported down the canyon; however, groundwater seeps have not been identified on MCAS Miramar. The distance to the installation boundary from the nearest point in the loading area is approximately one-quarter mile.

7.3.1.8. Potential Surface Water and Groundwater Receptors

Surface Water Receptors

Oak Canyon has been designated by the San Diego Region Basin Plan to have existing beneficial uses for agriculture, industrial service supply, contact and non-contact recreation, and warm freshwater and wildlife habitat (CRWQCB, 1994). Murphy Canyon shares the same designations, as well as an existing beneficial use for rare, threatened, or endangered species; the basin plan does not comment on designations for Elanus Canyon. Designation of an "existing beneficial use" signifies such use has occurred since November 28, 1975, or that water quality and quantity is suitable to allow the use to be obtained. The drainages are ephemeral within and outside the installation; consequently, the potential for actual recreational, agricultural, and industrial users is considered remote.

As noted in **Section 7.3.1.3**, runoff from Oak Canyon may eventually travel off the installation and reach the San Diego River, which provides a variety of human and

ecological receptors. The river ultimately discharges into the Pacific Ocean near the community of Ocean Beach.

Seasonal wetland areas, including vernal marsh, are present in the main reach of the Oak Canyon subwatershed; such habitat has been identified in the main drainage channel adjacent to the South MC loading area. This habitat has also been identified in the Murphy Canyon and Elanus Canyon subwatersheds. No vernal pools have been identified in Oak Canyon. A limited number of pools have been documented in Murphy Canyon. Additionally, small clusters of pools have been identified along the north and south sides of Elanus Canyon; elevation contours suggest that these pools are not exposed to the main drainage pathway in the canyon. The California gnatcatcher has been sighted a number of times in Murphy and Elanus Canyons, but not in Oak Canyon. Willowy monardella has been documented in the lower end of Elanus Canyon. Del Mar manzanita has been documented in Oak Canyon, including a portion of the South MC loading area. However, these canyons were badly burned during the Cedar Fire of 2003. In the latest INRMP (2006), no post-fire sightings of the California gnatcatcher in Murphy Canyon are noted. Additionally, most of the willowy monardella across MCAS Miramar and all of the Del Mar manzanita were lost during the fire. Due to the limited data available for species occurrences located off the installation, additional ecological receptors may exist within Oak and Elanus Canyons (the Murphy Canyon subwatershed lies within the installation boundary). Regardless, as noted in **Section 6.7**, the significance of MC exposure to these special status species is considered to be limited given potential for uptake or consumption of adversely impacted runoff.

Groundwater Receptors

Similar to the other MC loading areas previously described, there are no known human or ecological receptors for the shallow groundwater leaving the South MC loading area.

7.3.2. Historical MC Loading Analysis

The South MC loading area represents historical MC loading from three ranges that were active at varied times between WWI and WWII; these ranges were active for approximately 19 years total. No significant, active MC loading occurs in the subwatersheds where the MC loading area is located. Only TNT is likely to be an MC of concern for this area, as RDX, HMX, and perchlorate had just started entering the DoD arsenal or had not yet been fully developed during the period of operation. Because of these factors, it is believed that MC loading from the South MC loading area is negligible.

Further support for this statement is provided in the following first-order decay rate calculations. The first-order decay rate for TNT (provided in the *REVA Reference Manual* and used in the REVA modeling effort) was applied to the South MC loading

area for Period C (1938–1976) since its MC loading was estimated based on historical documentation. The following calculations provide the estimated time required for TNT to decay to a negligible concentration in soil (1.0 E-08 micrograms per kilogram [µg/kg]) following complete mixing in the upper 6 inches of soil within the MC loading area and conservatively assuming TNT is not lost to dissolution and subsequent transport via surface runoff or infiltration.

Assuming complete mixing into the top 6 inches of soil with no dissolution in water:

a. Calculate concentration in soil (C_s):

   The MC loading rate for TNT is estimated at 9.37E-06 kg/m^2/year from 1938 to 1950. Soil particle density (ρ_s) at the South MC loading area is 1948 kilograms per cubic meter (kg/m^3).

$$C_s = \left(\frac{9.37E-06\ \ kg}{m^2\ year}\right)\left(\frac{13 years}{1}\right)\left(\frac{1}{6 inches}\right)\left(\frac{39.37 inches}{m}\right)\left(\frac{1 m^3}{1948 kg}\right)\left(\frac{1E-09 \mu g}{kg}\right) = 410.3 \mu g/kg$$

b. Calculate time for TNT concentration in soil to drop to a near zero concentration (soil concentration = 1E-08 µg/kg):

   The first-order decay rate (k) for TNT in soil is 0.03 day^{-1} (HQMC, 2006).[3] The first-order decay rate is based on a literature search of academic, industrial and government papers and publications, which resulted in finding degradation rate values ranging from 0.0058 to 0.06 day^{-1}. As TNT degradation rates are dependent on a wide variety of factors (pH, temperature, redox potential, total organic carbon) it is impossible to determine the exact degradation rate on a particular site without actually doing studies of the site. Therefore, to be consistent with previous REVA evaluations at other installations, a decay rate of 0.03 day^{-1} was selected for this analysis.

$$C = C_o e^{-kt}$$

$$t = \frac{\ln\left(C/C_o\right)}{-k}$$

$$t = \frac{\ln\left(1E-08 \mu g/kg / 410.3 \mu g/kg\right)}{-0.03 day^{-1}}$$

$$t = 815 days$$

[3] There are no REVA trigger values established for MC concentration in soil. The Environmental Protection Agency Method 8330 method detection limit for TNT in soil is 20 µg/kg (HQMC, 2006).

Based on this calculation using the Period C MC loading rate, TNT is expected to decay to a trace level in soil within 2.2 years. Similar calculations using the Period A MC loading rate for TNT (2.37E-04 kg/m^2/year from 1917 to 1920) and Period B MC loading rate for TNT (4.79E-06 kg/m^2/year from 1934 to 1937) resulted in estimated degradation of TNT in 2.4 years and 2.0 years, respectively. Therefore, TNT can be expected to degrade to trace levels over a short period of time, indicating that no MC remain within the South MC loading area.

7.3.3. Surface Water Analysis Results

The South MC loading area accounts for historical loading from three ranges that operated at various times from WWI to WWII. No significant, active MC loading occurs at this location. As discussed in **Section 7.3.2**, MC attributed to these historical activities are not anticipated to be present within the area due to degradation processes over several decades; estimated historical MC loading rates are not believed to have been high enough for MC to be present at a level that could be transported. Consequently, MC transport from the MC loading area was not modeled under the screening analysis method utilized for the Current EOD Range MC loading area (**Section 7.1**).

7.3.4. Groundwater Analysis Results

A qualitative groundwater analysis was performed by analyzing the source media, migration mechanisms, and exposure pathways documented in the MCAS Miramar CSM. Based on the results of the qualitative analysis of the groundwater information, limited potential exists for MC migration to groundwater and no potential receptors of groundwater were identified. Therefore, a groundwater screening-level analysis was not conducted. Discussions of the qualitative analysis and screening-level analysis are presented in **Section 5**.

7.4. Range C

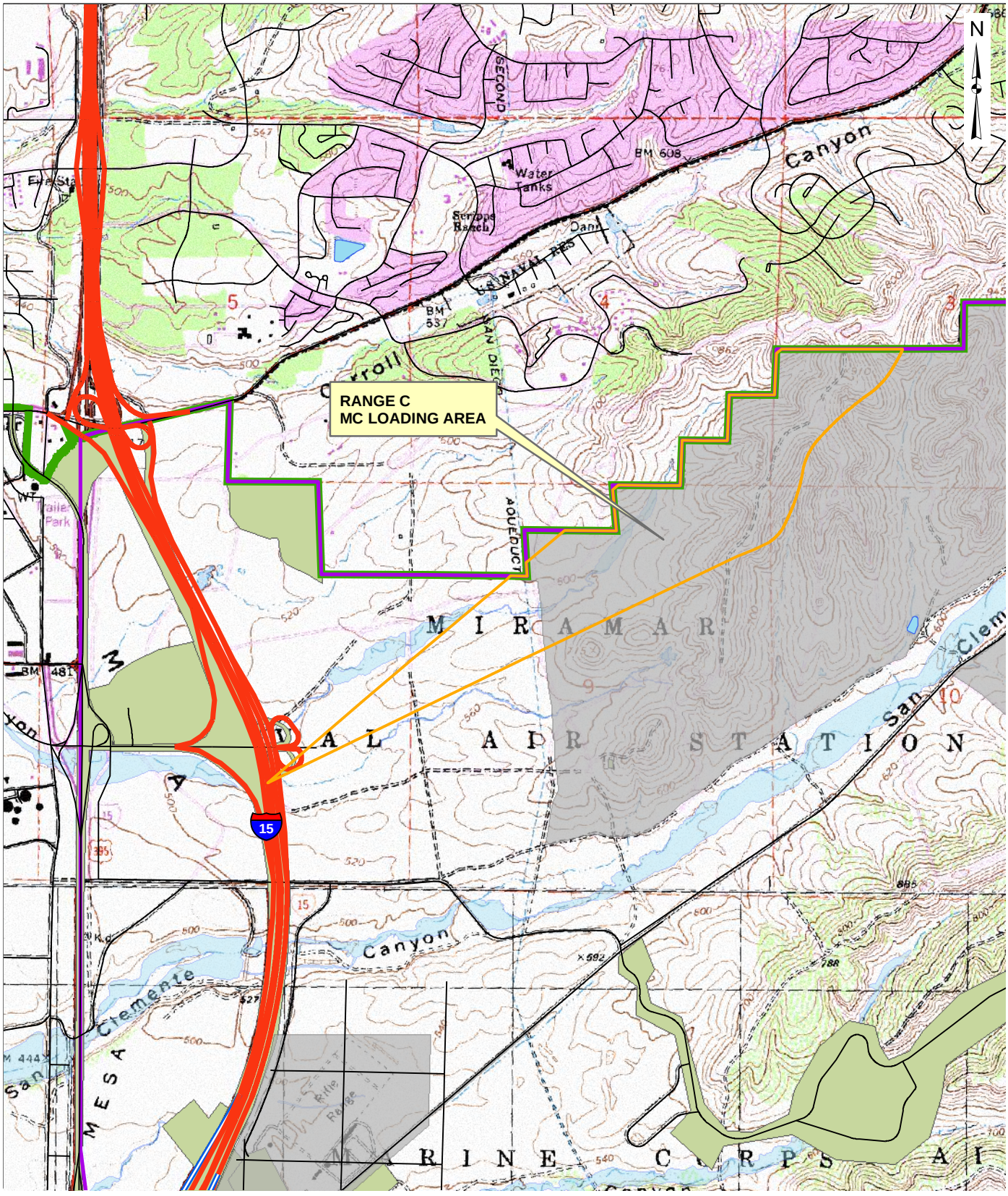
The Range C MC loading area covers an area used during WWII for firing HE munitions and small arms weapons. It is located in the northwestern corner of the East Miramar Range Complex (Figure 7.4-1), covering approximately 249.6 acres within the Rose Canyon subwatershed. A small portion of this historical use range falls outside the installation boundary; this portion of the range is excluded from the analysis of potential MC migration from Range C to an off-range location. This MC loading area is the closest one to the off-range areas of Main Station and South/West Miramar. A 7-acre fishpond is present in the portion of Rose Canyon that runs through West Miramar, though it is over three miles downstream and hydrologically isolated from the main drainage channel that runs the course of the canyon.

No live-fire ranges currently in use overlap with this historical MC loading area, though much of it falls within the designated boundary of Training Area 4. Range C was operated by the Marine Corps during the early 1940s (approximately 1941 to 1944); it is possible the Navy used the range shortly after this time period, though no documentation definitively supports this. Direction of fire was generally to the northeast.

A number of other historical training activities also occurred in the same area covered by Range C. During the WWI era, a SAR target was located within the SDZ of the range; the fans of two WWII-era SARs also overlapped with the MC loading area. The area was also used by the Army as a training area for military and amphibious vehicles from the early 1960s to the early 1970s, although no live fire occurred with this training (USACE, 2001a and 2001b). While former SARs were located in this area, the analysis of the Range C MC loading area focuses solely on HE munitions that may contain REVA MC.

Military Munitions and MC Loading

The classes of military munitions anticipated in this MC loading area include small arms, HE, and practice munitions. No information is available regarding quantities of munitions expended at Range C.



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- TRAINING AREAS
- UNAVAILABLE FOR TRAINING
- LAKES
- SURFACE WATER (INTERMITTENT)

0 500 1,000 2,000 3,000 FEET

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

RANGE C
MC LOADING AREA

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FIGURE 7.4-1

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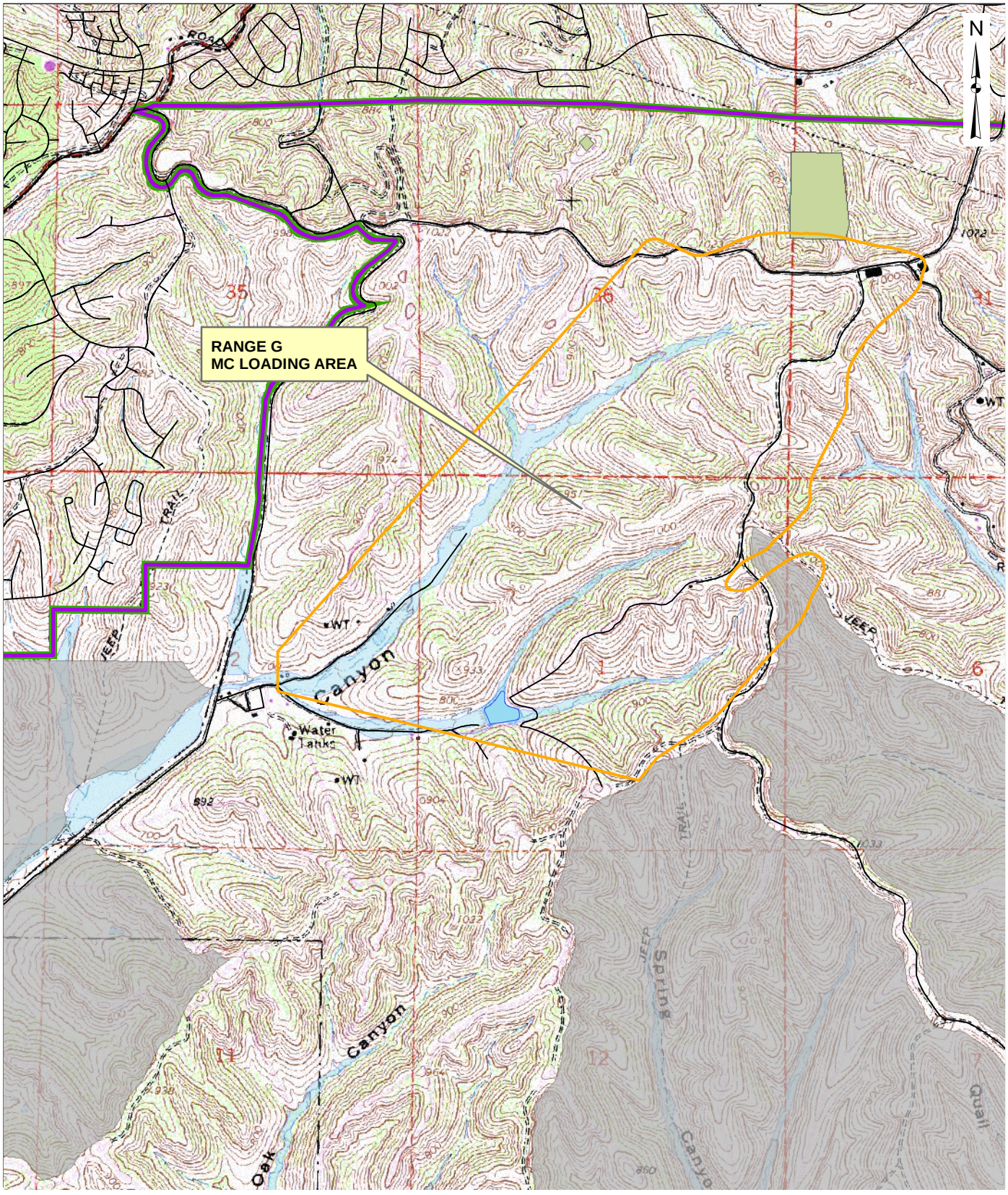
MC loading was not conducted for the Range C MC loading area. As no similar ranges are currently operational at MCAS Miramar, no expenditure data were available to estimate MC loading for the former ranges that comprise this MC loading area. This loading area operated for a limited period of time (three to four years), much shorter than the operation of the three ranges that factor into the South MC loading area where the Training Analysis Method was employed to estimate historical use MC loading (approximately 19 years total). Because only a single historical use range comprised this loading area, munitions expenditures were likely less than that of the South MC loading area, which received expenditures from three ranges that used a larger variety of munitions. In addition, TNT is likely to be the only MC of concern for this area, as RDX, HMX, and perchlorate had just started entering the DoD arsenal or had not yet been fully developed during the period of operation. Due to these factors and consideration of first-order decay rates for TNT made for the South MC loading area (**Section 7.3.2**), it is believed that MC loading from the Range C MC loading area is negligible. Thus, MC loading rates were not estimated for this area, as no further consideration of MC attributed to Range C is warranted.

7.5. Range G

The Range G MC loading area covers an area used as a multipurpose range during WWII, accommodating HE munitions use and small arms training; it was also the primary training area used by a Scout and Sniper School operated during the same time period. It is located in the northern portion of the East Miramar Range Complex, covering approximately 921.7 acres, which partially overlap the respective SDZ and ESQD of Range 100 and the current EOD range (Figure 7.5-1). Firing positions were located at its southwestern corner, with fire directed generally to the northeast and east-northeast. Its irregular shape reflects the downrange limit following the boundary of the surrounding foothills. Range G was operated by the Marine Corps during the early 1940s (approximately 1941 to 1944); the Scout and Sniper School, which utilized this range, was activated in January 1943. It is possible the Navy used the range shortly after 1944, though historical aerial photographs show buildings present in the area by 1949. Other historical training activities also occurred in the same area covered by Range G, specifically the Former EOD Range and DWSA facility (**Section 7.2**). As previously described, the Former EOD Range / DSWA MC loading area is largely located within the boundary of Range G.

Military Munitions and MC Loading

The former Range G, which operated from approximately 1941 to 1944, was used for various HE live-fire training and small arms training (USACE, 2001a and 2001b). Munitions used at this range included HE and practice rounds as well as small arms ammunition.



LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- TRAINING AREAS
- UNAVAILABLE FOR TRAINING
- LAKES
- SURFACE WATER (INTERMITTENT)

SOURCE: MCAS EMD GIS, 2007
HQMC GEOFIDELIS, 2007

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RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

RANGE G
MC LOADING AREA

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FIGURE 7.5-1

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MC loading was not conducted for the Range G MC loading area. As no similar ranges are currently operational at MCAS Miramar, no expenditure data were available to estimate MC loading for the former range at this MC loading area. Similar to Range C (**Section 7.4**), this loading area operated for a limited period of time and received impacts from a single range relative to the historical use of South MC loading area where the Training Analysis Method was employed to estimate historical use MC loading (approximately 19 years total). In addition, TNT is likely to be the only MC of concern for this area, as RDX, HMX, and perchlorate had just started entering the DoD arsenal or had not yet been fully developed during the period of operation. Due to these factors and consideration of first-order decay rates for TNT made for South MC loading area (**Section 7.3.2**), it is believed that MC loading from the Range G MC loading area is negligible. Thus, MC loading rates were not estimated for this area, as no further consideration of MC attributed to Range G is warranted.

8. Small Arms Range Assessments

The REVA indicator MC for SARs is lead, as it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. As described in previous sections, fate and transport parameters for lead at SARs are dependent on site-specific geochemical properties, which cannot be determined solely by physical observation. Therefore, ranges that solely utilize small arms ammunition (defined as nonexplosive ammunition, .50 cal or smaller) for training purposes are qualitatively assessed under the REVA program. Ranges that perform joint small arms and live-fire training with HE munitions are not qualitatively assessed through this process; rather, they are assessed through the MC loading process previously described, and no lead loading is performed. In addition, only operational SARs are addressed in this protocol; historical use SARs that are no longer used are not assessed due to lack of information to adequately perform an assessment.

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.

8.1. 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) – The 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.

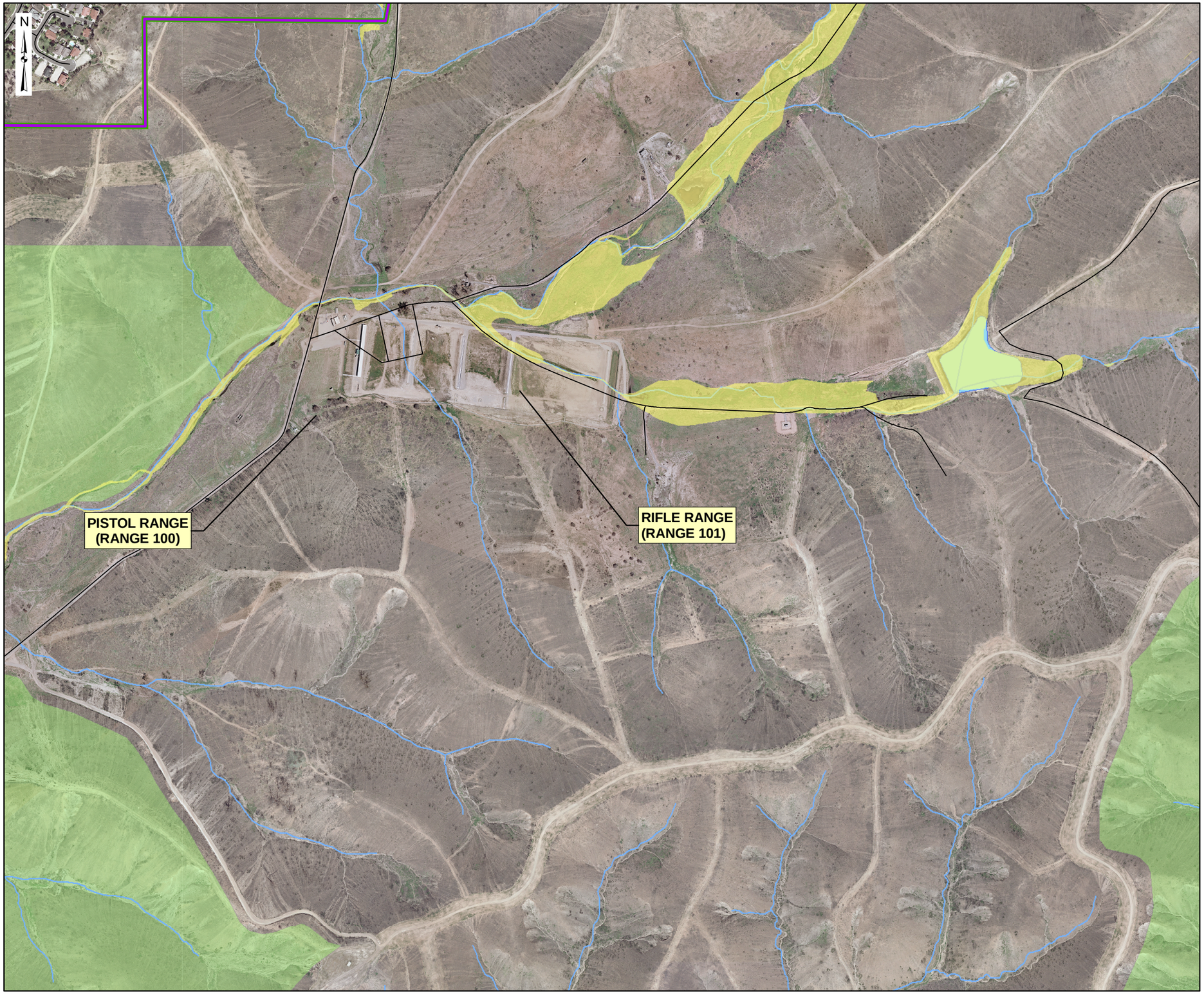
- Moderate (30 to 49 points) – The SAR may have the potential for lead migration and environmental concern, most likely indicating that there is not immediate environmental concern but actions may be necessary to prevent a greater or future concern.
- High (50 to 65 points) – The SAR most likely has 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 eight operational SARs at MCAS Miramar. While each range was evaluated separately using the SARAP, several of the ranges had similar periods of use, types of ammunition, and physical/environmental characteristics that resulted in similar scoring results. Therefore, the discussions of the evaluation of the San Diego County Sheriff's Department's ranges (Ranges 5, 6, and 7) have been grouped together in **Section 8.4**; likewise, the discussions of Marine Corps Ranges B, C, and D have been consolidated in **Section 8.5**.

The physical details of the ranges are shown in Figure 8.1-1 and Figure 8.1-2. A summary of the results of these range assessments is provided in the following sections. Table 8.1-1 provides a summary of the assessment of each range.

Table 8.1-1: Summary of SAR Prioritizations

Range Number	Range Type	Surface Water Environmental Concern	Groundwater Environmental Concern
Range 100	LOMAH Rifle Range	Minimal	Minimal
Range 101	Pistol Range	Minimal	Minimal
Range 5	San Diego County Sheriff's Department – Pistol/Shotgun Range	Moderate	Minimal
Range 6	San Diego County Sheriff's Department – Pistol/Shotgun Range	Moderate	Minimal
Range 7	San Diego County Sheriff's Department – Pistol/Shotgun Range	Moderate	Minimal
Range B	Pistol Range	Moderate	Minimal
Range C	Pistol/Shotgun Range	Moderate	Minimal
Range D	Pistol/Shotgun Range	Moderate	Minimal

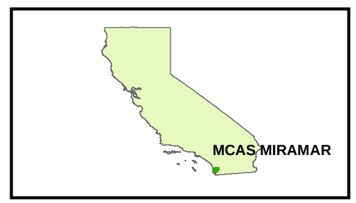


REVA
FIGURE 8.1-1
RANGES 100 AND 101

MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- TRAINING AREAS
- WETLANDS
- MINOR ROAD
- SURFACE WATER (INTERMITTENT)



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DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
LIDAR, SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

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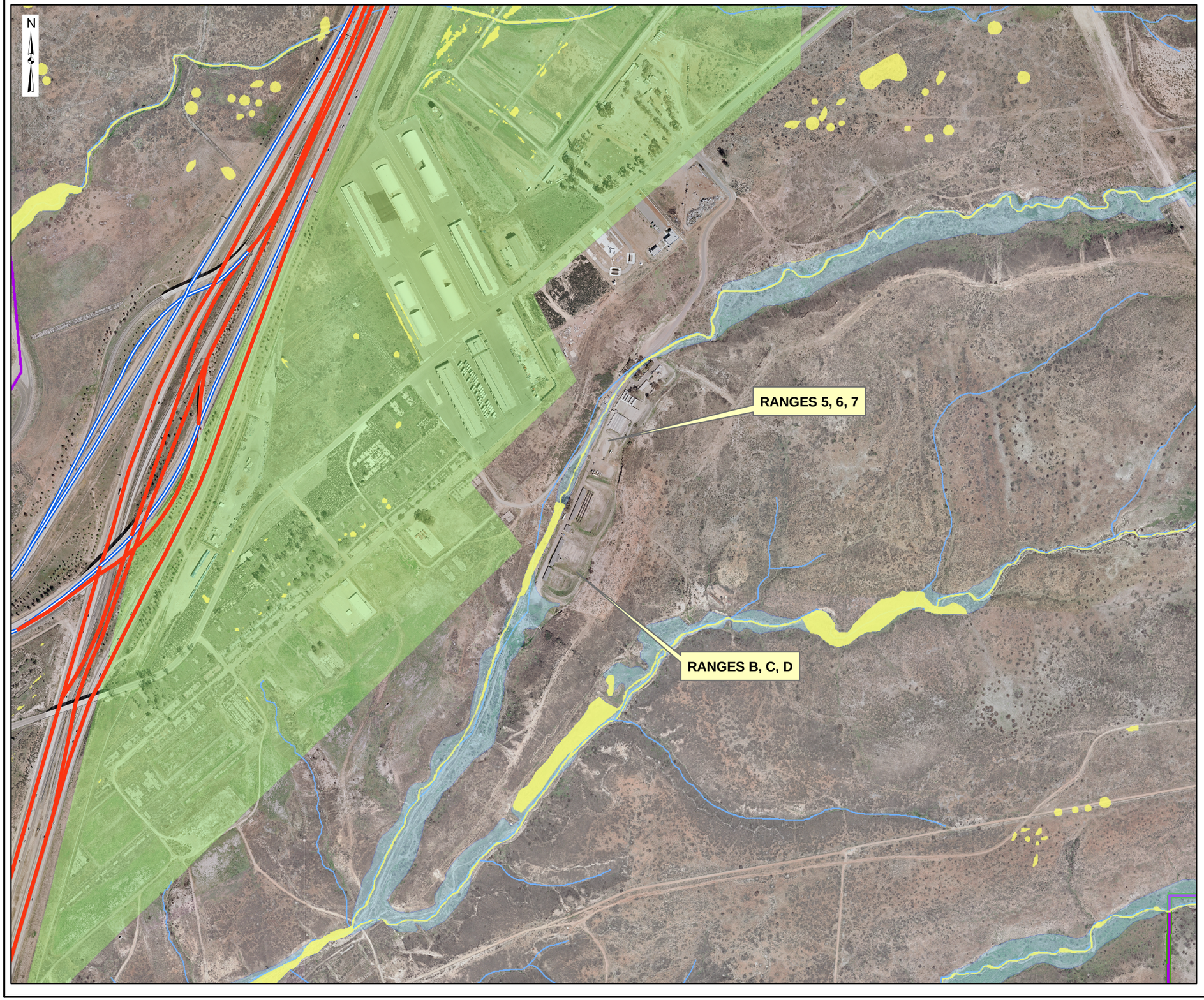


REVA
FIGURE 8.1-2
RANGES B,C,D AND 5,6,7

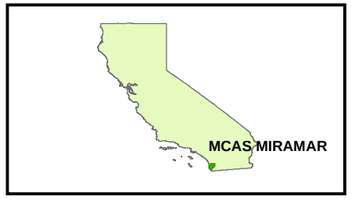
MCAS MIRAMAR
MIRAMAR, CA

LEGEND

- TRAINING AREAS
- WETLANDS

ROAD

- INTERSTATE
- STATE HIGHWAY
- SURFACE WATER (INTERMITTENT)



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DATE: OCTOBER 2008

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
LIDAR, SANGIS 2007
CASIL 2007

MALCOLM PIRNIE

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Range Operations oversees the scheduling and management of the eight SARs present within the East Miramar Range Complex. Summaries of expenditures for Ranges 100 and 101 from December 2005 to June 2007 were used to estimate lead loading. Expenditure data for Ranges 5, 6, and 7 consist only of monthly counts of expenditures for all three ranges between January 2005 and August 2007, preventing a numerical estimate of lead loading. Expenditure data for Ranges B, C, and D consist of a consolidated summary of expenditures at all three of these ranges between June 2006 and June 2007, allowing for a single lead loading estimate covering all three ranges. It was assumed that estimated expenditure rates are characteristic of use through the 2000s.

8.2. Range 100 – LOMAH Rifle Range

8.2.1. Site Background

Range 100, also known as the LOMAH Rifle Range and the Hathcock Range, is a 500-yard rifle range located in the north-central section of the East Miramar Range Complex (Figure 8.1-1). The range, constructed in 2004, is oriented for firing from west to east; its SDZ partially overlaps Training Areas 1 and 2. The rear impact berm is 500 feet in length and approximately 15 feet in height. Side berms are also present for safety / containment purposes. The range contains 40 firing lanes of multiple known distance targets, as well as eight lanes of unknown distance targets. Targets are located at distances of 100, 200, 300, and 500 yards from the firing line. The targets used in the LOMAH system electronically gauge the location of hits on the target and report scores in real-time. Based on 2006 expenditure summaries obtained from MCAS Miramar, the lead loading rate at Range 100 in 2006 was 14,884 lb per year. Ammunition used at this range includes rifle rounds.

Visual observations during the site visit indicated gravelly and silty sand across much of the surface of the Rifle Range. USDA NRCS data describe the soil beneath the firing lanes and berm as primarily Visalia gravelly sandy loam, which is associated with surface water drainages. The soil type is generally well drained with a slope less than 5%. The other soil type found in the more upland areas, with slopes between 15% and 50% in the Rifle Range SDZ is Redding cobbly loam. Vegetation consisting of grasses and weeds is present across the foot of the impact berm, with some limited vegetation along the range floor. Vegetation is also present in the drainage channel that is located in the middle of the range floor between the 200-yard firing line and the rear impact berm.

Surface water runoff in the area around the Rifle Range ultimately discharges into the main drainage of San Clemente Canyon. The dendretic San Clemente Canyon is located immediately north and west of the Rifle Range. Prior to its construction in 2004, a tributary of the San Clemente Canyon was present on the footprint of the Rifle Range, flowing east to west where it intersected with the main drainage of San Clemente

Canyon. A portion of the natural drainage remains present on the range between the 500-yard target line and the impact berm; the original natural channel has been improved and currently serves as an engineered drainage channel that diverts runoff to the north-central portion of the range footprint. Runoff is then carried westward where it intersects with the main channel of San Clemente Canyon, approximately 150 feet away. Wetlands associated with these natural drainages have been delineated directly north and east of the range.

The relatively new impact berm at the range is constructed with a gently sloped top, which reduces drainage over the impact berm face. In addition, a concrete-lined surface water diversion for run-on control is present along the southern boundary of the range. The engineered diversion continues west, across the top of the Pistol Range; surface water collected in this channel flows to the west and ultimately is discharged into the main drainage of San Clemente Canyon. San Clemente Canyon eventually discharges to Rose Canyon, approximately 3 miles west of the installation, which discharges to Mission Bay.

Surface water and groundwater receptors for the installation are identified in **Section 6**. Human receptors for surface water in off-range areas could include persons using the canyon for non-contact recreational purposes; however, as the drainage is typically dry and there are no specific activities within the drainage on MCAS Miramar, human receptors are likely to be limited. Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range; generally, vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. The California gnatcatcher is not likely to consume significant quantities of water from the drainages near the range. In addition, the willowy monardella and Del Mar manzanita, while previously present in the same subwatershed, were greatly affected by recent fires and may no longer be present near the range. Therefore, exposures to ecological receptors are likely to be limited.

Groundwater in the East Miramar region is generally considered to be at a depth of 200 feet bgs, with several locations having perched groundwater at depths between 10 and 30 feet bgs. It is possible that shallow groundwater may be present near the range following precipitation events or a particularly wet period. Groundwater is not used as water supply in the Miramar region. Groundwater is not known or suspected to discharge to surface water locations within MCAS Miramar. As such, there are no groundwater receptors for Range 100.

Additional site-specific data used to complete the qualitative evaluation of Range 100 are provided in the SARAP tables in Appendix A.

8.2.2. Assessment Results

Surface Water

The surface water environmental concern evaluation ranking resulted in a Minimal score (18 points). The short operational history (2004 to present), limited precipitation rates, and effective engineered controls (including a vegetated conveyance channel) reduce the potential for lead transport. Although sporadic storms might cause runoff to act as a transport mechanism, lead from this range would not be expected to reach off-range locations in high concentrations or quantities. Given the long distance to vernal pools and their potential isolation from surface water within the canyon drainage, exposures to potential ecological receptors within the pools are not anticipated. On the basis of the SARAP, there is minimal potential for lead migration and impact to surface water.

Groundwater

The groundwater environmental concern evaluation ranking resulted in a Minimal score (25 points). Similar to the surface water pathway, the short operational history, limited precipitation, limited permeability of the soil, and relatively great depth to groundwater reduce the potential for lead transport. No groundwater receptors have been identified in the area around the Rifle Range. On the basis of the SARAP, there is minimal potential for lead migration to impact receptors via groundwater.

8.3. Range 101 – Pistol Range

8.3.1. Site Background

Range 101 is located immediately adjacent to and southwest of Range 100, in the north-central section of the East Miramar Range Complex (Figure 8.1-1). This range opened in January 2007 and contains 25 firing lanes at 7-, 15-, 25-, and 50-yard distances. Shotgun training is also conducted at this range. Firing is directed to the southeast, where a natural hillside serves as the rear impact berm for bullet containment. Ammunition used at this range includes pistol and shotgun rounds. Based on expenditure data, the lead loading between January and June 2007 at Range 101 was estimated to be 6,390 lb.

The soil within the impact area consists of Redding cobbly loam and Visalia gravelly sandy loam. Eroded bullet pockets are present across the impact area. Very limited vegetation in the form of grass is present on the front top of the impact area, above the bullet pockets.

Surface water runoff at Range 101 is directed from the face of the impact berm to the floor. A small grated drain at the foot of the berm collects surface water drainage and directs the flow under the gravel-covered firing lines to a point west of the range, where it

discharges to a short but thick layer of riprap. Based on its design, the discharge point is anticipated to act as a sediment trap, reducing soil and lead particles from being carried downstream. Discharge ultimately runs into the main drainage channel of San Clemente Canyon, which runs from northeast to southwest. A concrete-lined diversion at the top of the berm directs surface water drainage from upland reaches around the range, reducing the erosion of the impact area. Human and ecological receptors for surface water at Range 101 are the same as those described in **Section 8.2.1**.

Groundwater conditions at Range 101 are similar to those previously described for Range 100. As such, there are no groundwater receptors for Range 101.

Additional site-specific data used to complete the qualitative evaluation of Range 101 are provided in the SARAP tables in Appendix A.

8.3.2. Assessment Results

Surface Water

The surface water environmental concern evaluation ranking resulted in a Minimal score for this range (24 points). The short operational history (January 2007 to present), limited precipitation rates, and engineering controls reduce the potential for lead transport. In addition, receptors are not present or potential interactions are anticipated to be limited. On the basis of the SARAP, there is minimal potential for lead migration and impact to surface water.

Groundwater

The groundwater environmental concern evaluation ranking resulted in a Minimal score (21 points). Similar to the surface water pathway, the short operational history, limited precipitation, and depth to groundwater reduce the potential for lead transport via groundwater. Additionally, no groundwater receptors have been identified in the area around Range 101. On the basis of the SARAP, there is minimal potential for lead migration to impact receptors via groundwater.

8.4. San Diego County Sheriff's Department Ranges 5, 6, and 7

8.4.1. Site Background

Ranges 5, 6, and 7 are located in Murphy Canyon, adjacent to Training Area 5 in the western portion of the East Miramar Range Complex (Figure 8.1-2). While MCAS Miramar owns the land and the ranges, the San Diego County Sheriff's Department leases and operates these SARs. Range 5 is the northernmost of the three Sheriff's Department ranges; Ranges 6 and 7 are located immediately adjacent, to the south. The

ranges are oriented toward the southeast hillside of Murphy Canyon; this hillside serves as the impact berm for this range as well as the nearby Ranges B, C, and D; see **Section 8.5**. While the date of initial operation is unknown, the ranges were constructed during Navy administration of the installation from 1952 to 1997 (USACE, 2001b). Ammunition types utilized at these ranges primarily include pistol and shotgun rounds; the latter is primarily used at Range 7.

The ranges are separated by concrete sidewalls. Range 5 is a long, narrow range with 10 firing positions and contains wooden baffling to reduce the allowable angle of fire and to reduce expenditures into the ranges' SDZ. The range floor is comprised of concrete from the rear firing line to the target area, where it transitions to a gravel base between the target area and impact zone (hillside). Range 6 contains 30 firing positions with a gravel floor. The hillside serving as the impact berm is approximately 25 feet in height near Ranges 5 and 6. Range 7 contains 28 firing points at distances of 3, 10, 15, 20, and 25 yards. A separate impact berm has been established for this range, approximately 40 feet in front of the hillside. The southern side wall for Range 7 is comprised of earthen material. All targets are comprised of paper set on wooden frames approximately 40 feet in front of each ranges' impact area.

All three of the Sheriff's Department ranges are utilized six days a week, resulting in significant lead deposition in the common impact area. No specific expenditure data were made available for Ranges 5, 6, and 7. San Diego County Sheriff's Department range personnel provided monthly counts of total expenditures from July 2005 to August 2007, without specification of type of ammunition or the individual range upon which the ammunition was used. Since January 2006, average monthly expenditures at the Sheriff's Department ranges have been over 100,000 rounds, suggesting heavy use of these three ranges.

To estimate the annual lead loading at each range, the two years of expenditure data were aggregated. The REVA assessment team then assumed that three-quarters of the rounds fired were pistol ammunition and one-quarter were shotgun rounds. This resulted in a total annual lead load to all three Sheriff's Department ranges of 13,695 lb of lead. Assuming an equal distribution and use of the ammunition, it is estimated that each of the three ranges received 4,565 lb of lead per year over the estimated time period. Visual observations during the REVA site visit noted heavy concentrations of embedded, recently fired (e.g., unweathered) small arms projectiles throughout the impact area, supporting this conclusion. Based on this information, it is assumed that the lead loading rate at all three ranges is greater than 1,000 lb/year.

The hillside, which acts as the rear impact berm for the ranges, contains soils characterized as Redding cobbly loam. Visual observations of the exposed impact area noted gravelly and silty sands. The impact area was heavily saturated with unweathered

small arms projectiles; however, no bullet pockets were visible, suggesting that the impact area had recently been reworked, though this could not be verified with installation personnel. There is no vegetation on the impact area; low-lying grassy vegetation is present immediately behind the impact area and beyond, within the range SDZ.

Runoff generated during rain events has the potential to erode the impact area and transport dissolved lead toward the main drainage of Murphy Canyon. Engineered drains are present on the floor of each range and collect runoff during storm events, conveying the runoff toward the Murphy Canyon drainage channel, 50 feet west of the firing lines at Ranges 5, 6, and 7. The ephemeral canyon drains to the southwest and ultimately discharges to the San Diego River, located approximately 3.6 miles south of the installation boundary.

Surface water and groundwater receptors for the installation are identified in **Section 6**. Human receptors for surface water in off-range areas could include persons using Murphy Canyon for non-contact recreational purposes; however, as the drainage is typically dry and there are no specific activities conducted within the drainage on MCAS Miramar, human receptors are likely to be limited. Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range. However, based on its foraging behavior, it is unlikely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are not anticipated.

Groundwater depths in the East Miramar region are generally considered to be 200 feet bgs, with several locations having perched groundwater at depths between 10 and 30 feet bgs. While the soil types present at the ranges are generally acidic, enhancing the potential for subsurface transport of dissolved lead, a shallow hardpan has been noted in the areas of East Miramar, which would restrict significant subsurface migration. In addition, groundwater is not used as water supply in the Miramar region. Groundwater is not known or suspected to discharge to surface water locations within MCAS Miramar. Therefore, groundwater receptors are not anticipated for these ranges.

Additional site-specific data used to complete the qualitative evaluation of Ranges 5, 6, and 7 are provided in the SARAP tables in Appendix A.

8.4.2. Assessment Results

Surface Water

Each of the San Diego County Sheriff's Department ranges was evaluated separately for potential off-range release of lead. The surface water environmental concern evaluation ranking for each of the three ranges resulted in a Moderate score (33 points). The long period of use, frequency of training activities, and proximity of the ranges to a major surface water drainage contribute to the Moderate score for these ranges. The presence of partial engineering controls (e.g., drainage structures) on the ranges decreases the potential for lead migration. In addition, human and ecological receptors are unlikely to interact with exposure media (e.g., surface water) in off-range areas that would result in an exposure to lead.

Groundwater

The groundwater environmental concern evaluation ranking for each range resulted in a Minimal score (29 points). The limited precipitation in the region, limited permeability of the soils, and depth to groundwater reduce the potential for lead transport to groundwater resources. No groundwater receptors have been identified in the area around Ranges 5, 6, and 7. On the basis of the SARAP, this represents minimal potential for lead migration to impact receptors via groundwater.

8.5. Ranges B, C, and D

8.5.1. Site Background

Ranges B, C, and D are located in the western section of the East Miramar Range Complex, adjacent to Training Area 5 (Figure 8.1-2). Range B is located south of Range 7; a parking area and an earthen side berm separate them. Ranges C and D are located immediately adjacent to Range B to the south. Like the San Diego County Sheriff's Department ranges, Ranges B, C, and D are oriented toward the southeast hillside of Murphy Canyon, with the hillside serving as the impact area. Similar to Ranges 5, 6, and 7, the ranges were constructed during Navy administration of the installation from 1952 to 1997 (USACE, 2001b). Ranges B, C, and D are used primarily by regional Army National Guard and Navy units, which schedule range usage with MCAS Miramar Range Operations. Marine Corps units also use the range for marksmanship training. Ammunition types utilized primarily include pistol and shotgun rounds.

Ranges B, C, and D are separated by earthen side berms. Range B is approximately 300 feet wide and contains 22 firing positions at distances of 35, 40, and 50 yards. Range B has wooden baffling above the rear of the firing line to reduce the vertical trajectory of small arms projectiles fired during training. Range C, approximately 200 feet wide,

contains 26 firing positions at distances of 9, 15, 25, and 35 yards. Range D, approximately 100 feet in width, contains 20 firing positions at 7, 11, and 25 yards. All targets are comprised of paper set on wooden frames in front of each range's impact area.

No specific expenditure data were available for Ranges B, C, and D. Range personnel were able to provide recent expenditure reports consolidated for all three ranges, without specifying which range upon which the ammunition was used. Using the available expenditure data for the three ranges (for January 2006 through June 2006) and assuming the expenditures are evenly distributed across all three ranges, it is estimated that approximately 361 lb of lead were deposited at each range over a one-year period in 2006. Visual observations during the REVA site visit noted numerous embedded small arms projectiles throughout the berm; however, the ranges did not appear to be used as frequently as Ranges 5, 6, and 7. Based on this information, it is estimated that the lead loading rate at Ranges B, C, and D falls between 100 and 1,000 lb/year of lead.

The hillside, which acts as the rear impact berm for the ranges, and the range floor contain soils characterized as Redding cobbly loam. Visual observations of the exposed impact area noted gravelly and silty sands. The impact area contained a few areas of minor bullet pocket formation. Limited vegetation is present on the upper portions of the impact area; low-lying grassy vegetation is present immediately behind the impact area and beyond, within the range SDZ. A concrete-lined channel is located on top of the hillside and runs the length of all three ranges, redirecting upland flow away from the face of the berm. An unlined lip sits below this concrete channel; it is gently sloped away from the berm face to further reduce the drainage flowing over the impact berm during precipitation events.

Runoff generated during rain events has the potential to erode the impact area and transport dissolved lead toward the main drainage of Murphy Canyon. Some water may accumulate at the base of each berm and infiltrate; however, the presence of a hardpan noted throughout East Miramar likely restricts downward migration of lead. Murphy Canyon drainage channel is located approximately 100 feet west of the firing lines at Ranges B, C, and D. The canyon drains to the southwest and ultimately discharges to the San Diego River, located approximately 3.6 miles south of the installation boundary.

Surface water and groundwater receptors for the installation are identified in **Section 6**. Human and ecological receptors for surface water at Ranges B, C, and D are the same as those described in **Section 8.4** for the San Diego County Sheriff's Department ranges (significant exposures to human or ecological receptors to lead associated with these ranges is not anticipated).

Groundwater characteristics for Range B, C, and D are similar to those previously described for adjacent Ranges 5, 6, and 7. As such, groundwater receptors are not anticipated for these ranges.

Additional site-specific data used to complete the qualitative evaluation of Ranges B, C, and D are provided in the SARAP tables in Appendix A.

8.5.2. Assessment Results

Surface Water

Each of the ranges (B, C, and D) was evaluated separately for potential off-range release of lead. The surface water environmental concern evaluation ranking for each of the three ranges resulted in a Moderate score (31 points). The anticipated long period of use and proximity to a major surface water drainage in Murphy Canyon contribute to the Moderate score for this range. The presence of a diversion above the impact berm and the wooden baffling decrease the potential for lead migration at these ranges.

Groundwater

The groundwater environmental concern evaluation ranking for each range resulted in a Minimal score (27 points). The limited precipitation in the region, the limited permeability of the soils, and the depth to groundwater reduce the potential for lead transport to groundwater resources. No groundwater receptors have been identified in the area around Ranges B, C, and D. On the basis of the SARAP, this represents minimal potential for lead migration to impact receptors via groundwater.

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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.

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Rifle Range (Range 100)

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	Use from 2004 to present.	5 if usage greater than 30 years 3 if usage is 10 to 30 years 1 if usage less than 10 years	1
Bullet-Capturing Technology	No bullet-capturing technology noted by installation personnel or observed by REVA team in addition to soil berm.	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	For 2006, approx. 14,884 lbs/yr. For the first six months of 2007, assuming only rifle ammunition reported was expended on this range, approx. 4,561 lbs.	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	5
Range Maintenance	No lead removal activities have occurred, though installation personnel report range only in existence for three 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			11

Notes:

Installation personnel interviews, field observations, and expenditure records strongly support the identified rankings for this table. This range was constructed within the last three years; it serves as a primary small arms range for live-fire training performed by the installation's Marines.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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%. The interior of the range itself is relatively flat.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Patches of grasses and weeds is present across the berm and around observed bullet pockets, as well as along its foot. The remainder of the range is relatively bare, though a drainage channel running through the middle of it is well-vegetated with grasses and brush; a portion of it was recently burned for maintenance.	5 if vegetation cover less than 20% 3 if vegetation cover is between 20% to 50% 1 if vegetation cover greater than 50%	1
Soil Type/Runoff Conditions	Visual observations indicated gravelly and silty sand across much of the surface of the range. NRCS data describes the soil beneath the firing lanes and berm as primarily Visalia gravelly sandy loam. A shallow hardpan is generally believed to exist across much of Miramar.	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	Drainage from the berm which does not infiltrate into the subsurface is collected in an unlined area just at the foot and directed towards a drain which flows a short distance to a vegetated ditch that runs the length of the range. The top of the berm is sloped back to direct drainage away from the berm face.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			-1

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The range is buffered by a taller hillside and berms along its sides, thereby keeping drainage from flowing immediately off the range. Some vegetation consisting of grass and weeds is present on the berm, primarily across its foot. Vegetation is also present in a channel that directs surface drainage away from the berm, down the middle of the range.

Visual observations indicated gravelly and silty sand to be present across much of the surface of the range. Varying pieces of rock and cobble were strewn across the range, though typically 1 to 2 inches in diameter; a partial gravel cover was also identified on the south side of the range. Shallow borings at IRP Site 10 (approximately 2 miles east-northeast of the range; Bechtel, 2005a) indicated the presence of sandy silts and gravel in soil. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

Drainage from the berm face flows down to the foot where it collects in a gently depressed, unlined access road that runs along the foot of the berm. Water which does not infiltrate into the soil flows towards a small drain located at the midpoint of the access road. It subsequently flows down a pipe that runs a short distance west beneath the target line and empties out into a vegetated dry swale that gently slopes to the west end of the range. Additionally, the top of the berm is gently angled so minimal precipitation can drain from the top over the berm face. Along with the partial vegetative cover on and along the lower portion of the berm, these controls minimize the amount of run-off that is exposed to embedded expenditures and creates opportunities for any suspended lead particles to settle, and are therefore considered effective engineering controls.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations; an assessment for this range indicated groundwater may be found approximately 10 feet below the surface.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	Visalia gravelly sandy loam described as “slightly acidic”, from 6.3 to 6.5 pH, in official soil descriptions.	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	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. Visalia soils contain little, if any, clay to which lead can adsorb.	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			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface. The environmental assessment prepared for this range (NAVFACSW, 2001) suggests that groundwater may be found approximately 10 feet below ground surface. A well was once present near this range, but no information or data regarding this well was located.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The NRCS soil series description of the Visalia gravelly sandy loam describes several soil layers that are "slightly acidic" (NRCS, 1973). pH range was listed between 6.3 and 6.5. No other data sources were found describing soil pH. The soil series description does not indicate clay is a component of these soils.

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is immediately adjacent to San Clemente Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are 4 miles from range and isolated from drainage areas. Coastal sage scrub habitat has been noted near the range, as well as the California Gnatcatcher, Willowy Monardella, and Del Mar Manzanita. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range; these vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. No contact with runoff potentially containing lead is anticipated. Del Manzanita, Willowy Monardella, and coastal sage scrub habitat have been observed within close proximity to the range; however, these observations were made prior to the Cedar Fire of 2003. These vegetative communities, if re-established near the range, are unlikely to come into contact with water in the San Clemente Canyon drainages. A California Gnatcatcher breeding site has been previously noted approximately 1,000 feet to the west (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range.

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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Sensitive habitat and species have been noted within close proximity to the range, though these observations were made prior to the Cedar Fire that occurred in 2003. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. Del Manzanita, Willowy Monardella, and coastal sage scrub habitat has been observed within close proximity to the range; a California Gnatcatcher breeding site has been previously noted approximately 1,000 feet to the west (MCAS Miramar INRMP, 2006). However, these observations were made prior to the Cedar Fire of 2003.

There are no known 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	11
Surface Water Pathways	2	-1
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**18**
Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**25**
The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media: Environmental Concern Evaluation Ranking* — Score Range High — 50-65 Moderate — 30-49 Minimal — 0-29 *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.		
Surface Water Environmental Concern Evaluation Ranking		**MINIMAL**
Groundwater Environmental Concern Evaluation Ranking		**MINIMAL**
Notes:		

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Pistol Range (Range 101)

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	Use from January 2007 to present.	5 if usage greater than 30 years 3 if usage is 10 to 30 years 1 if usage less than 10 years	1
Bullet-Capturing Technology	No bullet-capturing technology noted by installation personnel or observed by REVA team in addition to soil berm.	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	For the first six months of 2007, assuming only pistol rounds reported on expenditure summary were used on this range, approx. 6,390 lbs.	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	5
Range Maintenance	No lead removal activities have occurred, though installation personnel report range only in existence for six months at time of REVA visit. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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			11

Notes:

Installation personnel interviews, field observations, and expenditure records strongly support the identified rankings for this table. This range was recently constructed and not activated until January 2007. It serves as a primary small arms range for live-fire training performed by the installation's Marines.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Very little vegetation was present across the berm or range; there is no vegetated area on the range itself receiving drainage.	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	Visual observations noted silty sand across the surface of the berm. Much of the range floor is covered with a thick layer of gravel fill to facilitate drainage. NRCS data describes the soil beneath the firing lanes and berm as Redding cobbly loam with some Visalia gravelly sandy loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Drainage from the berm is collected at a drain which runs beneath the firing lanes, ultimately discharging into a short yet thick layer of rip-rap before reaching the fence of the range complex. Additionally, a concrete-lined channel runs high above of the visible bullet pockets in the berm, redirecting upland flow away from the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			5

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range is cut into a natural hillside. Sparse vegetation was noted on the range.

Visual observations noted silty sand across much of the surface of the berm; the surface of the firing lanes is largely covered with gravel to facilitate drainage. Shallow borings at IRP Site 10 (approximately 2 miles east-northeast of the range; Bechtel, 2005a) indicated the presence of sandy silts and gravel in soil. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

A small, grated drain at the foot of the impact area collects drainage that does not infiltrate into the subsurface. This drain runs beneath the gravel-covered firing lanes to a discharge point just behind the range; this discharge is intercepted by a short but thick run of cobble-sized rip-rap prior to flowing beyond the fence of the range complex. Range personnel noted that this drain at the foot of the berm usually works as designed, though it occasionally backs up with excessive sedimentation. There is also a concrete-lined diversion along the top of the berm that catches drainage from upland reaches and redirects it around the range, thereby preventing additional flow and erosion of bullet pockets. Together, it is anticipated that these controls minimize the amount of run-off that is exposed to embedded expenditures and creates opportunities for any suspended lead particles to settle, and are therefore considered effective engineering controls.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations; an assessment for this range indicated groundwater may be found approximately 10 feet below the surface.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8). Visalia gravelly sandy loam described as slightly acidic, from 6.3 to 6.5 pH.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan (30 inches) is generally present in Redding series soils; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface. The environmental assessment prepared for this range (NAVFACSW, 2001) suggests that groundwater may be found approximately 10 feet below ground surface. A well was once present near this range, but no information or data regarding this well was located.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a steep hillside, mostly consists of Redding cobbly loam (15-50% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is immediately adjacent to San Clemente Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are 4 miles from range and isolated from drainage areas. Coastal sage scrub habitat has been noted near the range, as well as the California Gnatcatcher, Willowy Monardella, and Del Mar Manzanita. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range; these vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. No contact with runoff potentially containing lead is anticipated. Del Manzanita, Willowy Monardella, and coastal sage scrub habitat have been observed within close proximity to the range; however, these observations were made prior to the Cedar Fire of 2003. These vegetative communities, if re-established near the range, are unlikely to come into contact with water in the San Clemente Canyon drainages. A California Gnatcatcher breeding site has been previously noted approximately 1,000 feet to the west (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range.

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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Sensitive habitat and species have been noted within close proximity to the range, though these observations were made prior to the Cedar Fire that occurred in 2003. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. Del Manzanita, Willowy Monardella, and coastal sage scrub habitat has been observed within close proximity to the range; a California Gnatcatcher breeding site has been previously noted approximately 1,000 feet to the west (MCAS Miramar INRMP, 2006). However, these observations were made prior to the Cedar Fire of 2003.

There are no known 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	11
Surface Water Pathways	2	5
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**24**
Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	7
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**21**
The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media: Environmental Concern Evaluation Ranking* — Score Range High — 50-65 Moderate — 30-49 Minimal — 0-29 *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.		
Surface Water Environmental Concern Evaluation Ranking		**MINIMAL**
Groundwater Environmental Concern Evaluation Ranking		**MINIMAL**
Notes:		

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Sheriff Range 5

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated annual lead loading is approximately 4,565 lbs/yr. Visual observations of the berm suggest heavy use.	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	5
Range Maintenance	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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			15

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the San Diego County Sheriff's Department. Installation personnel were not aware when these contiguous ranges were installed, though it is known that they were originally during Navy administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether the range was constructed for the San Diego County Sheriff's Department or originally used by the Navy. Additionally, it is not known when the County Sheriff began leasing this range, though it is known they held a two-year lease in 1995 on all three ranges (5, 6, and 7). It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided monthly counts of total expenditures from July 2005 to August 2007, without specification of type of expenditure or individual range upon which the ammunition was used. Since January 2006, average monthly expenditures have been over 100,000 rounds, suggesting heavy use of these ranges. Based on two years of expenditure data totals and assuming three-quarters of the rounds fired were pistol and one-quarter were shotgun rounds, the total annual load to all three Sheriff's ranges was 13,695 pounds of lead. Assuming an equal distribution and use of the ammunition at each of the three ranges, Range 5 is estimated to receive 4,565 pounds of lead per year. Visual observations during the REVA site visit noted concentrated embedded small arms projectiles throughout the berm, supporting this conclusion.

Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Little vegetation was noted on this range.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Floor drains and other surface water control measures are present. Range 5 has baffling to help limit expenditures into the ranges' SDZ.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Little vegetation was noted on this range during the REVA site visit.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site (just under ¼ miles northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

Drains are present at the corners of the range floor to collect and direct runoff to the drainage channel west of the firing points. Additionally, Range 5 has overhead baffling to reduce expenditure into the ranges' SDZ. Together, these controls may offer partial control of lead migration from this range.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately 0.2 miles to the west and 0.4 miles to northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	15
Surface Water Pathways	2	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**33**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	15
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**29**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes:

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Sheriff Range 6

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated annual lead loading is approximately 4,565 lbs/yr. Visual observations of the berm suggest heavy use.	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	5
Range Maintenance	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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			15

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the San Diego County Sheriff's Department. Installation personnel were not aware when these contiguous ranges were installed, though it is known that they were originally during Navy administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether the range was constructed for the San Diego County Sheriff's Department or originally used by the Navy. Additionally, it is not known when the County Sheriff began leasing this range, though it is known they held a two-year lease in 1995 on all three ranges (5, 6, and 7). It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided monthly counts of total expenditures from July 2005 to August 2007, without specification of type of expenditure or individual range upon which the ammunition was used. Since January 2006, average monthly expenditures have been over 100,000 rounds, suggesting heavy use of these ranges. Based on two years of expenditure data totals and assuming three-quarters of the rounds fired were pistol and one-quarter were shotgun rounds, the total annual load to all three Sheriff's ranges was 13,695 pounds of lead. Assuming an equal distribution and use of the ammunition at each of the three ranges, Range 6 is estimated to receive 4,565 pounds of lead per year. Visual observations during the REVA site visit noted concentrated embedded small arms projectiles throughout the berm, supporting this conclusion.

Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Little vegetation was noted on this range.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Floor drains and other surface water control measures are present.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Little vegetation was noted on this range during the REVA site visit.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site (just under ¼ miles northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

Drains are present at the corners of the range floor to collect and direct runoff to the drainage channel west of the firing points, which may offer partial control of lead migration from this range.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately 0.2 miles to the west and 0.4 miles to northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	15
Surface Water Pathways	2	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**33**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	15
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**29**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes:

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Sheriff Range 7

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated annual lead loading is approximately 4,565 lbs/yr. Visual observations of the berm suggest heavy use.	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	5
Range Maintenance	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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			15

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the San Diego County Sheriff's Department. Installation personnel were not aware when these contiguous ranges were installed, though it is known that they were originally during Navy administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether the range was constructed for the San Diego County Sheriff's Department or originally used by the Navy. Additionally, it is not known when the County Sheriff began leasing this range, though it is known they held a two-year lease in 1995 on all three ranges (5, 6, and 7). It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided monthly counts of total expenditures from July 2005 to August 2007, without specification of type of expenditure or individual range upon which the ammunition was used. Since January 2006, average monthly expenditures have been over 100,000 rounds, suggesting heavy use of these ranges. Based on two years of expenditure data totals and assuming three-quarters of the rounds fired were pistol and one-quarter were shotgun rounds, the total annual load to all three Sheriff's ranges was 13,695 pounds of lead. Assuming an equal distribution and use of the ammunition at each of the three ranges, Range 7 is estimated to receive 4,565 pounds of lead per year. Visual observations during the REVA site visit noted concentrated embedded small arms projectiles throughout the berm, supporting this conclusion.

Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Little vegetation was noted on this range.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Floor drains and other surface water control measures are present.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Little vegetation was noted on this range during the REVA site visit.

Visual observations noted gravelly and silty sand across much of the range, though concrete firing lines are present on Range 7. Shallow borings at a former UST site (just under ¼ miles northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

Drains are present at the corners of the range floor to collect and direct runoff to the drainage channel west of the firing points and may offer partial control of lead migration from this range.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately 0.2 miles to the west and 0.4 miles to northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	15
Surface Water Pathways	2	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**33**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	15
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**29**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes:

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Small Arms Range B

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated loading of 333 lb/yr. Visual observation of the berm suggests moderate use.	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	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the Army National Guard. Installation personnel were not aware when this range was installed, though it is known that it was originally activated by the Navy during its administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided recent expenditure reports consolidated for all three ranges (B, C, and D), with the most complete range of records from October 2006 to June 2007. Using references and assumptions in the REVA Reference Manual, it is estimated that 542 pounds of lead were deposited at Ranges B, C, and D during the first six months of 2007. Assuming the same rate of expenditures for a one-year period, and even distribution of the ammunition across all three ranges, Range B is estimated to receive 333 pounds of lead per year. Visual observations during the REVA site visit noted small arms projectiles throughout the berm. Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Sporadic, dry grass patches were present across the berm and range, though overall cover was judged to be low.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm. Range B has wooden baffling to help limit expenditures into the ranges' SDZ.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Sporadic grassy vegetation is present across these ranges, though actual overall cover is judged to be low.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site (just over ¼ miles north-northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

There is a continuous, concrete-lined channel that runs along the top of the berm that is situated to capture upland drainage and direct it away from the impact area on the berm. An unlined lip rests just below this concrete channel; it sloped away from the range to further prevent drainage from reaching the berm. Additionally, Range B has wooden overhead baffling to reduce expenditure into the ranges' SDZ. Together, these controls may offer partial control of lead migration from this range.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately ¼ mile to the west and ½ mile to northeast. Vernal marsh and coastal sage scrub habitats have been observed within close proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**31**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes:

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Small Arms Range C

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated loading of 333 lb/yr. Visual observation of the berm suggests moderate use.	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	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the Army National Guard. Installation personnel were not aware when this range was installed, though it is known that it was originally activated by the Navy during its administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided recent expenditure reports consolidated for all three ranges (B, C, and D), with the most complete range of records from October 2006 to June 2007. Using references and assumptions in the REVA Reference Manual, it is estimated that 542 pounds of lead were deposited at Ranges B, C, and D during the first six months of 2007. Assuming the same rate of expenditures for a one-year period, and even distribution of the ammunition across all three ranges, Range C is estimated to receive 333 pounds of lead per year. Visual observations during the REVA site visit noted small arms projectiles throughout the berm. Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Sporadic, dry grass patches were present across the berm and range, though overall cover was judged to be low.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Sporadic grassy vegetation is present across these ranges, though actual overall cover is judged to be low.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site (just over ¼ miles north-northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

There is a continuous, concrete-lined channel that runs along the top of the berm that is situated to capture upland drainage and direct it away from the impact areas on the berm. An unlined lip rests just below this concrete channel; it sloped away from the ranges to further prevent drainage from reaching the berm. Together, these controls may offer partial control of lead migration from these ranges.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately ¼ mile to the west and ½ mile to northeast. Vernal marsh and coastal sage scrub habitats have been observed within close proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**31**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes:

Small Arms Range Protocol Evaluation Forms
MCAS Miramar Small Arms Range D

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	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	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 REVA team in addition to soil berm.	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	Estimated loading of 333 lb/yr. Visual observation of the berm suggests moderate use.	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	No lead removal activities have occurred. Personnel are exploring conducting lead removal activities for all active small arms ranges at MCAS Miramar.	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

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Currently, this range is primarily utilized by the Army National Guard. Installation personnel were not aware when this range was installed, though it is known that it was originally activated by the Navy during its administration of the installation (USACE, 2001) from 1952 to 1997. It is unknown whether of any bullet-capturing technology has ever been used at this range; none was observed during the REVA site visit.

Range personnel provided recent expenditure reports consolidated for all three ranges (B, C, and D), with the most complete range of records from October 2006 to June 2007. Using references and assumptions in the REVA Reference Manual, it is estimated that 542 pounds of lead were deposited at Ranges B, C, and D during the first six months of 2007. Assuming the same rate of expenditures for a one-year period, and even distribution of the ammunition across all three ranges, Range D is estimated to receive 333 pounds of lead per year. Visual observations during the REVA site visit noted small arms projectiles throughout the berm. Information regarding historical lead removal activities was not available; installation personnel are examining this for future implementation at all active small arms ranges at the installation.

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	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	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 averages approximately 10 inches/yr.	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 is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat. A natural ephemeral drainage runs behind the rear of this range.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	Sporadic, dry grass patches were present across the berm and range, though overall cover was judged to be low.	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	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			10

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

Notes:

Most sources (MCAS Miramar INRMP, 2006; NAVFACSW, 2001; USACE, 2001) list the annual precipitation as approximately 10 inches, though Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. Recent stormwater monitoring data (Mactec, 2007) indicate a total of only 5.6 inches of precipitation during the 2006-2007 season. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation have typically shown pH levels in a neutral range over the last four reporting years, with limited, incidental exceptions (Mactec, 2007). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the unpaved access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Sporadic grassy vegetation is present across these ranges, though actual overall cover is judged to be low.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site (just over ¼ miles north-northwest of the range; OHM, 1997) indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate. Other Camp Elliot studies involving excavation and/or soil borings (Foster Wheeler, 2000) report similar soils. Many reports (see MCAS Miramar INRMP, 2006; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989) indicate the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

There is a continuous, concrete-lined channel that runs along the top of the berm that is situated to capture upland drainage and direct it away from the impact areas on the berm. An unlined lip rests just below this concrete channel; it sloped away from the ranges to further prevent drainage from reaching the berm. Together, these controls may offer partial control of lead migration from these ranges.

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 at the installation suggest regional groundwater is approximately 200 feet below ground surface. However, shallow perched water is known to exist at some locations.	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 averages approximately 10 inches/yr.	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	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	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	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

A number of reports (see Bechtel, 2005b; Bechtel, 2002; OHM, 1997) cite previous investigations which found regional groundwater to be approximately 200 feet below ground surface; perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967) report that pH levels in all wells sampled ranged from 6.5 to 7.6. Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9-30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

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	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	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. 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. 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may abut the westernmost side of the installation.	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. 3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California Gnatcatcher have also been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary. 5 if potential for receptors to have access to possibly contaminated media. 1 if little or no potential for receptors to have access to possible contaminated media.	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:

All water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surround East Miramar. However, recent aerial photographs (via Google Maps) suggest a nursery/agricultural operation may neighbor the westernmost side of the installation.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California Gnatcatcher have been previously noted to the north and west of the range (MCAS Miramar INRMP, 2006). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be 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	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	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. 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. 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	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. 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. 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.	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California Gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources. 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element

(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar INRMP, 2006). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified within the vicinity of this range, approximately ¼ mile to the west and ½ mile to northeast. Vernal marsh and coastal sage scrub habitats have been observed within close proximity of the range; California Gnatcatcher breeding sites have been previously noted to the north and west of this range (MCAS Miramar INRMP, 2006). Most of these avian observations were made prior to the Cedar Fire of 2003, though a reduced number of sites have been noted in similar areas following the fire.

There are no known 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	10
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**31**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Environmental Concern Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*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.

Surface Water Environmental Concern Evaluation Ranking	**MODERATE**
Groundwater Environmental Concern Evaluation Ranking	**MINIMAL**

Notes: