GROUP 7 – NORTHERN PORTION OF AREA IV
RCRA FACILITY INVESTIGATION REPORT
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

VOLUME I – TEXT, TABLES, AND FIGURES

Prepared For:

UNITED STATES DEPARTMENT OF ENERGY

Prepared by:

MWH Americas, Inc.
618 Michillinda Avenue, Suite 200
Arcadia, CA 91007

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PROFESSIONAL GEOLOGIST
MARK RUSSELL SHERWIN
No. 7874
EXP. 3/31/11
STATE OF CALIFORNIA

Mark Sherwin, P.G. 7874
RFI Senior Technical Lead

PROFESSIONAL GEOLOGIST
DIXIE A. HAMBRICK
No. 5487
EXP. 7/09
STATE OF CALIFORNIA

Jose Toledo
Group 7 RFI Manager

Dixie A. Hambrick, P.G. 5487
Program Director

MWH

GROUP 7 RFI REPORT – VOLUME I

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
AI	Atomics International
AOC	Area of Concern
AST	aboveground storage tank
B4029	Building 4029
B4133	Building 4133
BaP	benzo(a)pyrene
BBC	Brandeis-Bardin Campus
bgs	below ground surface
Boeing	The Boeing Company
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylenes
CCR	Current Conditions Report
CFGW	Chatsworth Formation Groundwater
CFOU	Chatsworth Formation Operable Unit
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COPC	chemical of potential concern
CPEC	chemical of potential environmental concern
CSM	conceptual site model
CTE	central tendency exposures
DCA	dichloroethane
DCE	dichloroethene
D&D	decontamination and decommissioning
DHS	California Department of Health Services
Dioxins/Furans	(a) - *see table below*
DOE	United States Department of Energy
DPH-RHB	Department of Public Health - Radiologic Health Branch
DQO	Data Quality Objective
DTSC	Department of Toxic Substances Control
EIR	Environmental Impact Report

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

ELV	Expendable Launch Vehicle
EPC	exposure point concentration
ERA	ecological risk assessment
ETEC	Energy Technology Engineering Center
ft/ft	feet per foot
Freon 113	1,1,2-trichloro-1,2,2-trifluoroethane
FS	Feasibility Study
GWCC	groundwater comparison concentration
GWTS	groundwater extraction/treatment system
HI	hazard index
HQ	hazard quotient
HRA	human health risk assessment
HSC	California Health and Safety Code
HWMF	Hazardous Waste Management Facility
HWTF	Hazardous Waste Treatment Facility
ILCR	incremental lifetime cancer risk
IM	interim measure
K_b	bulk permeability
LF	leach field
LMEC	Liquid Metal Engineering Center
LMFBR	Liquid Metal Fast Breeder Reactor
LMS	linearized multistage
LOX	liquid oxygen
LSA	low-specific activity
MCL	maximum contaminant level
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram
MRCA	Mountains Recreation Conservancy Authority
msl	mean sea level
MWH	MWH Americas, Inc.
ng/L	nanograms per liter

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

NA	not applicable
NAA	North American Aviation
NASA	National Aeronautics and Space Administration
NCP	National Contingency Plan
NDMA	N-nitrosodimethylamine
NFA	no further action
NPDES	National Pollutant Discharge Elimination System
NSGW	near-surface groundwater
ORISE	Oak Ridge Institute for Science and Education
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pg/g	picograms per gram
ppb	parts per billion (μg/kg or μg/L)
ppm	parts per million (mg/kg or mg/L)
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RI	Remedial Investigation
RIHL	Rockwell International Hot Laboratory
RFI	RCRA Facility Investigation
RME	reasonable maximum exposure
RMDF	Radioactive Materials Disposal Facility
RMHF	Radioactive Materials Handling Facility
Rocketdyne	Rocketdyne Propulsion and Power
Rockwell	Rockwell International Corporation
RWQCB	Regional Water Quality Control Board
SB990	Senate Bill 990

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SGR	sodium graphite reactor
SRAM	Standardized Risk Assessment Methodology
SRE	Sodium Reactor Experiment
SNAP	System for Nuclear Auxiliary Power
SSFL	Santa Susana Field Laboratory
STIR	Shield Test Irradiation Reactor
Surficial OU	Surficial Media Operable Unit
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
TCA	trichloroethane
TCE	trichloroethene
TEQ	toxic equivalent (see dioxins below)
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TRV	toxicity reference value
UDMH	unsymmetrical dimethylhydrazine
USEPA	United States Environmental Protection Agency
UST	underground storage tank
µg/dl	micrograms per deciliter
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/Lv	micrograms per liter vapor
VCEHD	Ventura County Environmental Health Department
VOC	volatile organic compound
WDR	Waste Discharge Requirement
WPA	RFI Work Plan Addendum
WPAA	RFI Work Plan Addendum Amendments

(a) Definition of dioxin/furan congeners

PCDD/PCDDs	Polychlorinated dibenzo-p-dioxins/dibenzofurans
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
1,2,3,7,8-PeCDD	1,2,3,7,8-pentachlorodibenzo-p-dioxin
1,2,3,4,7,8-HxCDD	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin
1,2,3,6,7,8-HxCDD	1,2,3,6,7,8-hexachlorodibenzo-p-dioxin
1,2,3,7,8,9-HxCDD	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin
OCDD	1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin
2,3,7,8-TCDF	2,3,7,8-tetrachlorodibenzofuran
1,2,3,7,8-PeCDF	1,2,3,7,8-pentachlorodibenzofuran
2,3,4,7,8-PeCDF	2,3,4,7,8-pentachlorodibenzofuran
1,2,3,4,7,8-HxCDF	1,2,3,4,7,8-hexachlorodibenzofuran
1,2,3,6,7,8-HxCDF	1,2,3,6,7,8-hexachlorodibenzofuran
2,3,4,6,7,8-HxCDF	2,3,4,6,7,8-hexachlorodibenzofuran
1,2,3,7,8,9-HxCDF	1,2,3,7,8,9-hexachlorodibenzofuran
1,2,3,4,6,7,8-HpCDF	1,2,3,4,6,7,8-heptachlorodibenzofuran
1,2,3,4,7,8,9-HpCDF	1,2,3,4,7,8,9-heptachlorodibenzofuran
OCDF	1,2,3,4,6,7,8,9-octachlorodibenzofuran
TEQ	Toxic Equivalent (normalized to 2,3,7,8-TCDD)

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EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report presents a comprehensive, integrated assessment of current and future conditions for the Group 7 Reporting Area, located in Area IV at the Santa Susana Field Laboratory (SSFL). This report meets current RFI requirements defined by the Department of Toxic Substances Control (DTSC) as contained in the Consent Order for Corrective Action, Docket No. P3-07/08-003. The purposes of the RFI are to characterize the nature and extent of chemicals in environmental media; evaluate risks to potential receptors; gather data to support the next phase of the RCRA Corrective Action Program, the Corrective Measures Study (CMS); and identify areas for further work. However, the 2007 Consent Order is in the process of being revised and the regulatory framework for SSFL cleanup will be transitioned from RCRA Corrective Action to the California Superfund Remedial Investigation / Feasibility Study (RI/FS) Process. Therefore, this report has been prepared to meet current requirements as an "RFI" report, and is considered functionally equivalent to a "RI" report. Also, determinations of additional characterization and risk requirements for the SSFL associated with Senate Bill 990 are ongoing. Once these determinations are made, RFI/RI Group documents will be reviewed and revised, as appropriate.

The Group 7 RFI Report is the ninth of 11 Group RFI reports that present results and recommendations for large, interrelated portions of the SSFL. The Group 7 Reporting Area includes three RFI sites: the Building 4029 (B4029) RFI Site, the Building 4133 (B4133) RFI Site, and the Radioactive Materials Handling Facility (RMHF) RFI Site. The Group 7 Reporting Area is comprised of two noncontiguous areas, with the larger portion located in the northern portion of Area IV including the B4133 and RMHF RFI Sites, and the smaller portion located in the central portion of Area IV including the B4029 RFI Site.

A comprehensive review of historical documents generated during facility operations or in subsequent environmental investigations was performed to identify known or potential chemical use areas within the Group 7 Reporting Area. Over 23,000 records (provided in the documents submitted in conjunction with this report) dating back to 1958 were reviewed, including: facility operational reports, maps and drawings, internal and external correspondence, regulatory compliance information, historical and aerial photographs, facility personnel interview records, and previous environmental reports. Based on a comprehensive review of this compiled information, known and potential chemical use areas were identified, sampled, and the nature and extent of chemicals determined.

Characterization included evaluation of both lateral and vertical potential contaminant migration pathways (i.e., between RFI sites, and between surficial media and groundwater).

Characterization of the Group 7 Reporting Area is sufficiently complete to estimate current and future risks to potential human and ecological receptors using currently approved risk assessment methodologies for the primary chemical use areas and other areas where chemicals were potentially used, and to support CMS evaluations for chemicals in surficial media. Group 7 site action recommendations have been made, and areas have been identified for: (a) further evaluation in the CMS ("CMS Areas"); and (b) no further action ("NFA Areas").

Site action recommendations are based on information in historical documents, site characterization data, and risk assessment findings. Historical document review findings are used to determine areas of potential chemical use and identify areas for RFI sampling and characterization. CMS or NFA Area recommendations for chemicals in surficial media are based on an integrated evaluation of site characterization and risk assessment results using currently approved risk assessment methodologies. Chemicals contributing to estimated risks above the most conservative lower end of the regulatory agency-acceptable risk range (i.e., risks of 1×10^{-6}, or 1 in 1,000,000) and/or a Hazard Index of greater than 1 were identified for potential residential, recreational, and ecological receptors.

Sampling results were reviewed to locate areas where chemicals are present at concentrations contributing to or driving the estimated risks. For Group 7, this evaluation resulted in six CMS Areas being recommended for further evaluation. Primary chemicals contributing to or driving the estimated risks are summarized in Tables ES-1 and ES-2, and on Figure ES-1. Also, a brief summary of the historical operations, including primary chemicals used, and CMS Area recommendations is presented in Table ES-1, and additional details are presented in Table ES-2.

The extent of CMS Areas shown on Figure ES-1 is comprehensive for the potential receptors evaluated using currently approved risk assessment methodologies. Portions of the Group 7 Reporting Area that have not been recommended for CMS are recommended for NFA. This recommendation is based on (1) the absence of historical chemical use practices; (2) sampling results generally within the agency-acceptable risk range described above; and/or, (3) RFI site-specific risk assessment results indicating that the detected chemical concentrations do not pose a risk to residential, recreational, or ecological receptors. It is

worth noting that extents of the CMS Areas depicted graphically on Figure ES-1 are conservative and likely over-estimated for the receptors evaluated. CMS Areas are based on identifying chemical concentrations that are above their respective risk-based screening levels. This process results in CMS Areas that are larger than would need to be addressed during cleanup to achieve acceptable risks for residential, recreational, and/or ecological receptors. This is because individual soil sample results, rather than area-average concentrations, are compared directly to RBSLs. Area-averaged concentrations will be used in the CMS to refine the cleanup extent at these recommended CMS Areas.

Recommendations in this report are protective of residential, recreational, and ecological receptors using currently approved risk assessment methodologies. Recommendations are made for chemicals in surficial media (soil, soil vapor, sediment, etc.), and are based on the characterization data and risk estimates from all the media evaluated, including groundwater. Because the SSFL facility-wide groundwater investigation is ongoing, specific CMS recommendations for groundwater will be presented in a future Site-Wide Groundwater RFI Report. There will also be an additional ecological risk assessment of large-home range receptors (e.g., bobcat, mule deer, hawk) once sufficiently large areas of the SSFL have been evaluated, and any site action recommendations resulting from the large-home range evaluation will be presented in that future report. Site action recommendations presented in this Group 7 RFI Report will be reviewed once these additional evaluations are completed, as well as when SB990 requirements are determined, and, as needed, updates to this report will be prepared. However, the site action recommendations included herein can be confidently carried forward into the CMS since these two additional evaluations or requirements will identify areas that would be added to, not removed from, subsequent CMS decision-making.

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1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report presents results and recommendations for the investigation conducted within the Group 7 Reporting Area located in the northern portion of Area IV at the Santa Susana Field Laboratory (SSFL). The RCRA Corrective Action Program is being conducted at the SSFL under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). As discussed in Section 1.2 below, the RFI is being conducted at former operational areas called "RFI sites." The Group 7 Reporting Area includes three RFI sites: the Building 4029 (B4029) RFI Site, the Building 4133 (B4133) RFI Site, and the Radioactive Materials Handling Facility (RMHF) RFI Site.

Currently the RCRA Corrective Action Program at the SSFL is being conducted under the authority of Chapter 6.5 of Division 20 of the California Health and Safety Code (HSC) in accordance with the Consent Order for Corrective Action, Docket No. P3-07/08-003, issued by DTSC in 2007 (DTSC, 2007b). However, the 2007 Consent Order is in the process of being revised and the regulatory framework for SSFL cleanup will be transitioned from RCRA Corrective Action to the California Superfund Remedial Investigation / Feasibility Study (RI/FS) Process under authority of the Chapter 6.8 of the HSC. Therefore this report has been prepared to meet current requirements as an "RFI" report, and is considered functionally equivalent to a "RI" report. Also, determinations of additional characterization and risk assessment requirements for the SSFL associated with Senate Bill 990 (SB990) are ongoing. Once these determinations are made, RFI/RI Group documents will be reviewed and revised as appropriate.

1.1 SSFL FACILITY INFORMATION

The SSFL is located approximately 29 miles northwest of downtown Los Angeles, California, in the southeast corner of Ventura County. The SSFL occupies approximately 2,850 acres of hilly terrain, with approximately 1,100 feet of topographic relief near the crest of the Simi Hills. Figure 1-1 shows the geographic location and property boundaries of the site, as well as surrounding communities. The following sections describe the site use, history, land ownership, surrounding land use, and environmental programs at the SSFL. Additional SSFL facility information is provided in the RFI Program Report (MWH, 2004a).

1.1.1 SSFL Ownership and History

The SSFL is jointly owned by The Boeing Company (Boeing) and the National Aeronautics and Space Administration (NASA), and is operated by Boeing. The site is divided into four administrative areas (Areas I, II, III, and IV), with undeveloped land areas to both the north and south (Figure 1-2). The real property in areas I, III, and IV are owned by Boeing. The federal government property administered by NASA includes a 42-acre portion of Area I and all of Area II. Ninety acres of Area IV were leased to the United States Department of Energy (DOE). The northern and southern undeveloped lands of the SSFL were not used for industrial activities and are owned by Boeing. The Group 7 Reporting Area, described further in Section 1.3, is primarily located in the northern portion of administrative Area IV.

Prior to development, the land at the SSFL was used for ranching. During 1948, North American Aviation (NAA), a predecessor company to Boeing, began using (by lease) what is now known as the northeastern portion, or administrative Area I, of the SSFL. The majority of the SSFL was acquired with the purchase of the Silvernale property in 1954, and development of the western portion of the SSFL began soon after. Undeveloped land parcels to the south of the SSFL were acquired during 1968 and 1976, and land parcels to the north during 1998. No site-related operations were conducted in these undeveloped portions of the SSFL.

The primary site activities at the SSFL since 1948 have included research, development, and testing of liquid-fueled rocket engines and associated components (pumps, valves, etc.) (SAIC, 1994). Since 1996, operations at the SSFL have been conducted by Boeing. Predecessor companies (divisions) to Boeing have included the Rocketdyne Propulsion and Power Division (Rocketdyne) and Atomics International (AI) Division of NAA and Rockwell International Corporation (Rockwell). The vast majority of rocket engine testing and ancillary support operations occurred from the 1950s through the early 1970s. These were conducted by Rocketdyne in Areas I and III in support of various government space programs and in Area II on behalf of NASA. Rocket engine testing frequency decreased during the 1980s and 1990s, and ceased in 2005. Currently, no rocket engine test areas are in operation. Engine testing at the SSFL primarily used petroleum-based compounds as the ‘fuel’ and liquid oxygen (LOX) as the ‘oxidizer.’ Solvents, primarily trichloroethene (TCE), were used for cleaning rocket engine components, as well as other cleaning purposes.

Solid propellant testing was not conducted at the large rocket engine test stands, but solid propellants were used in small rocket motor testing and various research and development programs. Solid propellants, including perchlorate compounds, were primarily used, stored, and tested within a small portion of Area I.

In addition to the primary facility operation of rocket engine testing, the SSFL was used for research, development, and testing of water jet pumps, lasers, and liquid metal heat exchanger components; nuclear energy research; and research and development of related technologies. Nuclear energy research, testing, and support facilities were located within the 90-acre portion of Area IV that was leased to DOE. This area was designated as the Liquid Metal Engineering Center (LMEC) until 1978, at which time it was renamed the Energy Technology Engineering Center (ETEC). Nuclear research and energy development activities, conducted by Atomics International (AI), a division of NAA, and Rocketdyne on behalf of DOE, primarily occurred from the mid-1950s through 1988 (MWH, 2004a). Area IV was inactive prior to 1953, when the land was purchased by NAA. The research and energy development activities included nuclear energy operations (development, fabrication, disassembly, and examination of nuclear reactors, reactor fuel, and other radioactive materials) and large-scale liquid sodium metal experiments for testing liquid metal fast-breeder reactor components. Nuclear energy activities within Area IV ceased in 1988 (MWH, 2004a). Since the mid-1990s, activities in Area IV have focused on facility decontamination and decommissioning (D&D) site restoration activities.

1.1.2 Surrounding Land Use

Land surrounding the SSFL is generally open space or rural residential, although other uses are present. A brief description of the current land use of each of the offsite adjacent properties is presented below (MWH, 2004a). Adjacent land is shown on Figure 1-1.

Northern Adjacent Properties - The adjacent property to the northwest is occupied by the American Jewish University Brandeis Bardin Campus (BBC), formerly known as the Brandeis-Bardin Institute, and the adjacent property to the northeast is occupied by the Mountains Recreation Conservancy Authority (MRCA). The BBC is zoned as rural agricultural on Ventura County zoning maps. This designation permits a wide range of agricultural uses. The specific land use permit conditions for the BBC indicate that this property contains religious, teaching, and camping facilities. The MRCA property is zoned as open space and currently operates as Sage Ranch Park (a County of Ventura Park) and has

a house where the park ranger resides. Approximately 75 acres in the southern and eastern portion of the current MRCA property was formerly leased by Rockwell between 1947 and 1970 (Rockwell, 1984c).

Eastern Adjacent Properties - The properties situated immediately adjacent to the east of the SSFL are zoned light agricultural, with variances that permit higher-density use (i.e., mobile home parks). A residential community is present approximately ¼-mile east of the SSFL boundary in Woolsey Canyon. A new residential community has been proposed ½-mile southeast of the SSFL boundary near Dayton Canyon.

Southern Adjacent Properties - The properties situated adjacent to the south of the SSFL are used for residential purposes (Bell Canyon). Dense residential development begins in the San Fernando Valley about 3.5 miles east of the SSFL.

Western Adjacent Properties - The majority of properties situated adjacent to the west of the SSFL are designated by Ventura County as open space. This land has been and is currently used for cattle grazing. A portion of Runkle Canyon located in this area has been proposed for residential development.

1.1.3 SSFL Environmental Programs

Four environmental programs at the SSFL are currently being conducted under the authority of RCRA. The RCRA Program is described further in Section 1.2. In addition to RCRA, other federal, state, and county environmental programs are being conducted at the SSFL, including permitting for air emissions, surface water discharge permitting, and other site investigation and closure activities. Information regarding environmental programs conducted at the SSFL is provided in the RFI Program Report (MWH, 2004a). Since these other environmental programs overlap and are relevant to some of the RCRA RFI sites, they are briefly described below:

- Waste Discharge Requirements (WDRs) have been issued to the SSFL by the Regional Water Quality Control Board (RWQCB) since 1958. Currently, surface water discharge from the SSFL is regulated under a National Pollutant Discharge Elimination System (NPDES) permit issued by the RWQCB, which began providing oversight in 1984. Currently, surface water discharges are regularly monitored at 16 NPDES locations, shown on Figure 1-2.
- Historically, underground storage tanks (USTs) were regulated by the Ventura County Environmental Health Division (VCEHD). Aboveground storage tanks

(ASTs) were regulated by the RWQCB. Fuel storage tanks at the site are now included in the RCRA Program under oversight by DTSC.

- Closure of nuclear testing and research facilities in Area IV is being performed under the jurisdiction of DOE. The California Department of Public Health-Radiologic Health Branch (DPH-RHB) oversees the Boeing Radioactive Materials License, conducts facility verification surveys, evaluates the radioactive facility cleanup, and conducts environmental monitoring.

1.2 RCRA CORRECTIVE ACTION PROGRAM

RCRA Corrective Action at the SSFL is being conducted as required by the Stipulated Enforcement Order issued by DTSC in 1992 (DTSC, 1992). Specifications regarding the ongoing Corrective Action Program were subsequently provided in three Hazardous Waste Facility Permits issued to Boeing by DTSC. The three permits governing the RCRA Corrective Action Program at the SSFL include (1) the Areas I and III Post-Closure Permit issued in 1995 (PC 94/95-3-02 Mod SC3-111904-A), (2) the Area II Post-Closure Permit issued in 1995 (PC 94/95-3-03 Mod SC3-111904-B), and (3) the Area IV Hazardous Waste Management Facility Operating Permit issued in 1993 (93-3-TS-002). Additional requirements for the RCRA Corrective Action Program were specified in the Consent Order for Corrective Action, Docket No. P3-07/08-003, issued to Boeing, NASA, and DOE in 2007 (DTSC, 2007b).

The RCRA-related activities at the SSFL are performed as part of four major environmental programs, all under the oversight and jurisdiction of the DTSC. These programs include: (1) RCRA Corrective Action; (2) Closure of inactive RCRA units; (3) Compliance/permitting of RCRA units; and, (4) Interim Measures (IMs). In some instances these programs overlap (e.g., closed RCRA units within RFI sites that are investigated as part of Corrective Action). Although related under RCRA, each program has separate process requirements and guidelines. Collectively, these programs represent a comprehensive program for the handling and cleanup of hazardous chemicals. The RCRA Corrective Action Program is described below, and the reader is referred to the RFI Program Report (MWH, 2004a) for descriptions of the other RCRA Programs.

As indicated above, the 2007 Consent Order is in the process of being revised and the regulatory framework for SSFL cleanup will be transitioned from RCRA Corrective Action under authority of Chapter 6.5 of the California HSC to the California Superfund RI/FS Process under Chapter 6.8 of the California HSC. Therefore, this report has been prepared to meet current requirements as an “RFI” report, and is considered functionally equivalent to a

"RI" report. The following sections describe the current RCRA Corrective Action program being conducted at the SSFL.

1.2.1 Corrective Action Process

The RCRA Corrective Action process includes four phases to achieve site cleanup and closure. These are the RCRA Facility Assessment (RFA), RCRA Facility Investigation (RFI), Corrective Measures Study (CMS), and Corrective Measures Implementation (CMI) phases. The first phase, the RFA, is performed to identify Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs), which are units that have used, stored, or handled various hazardous materials. The RFA was completed in 1994 (SAIC, 1994).

The SSFL RCRA Corrective Action program is currently in the RFI phase. During the RFI, additional AOCs (beyond those listed in the RFA) have been identified and investigated at the SSFL (MWH, 2004a). A total of 135 SWMUs and AOCs have been identified at the SSFL, and those undergoing closure as part of the RFI Program have been grouped by location for purposes of investigation and are called "RFI sites." RFI sites have been grouped for reporting as described in Section 1.2.3. The RFI Program Report (MWH, 2004a) listed 51 RFI sites. Further evaluation of the RCRA Program has resulted in a new total of 57 RFI sites. Four sites were added to include land surrounding permitted facilities (Area I Burn Pit, Radioactive Materials Handling Facility [RMHF], Building 4133, and Building 4029). Two sites were added when leach fields were regrouped for reporting purposes. The 57 RFI sites identified for investigation are shown on Figure 1-3. For ease of presentation on this figure, and as reported in previous documents (MWH, 2004a), Boeing and DOE leach fields not associated with an existing RFI site have been grouped together (i.e., a DOE group and a Boeing group) and listed as additional RFI sites.

The RFI includes chemical characterization of all relevant environmental media present at the SSFL. Investigations of environmental media have been conducted following DTSC-approved work plans (ICF, 1993; GRC, 1995a; 1995b; Ogden, 1996; 2000a; 2000b; Montgomery Watson, 2000b; MWH, 2003b; 2003c;; 2005c; 2008b; 2008c). The scope and extent of sampling of the SSFL during the RFI is described in the Program Report (MWH, 2004a) and in the Site-Wide Groundwater Characterization Work Plan (MWH, 2008a).

The objectives of the RFI are to characterize the nature and extent of chemical contamination in environmental media, evaluate risks to potential receptors, gather data for the CMS, and identify areas for additional work (DTSC, 1995). Site action recommendations resulting from the RFI are categorized into either: (1) further evaluation in the CMS; (2) no further action (NFA); or (3) interim source area stabilization measures to control contaminant migration (Stabilization Areas) while cleanup plans are prepared. Stabilization Areas are included at or within CMS Areas when warranted, based on characterization findings and site conditions.

The CMS phase of the RCRA Corrective Action Program will be an evaluation of remedial alternatives for areas that are identified in the RFI for further evaluation. The CMS may also include further evaluation of uncertainties identified in the RFI, such as risk assessment uncertainties or delineation of chemicals requiring cleanup. CMS plans will be prepared for DTSC review, and findings will be published in a final CMS report for DTSC approval. In anticipation of transitioning from a RCRA Corrective Action to a RI/FS process as described above, a Feasibility Study (FS) Work Plan rather than a CMS Work Plan, was recently submitted to DTSC for review based on the findings of the RFI to date (MWH, 2009b).

During the CMI, the Corrective Action Program moves from cleanup planning to cleanup implementation and confirmation/monitoring sampling. The complete SSFL cleanup plan will be evaluated in an Environmental Impact Report (EIR) prior to implementation. Public review and comment will be included during several steps in this process prior to the selection and implementation of cleanup activities.

As described above, determinations of characterization and risk requirements associated with SB990 are ongoing. Once these determinations are made and the revised Consent Order finalized, RFI Group documents will be reviewed and revised as appropriate.

1.2.2 Operable Units at the SSFL

Since the early 1980s, SSFL site characterization has proceeded along two parallel paths: one for groundwater and the other for soil and related surficial media. In 1999, DTSC formalized this approach by identifying two Operable Units (OUs) (DTSC, 1999). As defined by United States Environmental Protection Agency (USEPA), an OU is a discrete entity that may comprise various attributes, including characteristics of the impacted media, geographical location, vertical and aerial considerations, specific site problems, and potential exposure pathways. The OUs identified at the SSFL are consistent with this definition and incorporate

different geographical portions of the site, project phases, and exposure pathways. The two SSFL OUs have been identified through discussion with DTSC based on an understanding of where chemicals are present today, where they may migrate in the future, and how either human or ecological receptors may be exposed to those chemicals (DTSC, 1999). The OUs at the SSFL are:

- The Surficial Media OU (Surficial OU), comprised of saturated and unsaturated soil, sediment, surface water (including springs and seeps), near-surface groundwater (NSGW), air, biota, and weathered bedrock. NSGW occurs within alluvium or weathered bedrock.
- The Chatsworth Formation OU (CFOU), comprised of the Chatsworth formation groundwater, and both saturated and unsaturated unweathered (competent) bedrock.

The boundary between the Surficial OU and the CFOU occurs at the transition from weathered to unweathered bedrock, which is defined as the maximum depth to which one can bore using a hollow-stem auger. Although the terms weathered and unweathered bedrock do not define distinct stratigraphic units, they distinguish regions of the subsurface that have measurably different influences on groundwater flow characteristics. Weathered bedrock is typically less resistant to groundwater flow as a result of the natural physical and chemical degradation processes that it has undergone. The OUs are depicted graphically on Figure 1-4.

The Surficial OU consists primarily of soil, sediment, and surface water that are potentially impacted by spills. Also included in this OU are NSGW, air, biota, and the upper, weathered portion of the bedrock. These additional media have been included in the Surficial OU because chemicals released into soil, sediment, or surface water could directly contact, or potentially be transferred to NSGW, surface seeps or springs, air, biota, and weathered bedrock. Direct exposure to surficial media by receptors is possible, although the type of exposure may vary based on location (e.g., steep drainage terrain versus flat upland terrain). These potential surficial media exposures within Group 7 are evaluated in the risk assessments completed for the RFI sites within this group.

The CFOU consists of groundwater and associated unweathered, competent bedrock of the Chatsworth formation, which is comprised of thickly-bedded sandstone with interbeds of siltstone and shale. This unit has been impacted by downward migration of chlorinated solvents (primarily TCE) from surficial spills and/or by dissolved-phase contaminants transported to and within Chatsworth formation groundwater. In contrast to surficial media,

due to its nature and depth (typically more than 70 feet below ground surface [bgs]), it is unlikely human or ecological receptors would be exposed directly to chemicals within the unweathered, deeper bedrock. Direct exposures to Chatsworth formation groundwater could only occur through installation of a drinking water well or at a surface seep or spring supplied by Chatsworth formation groundwater. Indirect exposures to chemicals in Chatsworth formation media (bedrock or groundwater) are also considered as part of the RFI site risk assessments. These potential direct and indirect groundwater exposures within Group 7 are evaluated in the risk assessments completed for the RFI sites within this group.

As stated above, one goal of the RFI Program is to characterize chemical impacts in all relevant environmental media at the SSFL. This goal is achieved by combining and integrating site data from the characterization programs for both OUs. Similarly, the goal of the RFI risk assessment is to evaluate chemical risks from all relevant environmental media. This goal is accomplished by combining the estimated risk associated with exposure pathways for both OUs. Several possible pathways of chemical migration across or between OUs have been identified. Each of these potential pathways is included in the risk evaluations of the Surficial OU and the CFOU, as described further in Section 5.0.

1.2.3 RFI Program and Reporting Approach

As described in the RFI Program Report (MWH, 2004a), the Data Quality Objective (DQO) process (USEPA, 1994; 2000) was used to guide the SSFL RFI. The problem statement developed for the Surficial OU RFI is:

"Comply with regulatory requirements by characterizing the nature and extent of contamination in surficial media (soil matrix, soil vapor, sediment, surface water, near-surface groundwater, air, biota, and weathered bedrock)."

Five decision questions were identified during DQO development and have been used to guide the data collection and evaluation process for the Surficial OU RFI. These five questions are:

1. Has historical information on chemical use areas and chemical releases been used to identify potential source areas?
2. Have source area sampling and analysis plans been developed to characterize the nature and extent of contamination?

3. Is the nature and extent of contamination at potential source areas within RFI sites characterized sufficiently for risk assessment?
4. Have potential human health and ecological impacts been assessed?
5. Have characterization and risk assessment results been used to make site action recommendations for the CMS?

Although developed for the Surficial OU, these five questions are relevant for the overall RFI Program at the SSFL. The RFI reporting approach has been designed to answer these questions in a comprehensive, integrated manner for large areas of the site.

Based on input from DTSC, the SSFL has been divided into 11 Group Reporting Areas as shown on Figure 1-5. While 10 of the reporting areas consist of contiguous land, Group 7 includes two separate areas that are being reported together. The Group Reporting Areas have been established to accomplish the goal of providing a comprehensive, integrated description of site data from all media across large, interrelated areas of the site. As such, the Group RFI Reports include evaluation of data from both OUs to determine characterization completeness, transport and fate of contaminants, and assessment of potential risks to receptors. As necessary, offsite areas are included in the RFI evaluation of SSFL-related impacts. Group Reporting Areas were identified generally based on natural topographic constraints at the SSFL, but groundwater plume extents, RFI site responsibility, and operational boundaries were also considered. The Group Reporting Areas shown on Figure 1-5 serve to facilitate evaluation of all migration pathways and, therefore, capture all appropriate site data for risk assessment.

The focus and objective of the Group RFI Reports is to provide DTSC sufficient information so that site action decisions regarding chemicals in Surficial Media can be made and CMS evaluation areas for chemical contamination determined. Since the CFOU investigation is ongoing while the Group Reports are being prepared, CMS recommendations regarding groundwater will be provided in a final Site-Wide Groundwater RFI Report, which will be submitted at the completion of the CFOU investigation. However, groundwater-related risks are presented in the risk assessments and considered with the Surficial OU risks in making CMS recommendations.

Two aspects of the Surficial Media RFI will be addressed after all Group RFI Reports are prepared. In both of these cases, additional Surficial Media recommendations will be provided in addition to those presented in the Group Reports. The first involves completion of the CFOU investigation described above. Since all media are being assessed for potential

risks to receptors in the current Group RFI Reports, new data collected during the ongoing CFOU investigation must be re-assessed for contribution to Surficial Media risks and, if necessary, additional areas recommended for CMS evaluation. This assessment of subsequent CFOU data will be included in the Site-Wide Groundwater RFI Report.

The second aspect that affects the Surficial Media site action recommendations for chemicals in the CMS is a site-wide evaluation for large-home range receptors (e.g., bobcat, mule deer, and hawk). Assessment of potential risks to these receptors will be performed once sufficiently large areas of SSFL have been evaluated and presented in the Group RFI Reports. Estimated large-home range receptor risks will be reported in a Site-Wide Large-Home Range Risk Assessment Report, which will also identify any additional areas that should be considered for CMS evaluation resulting from that assessment.

These two additional aspects of RFI reporting will serve to confirm the areas to be evaluated in the CMS for chemicals in surficial media developed based on existing RFI work plans as described in this (and other) Group RFI Reports. Site action recommendations presented in this Group 7 RFI Report will be reviewed once these additional evaluations are completed, as well as when SB990 requirements are determined, and as needed, updates to this report will be prepared. However, the areas recommended for further evaluation in this report can be confidently carried forward into the CMS because it is believed that additional, not fewer, areas will be identified during these additional evaluations.

The Group 7 RFI Report for the Northern Portion of Area IV is the ninth RFI Report to be submitted for DTSC review. Previously submitted reports include:

- Group 1A RFI Report for the Northeastern Portion of Area I (MWH, 2009a).
- Group 2 RFI Report for the Northern Portion of Area II (NASA, 2008)
- Group 3 RFI Report for Central Portion of Area II (NASA, 2009)
- Group 4 RFI Report for the Southern Portion of Area II (MWH, 2007c)
- Group 5 RFI Report for the Central Portion of Areas III and IV (CH2M Hill, 2008)
- Group 6 RFI Report for the Northeastern Portion of Area IV (MWH, 2006b)
- Group 8 RFI Report for the Western Portion of Area IV (MWH, 2007e)
- Group 10 RFI Report for the Undeveloped Boeing Land (CH2M Hill, 2009)

1.3 SCOPE, OBJECTIVES, AND INFORMATIONAL SOURCES FOR THE GROUP 7 RFI REPORT

The Group 7 RFI Report presents RFI findings and CMS recommendations for chemicals present in the northern portion of Area IV. The scope, objectives, and informational sources for the Group 7 RFI Report are described below. The content and format of this report is also presented.

1.3.1 Scope

The Group 7 Reporting Area includes two separate, noncontiguous areas located entirely within the northern portion of Area IV (Figure 1-6). The main area of Group 7 is approximately 44 acres and the smaller area, where the B4029 RFI Site is located, is about 3.5 acres. Areas adjacent to the main Group 7 Reporting Area include the Group 8 Reporting Area to the southwest, the Group 5 Reporting Area to the south, the Group 6 Reporting Area to the northeast, and the property occupied by BBC to the north. The areas adjacent to the smaller portion of Group 7 include the Group 5 Reporting Area to the southeast, the Group 9 Reporting Area to the south, and the Group 6 Reporting Area to the north. The adjacent properties are described in Section 1.1.2. The undeveloped, Boeing-owned land to the north of the SSFL is included as part of the Group 7 Reporting Area.

Three RFI sites are included in the Group 7 Reporting Area:

B4029 RFI Site	SWMU 7.11 (Reactive Metals Storage yard), approximately 0.3 acre.
B4133 RFI Site	SWMU 7.2 (Sodium Burn Facility), approximately 1.5 acres.
RMHF RFI Site	SWMU 7.6 (the operational area of RMHF, including the former Catch Basin) and one Area IV AOC (the Building 4021 Leach Field), approximately 4.1 acres.

It should be noted that the RFI site boundaries shown on Figures 1-3 and 1-6 (and on other maps depicted in this report) are not meant as administrative boundaries, but rather serve as outlines that encompass the primary operational activities at a site. To address this requirement, the RMHF RFI Site boundary has been modified to include operational areas to the south at former Buildings 4028 and 4811. The B4133 RFI Site boundary has also been modified to include operational areas to the south at the Former Building 4654 Interim Storage Facility (ISF).. As described in Appendices A, B and C and in Section 4, RFI

sampling extended outside of these boundaries, as necessary, to determine the nature and extent of potential contamination and assess potential migration pathways. Overall, approximately 6 of the 47.5 acres of the Group 7 Reporting Area are contained within the outlines of the RFI site boundaries shown on Figures 1-5 and 1-6.

Nature and extent evaluations, risk assessments, and site action recommendations presented in this report are based on data that were collected and requested for analysis before December 31, 2008. Twelve additional data gap soil samples were collected and analyzed within the Group 7 Reporting Area on May 8, 2009. Two of the additional samples are associated with the B4029 RFI Site. Ten of the additional samples are associated with the RMHF RFI Site. Sample results for the Group 7 data gap samples analyzed May 8, 2009 are included in the RFI Site Reports for B4029 and RMHF (Appendices A, and C, respectively) since they could be reviewed and validated before report completion. These Group 7 data gap sample results are also considered for site action recommendations presented herein, but could not be included in the quantitative site risk assessments. These data will be quantitatively evaluated in the revised report prepared following DTSC review of this document.

1.3.2 Objectives

The objectives of this report are three-fold. They are:

- To present chemical characterization results for the Group 7 Reporting Area and to identify the nature and extent of chemical contamination in environmental media.
- To present human health and ecological risk assessment results based on chemicals present in the Group 7 Reporting Area.
- To present risk-based recommendations for chemical site actions, including NFA areas, areas recommended for further evaluation in the CMS, and areas recommended for source stabilization.

As stated above, Surficial Media areas recommended for further CMS evaluation for chemical impacts are considered to be defined sufficiently for CMS planning, although additional areas may be added following completion of the Site-Wide Groundwater RFI Report, the Site-Wide Large-Home Range Risk Assessment Report, or resolution of SB990 requirements.

1.3.3 Informational Sources

Historical documents for the Group 7 Reporting Area are being submitted to DTSC along with this report (Boeing, 2009d). These documents represent a compilation of information from multiple sources that were searched in an attempt to find SSFL documents relevant to the Group 7 RFI. Included in the document submittal are the available photographs, maps and drawings, manifests, memoranda, tabulations, facility records, correspondence, and reports relevant to site operations and types and sources of chemicals that may have been used, handled, or released in the Group 7 Reporting Area. Documents pertaining to the entire SSFL are also included if they have relevant information also specific to Group 7. These documents were reviewed to (1) determine the history of site operations, (2) identify areas of known or potential chemical use for evaluation in the RFI, (3) compile site characterization data, and (4) identify areas where additional data were required to adequately characterize environmental site conditions. The results of the historical document review and sampling data collected for the Group 7 Reporting Area are presented in this report. The historical document review, coupled with the site characterization data, provides a solid basis for the recommendations for chemicals in surficial media provided in Section 7 of this report, including areas that are recommended for further evaluation in the CMS and areas that are recommended for NFA.

1.3.4 Content and Format

To present the necessary information regarding characterization findings, risk assessment results, and site action recommendations, this Group 7 RFI Report is divided into nine sections (seven sections of text, plus references and a glossary of terms), and seven appendices. A diagram for the Group 7 RFI report structure is shown on Figure 1-7 and presented in relationship to the overall RFI reporting approach for the SSFL. This figure also describes the key elements of each component of the report, how and where information is presented, and the informational relationships between the components of the document.

This volume (i.e., Volume I) of the Group 7 Report (Sections 1 through 9) presents an integrated summary of the detailed information presented in appendices (Volumes II and III), and describes intra-site relationships regarding the nature and extent and transport and fate of chemical impacts within the reporting area.

Volume I:

Section 1 – Introduction. This section provides SSFL background and operations; descriptions of environmental programs, RFI strategy, and reporting; and the scope and objectives, and informational sources of this Group 7 RFI Report.

Section 2 – Physical Setting of the Reporting Area. This section describes physical features of the reporting area including topography, climate and meteorology, geology, surface water, groundwater, and biological conditions.

Section 3 – Group 7 Site History and Chemical Use. This section summarizes the history of the Group 7 RFI sites and presents the potential chemical use areas considered during the investigation. Current conditions and how they may be different from conditions during site operations are also presented, including historical changes to physical features (e.g., grading following building demolition) as they relate to characterization findings or risk assessment results.

Section 4 – Nature and Extent of Chemicals in Group 7. This section summarizes the results of the investigations across the entire reporting area. Detected chemical concentrations in environmental samples and the interpretation of the results are included. Detailed findings for individual RFI sites are presented in Appendices A, B, and C as described below.

Section 5 – Contaminant Transport and Fate. This section presents conceptual site models and describes contaminant migration pathways, and transport and fate evaluation results used to assess chemical migration in groundwater, soil vapor, air, and surface water drainages.

Section 6 – Risk Assessment Summary. This section presents a summary of the human health and ecological risk assessment results for the Group 7 Reporting Area based on three RFI site risk assessments.

Section 7 – Group 7 RFI Report Summary and Site Action Recommendations. This section summarizes how this report meets SSFL RCRA reporting requirements, presents the criteria and processes applied to make site action recommendations, and identifies specific areas within the RFI sites that are recommended for further evaluation in the CMS and for source stabilization measures, as appropriate.

Section 8 – References. This section provides the references cited in the text.

Section 9 – Glossary and Definition of Terms. This section provides definitions of technical terms that are used in the document and may be unfamiliar to the reader.

Volume II:

Appendices A, B and C – RFI Site Reports. These appendices present detailed site history, characterization findings, risk assessment results, and site action recommendations for the three RFI sites evaluated in the Group 7 RFI Report:

- B4029 RFI Site: Appendix A
- B4133 RFI Site: Appendix B
- RMHF RFI Site: Appendix C

Site operational histories are described, sampling results are presented in tables for each potential chemical use area, and analytical data are depicted on maps. Groundwater conditions and risk assessment findings for each site are summarized. The overall format of these appendices generally follows that presented in this volume of the Group Report. Each RFI site report is an individual Appendix, and each Appendix has four Attachments. The Attachments present further details not presented in the Appendix text and include:

- Attachment 1: Regulatory Agency Correspondence
- Attachment 2: Subsurface Information (e.g., boring logs)
- Attachment 3: Data Quality, Validation and Laboratory Reports
- Attachment 4: Building Feature Documentation

Existing Group 7 buildings were inspected in 2008 for known or potential chemical use features following procedures described in the Building Feature Evaluation and Sampling Standard Operating Procedures (MWH/CH2M Hill, 2008b). Included in Attachment 4 are photographs, inspection findings, and associated sampling recommendations. In cases where samples were collected, results are described in the site reports (Appendices A, B, and C).

Appendix D – Chemicals in Groundwater. This appendix presents information regarding groundwater conditions in the Group 7 Reporting Area. Information includes groundwater occurrence and quality, chemical transport, data set representativeness, and supporting data (monitoring results, time-series plots, and hydrographs), as well as an evaluation of naturally occurring constituents. It also provides the basis for identifying site-related chemicals in groundwater to support characterization and risk assessment.

Appendix E – RFI Risk Assessment. This appendix presents risk assessment information including a description of any methodology variances from the Standardized Risk Assessment Methodology (SRAM) Work Plan, Revision 2 (MWH, 2005b), RFI site risk assessments, risk calculations, result tables, and all transport and fate modeling except for groundwater transport modeling (presented in Appendix D).

Appendix F – Group 7 Debris Survey Results. This appendix presents the results of a detailed survey for surficial waste debris conducted in 2008 across the Group 7 Reporting Area. Findings from this survey have been incorporated into the RFI sampling conducted at the Group 7 RFI sites, and are described in Appendices A, B, and C.

Appendix G – Group 7 Sewer Pipeline Survey Results. This appendix presents the results of a sewer pipeline manhole inspection survey performed in 2008. Sampling performed to assess sewer pipeline conditions in Group 7 are described in the site reports (Appendices A, B, and C).

As stated above, historical documents for the Group 7 Reporting Area are being submitted to DTSC along with this Group RFI Report (Boeing, 2009d). Since historical document review is ongoing for the other RFI Groups, if other documents are identified that are pertinent to the Group 7 Reporting Area, these will be provided to DTSC as an addendum to the Group 7 historical document submittal.

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2.0 PHYSICAL SETTING OF THE REPORTING AREA

This section describes the physical setting within the Group 7 Reporting Area. The RFI Program Report provides an overview of the physical setting at the SSFL (MWH, 2004a). Additional specific information is also provided within each of the RFI site reports (Volume II, Appendices A, B, and C) and in the groundwater appendix (Volume III, Appendix D).

2.1 TOPOGRAPHY

The Group 7 Reporting Area occupies approximately 47.5 acres with about 260 feet of topographic relief. A shaded relief map showing the site topography is provided as Figure 2-1. The Group 7 Reporting Area slopes generally to the west and north. The northern portion of the Group 7 Reporting Area is characterized by topographically flat areas where buildings were located, surrounded by moderate hillslopes with bedrock outcrops near and within the former operational areas of the B4133 and RMHF RFI Sites. North of the RMHF RFI Site, the surface elevation of the Group 7 Reporting Area reaches a maximum of approximately 1,940 feet above mean sea level (feet msl). The lowest surface elevation is approximately 1,680 feet msl in the canyons located in the western portion of the reporting area. Within former operational areas of the northern two Group 7 RFI sites, surface elevations range from approximately 1,760 feet above msl at the northwestern edge of the RMHF RFI Site at a surface water divide, to approximately 1,900 feet msl at the southern and northern edges of the B4133 RFI Site. Topographically, the northeastern portion of Group 7 is the flattest area, and the portion surrounding the RMHF RFI Site is the steepest.

In the southern portion of the Group 7 Reporting Area, the B4029 RFI Site is located in a topographically flat portion of the SSFL known as Burro Flats. The B4029 RFI Site is bordered by a large sandstone outcrop to the north, and bedrock outcrops to the east. To the west, topography slopes gently south, and to the south, the site is bordered by a south-facing slope leading a generally flat topography which drains southward. Surface elevation in the southern portion of the Group 7 Reporting Area ranges from about 1,820 feet above msl to about 1,880 feet msl at the top of the bedrock outcrop in the southern portion of the site.

2.2 CLIMATE AND METEOROLOGY

Climate and meteorological data have been collected for the SSFL since the 1960s. The climate falls within the Mediterranean sub-classification, and monthly mean temperatures range from 50 degrees Fahrenheit (ºF) during winter months to 70 ºF during summer months

(SAIC, 1994). During the summer months (April through October), an onshore wind pattern occurs due to proximity of the nearby Pacific Ocean; during the winter months this is interrupted by weather fronts (SAIC, 1994). Wind measurements have been collected at the SSFL in Area IV west of the Group 7 Reporting Area. A wind rose diagram showing data collected from 1994 to 1997 is presented on Figure 2-2 and indicates that the prevailing wind pattern is northwest-southeast (STI, 2003). This wind rose pattern is consistent with historical data collected in the 1960s.

Precipitation at the SSFL is normally in the form of rain, although snow has occasionally fallen during winter months. Precipitation at the site has averaged approximately 18 inches per year between 1960 and 2007, as shown on Figure 2-3A. The annual precipitation has ranged from a low of 5.7 inches in 2002 to a maximum of 41.2 inches in 1998. Precipitation has been measured at the SSFL daily during rainstorms at two onsite stations. Monthly precipitation for the 6-year period from October 2000 through June 2008 is presented on Figure 2-3B. The majority of annual precipitation at the SSFL occurs between the months of November and March, consistent with the regional precipitation pattern of southern California.

2.3 GEOLOGY

The SSFL is located in southern California's Transverse Ranges, a geomorphic province resulting from north-south compression associated with the San Andreas Fault. As a result, geologic structures such as faults and folds generally trend in an approximate east-west direction at the SSFL. Soils and bedrock within the Group 7 Reporting Area are described in this section.

2.3.1 Soil

Group 7 soils consist of alluvium, primarily comprised of weathered Chatsworth formation bedrock, colluvium, and fill soils. Figure 2-4 shows the approximate extent of alluvium, including fill soil areas, in the Group 7 Reporting Area. Native soil (i.e., alluvium and colluvium), that is present primarily in topographic lows and stream drainages, typically ranges in thickness from less than 1 foot to approximately 20 feet. Based on soil boring logs (Appendices A, B, and C), the approximate soil and/or fill thickness ranges from less than 1 foot to approximately 11 feet at the B4029 RFI Site, less than 1 foot to approximately 20 feet at the B4133 RFI Site, and about 1 foot to approximately 20 feet at the RMHF RFI Site.

Soils at the B4133 and RMHF RFI Sites are generally comprised of fine-grained silty sands and clayey sands, with occasional clayey silts, silt with sand, and lean clay. These soils are interpreted to be weathered products of the Chatsworth formation Upper Burro Flats member interbedded sandstone, siltstone, and shale bedrock. Soils at the B4029 RFI Site are generally comprised of fine-grained silty sands with occasional clayey sands, and silty sandstone. These soils are interpreted to be weathered products of the Chatsworth formation Lower Burro Flats member interbedded sandstone, siltstone, and shale bedrock. Surface conditions at the B4029, B4133, and RMHF RFI Sites include asphalt and/or concrete covered surfaces over most of the sites.

Soils and bedrock have been excavated from the B4133 and RMHF RFI Sites and adjacent areas due to building demolition and/or site remediation activities. Excavations within the Group 7 Reporting Area have ranged from 1 foot to 25 feet at the B4133 RFI Site, and less than 1 foot to 25 feet at the RMHF RFI Site and adjacent areas. The deepest excavations at both RFI sites were related to demolition of sub-grade building structures. Excavations were generally backfilled with disturbed native soil from onsite borrow sources and/or clean overburden from the excavation. The Building 4021 Leach Field excavation at the RMHF RFI Site was backfilled below grade and several shallow excavations were not backfilled or graded.

2.3.2 Bedrock

Figure 2-5 shows the geologic units present within the Group 7 Reporting Area. The Upper Chatsworth formation is present throughout the Group 7 Reporting Area. A stratigraphic column of the Chatsworth formation, which underlies most of the SSFL and the Group 7 Reporting Area, is included as Figure 2-6. As shown, the Chatsworth formation is comprised predominantly of sandstone with interbeds of siltstone and shale. The members of the Chatsworth formation are described in more detail in the following sections.

Beds of the Upper Chatsworth formation generally strike N70˚E and dip 25˚NW. There is one stratigraphic member the Chatsworth formation underlying the Group 7 Reporting Area. The Upper Burro Flats member is primarily composed of fine- and medium-grained sandstone with minor interbeds of fine-grained conglomerates, siltstones, and shales. A finer-grained unit was identified within the Upper Burro Flats member, the Lot bed, characterized by interbeds of sandstone, siltstone, and shale ranging in thickness from approximately 3 to 10 feet (MWH, 2007d). Additional geologic information is presented in Appendix D.

The Group 7 Reporting Area is partially bounded along the north edge of the group and SSFL property boundary by the western portion of the North Fault. The fault strikes approximately northeast from the Burro Flats Fault in the south through the Group 7 Reporting Area. Within the Group 7 Area, the fault is comprised of closely spaced deformation bands of variable orientations, in an approximately 600 to 800 foot width along the fault zone (MWH, 2007d). From the northeast portion of this area it then follows an east-west strike as it continues east, ultimately terminating at the Shear Zone in the Group 7 Reporting Area (Figure 2-5).

The bedrock underlying the SSFL has a controlling influence on groundwater flow and contaminant transport and fate. For this reason, various bedrock properties have been estimated based on laboratory measurements of bedrock samples and borehole geophysical logs collected from Group 7 Reporting Area wells. Bedrock properties are briefly discussed in Section 5, and presented in tables included within Appendix D.

2.4 SURFACE WATER

The SSFL is located on top of the Simi Hills and surface water runoff drains to the north into Arroyo Simi in Simi Valley and to the south into Bell Creek, which leads to the Los Angeles River (Figure 2-7A). Details of Group 7 surface water drainage basins and surface water flow directions are shown on Figure 2-7B for the northern portion of Group 7, and on Figure 2-7C for the southern portion. The following description of the surface flow directions and drainage patterns within the Group 7 Reporting Area first presents overall drainage patterns, followed by more detailed site descriptions. Surface water within the Group 7 Reporting Area exists only as intermittent discharge resulting from rain events.

There are two surface water catchment basins represented within the Group 7 Reporting Area (Figure 2-7B), one in the northern portion of the Group and one in the south. The northern watershed includes the entirety of the B4133 RFI Site, the majority of the RMHF RFI Site, and the area west of the RMHF fenced area. This watershed includes the NPDES monitoring location Outfall 003, and drains to the BBC and Arroyo Simi via the Meier Canyon Drainage. The area west of the RMHF RFI Site (north of the Group 5 Reporting Area), flows to a north-trending drainage leading offsite onto BBC property where the drainage first converges with a drainage from the Group 8 RFI Reporting Area, and then converges with the Outfall 003 drainage leading from RMHF. The southern portion of Group 7 is contained within the central SSFL watershed which discharges to the south with flow leading to the R-2 Pond (SWMU 5.26), and ultimately to Bell Creek and the Los Angeles River. Within the

southern portion of Group 7, surface water flow leads to a drainage south of the Silvernale Reservoir (SWMU 6.8).

Surface water is monitored at one NPDES location in this portion of the SSFL, Outfall 003 northwest of the RMHF RFI Site (Figure 2-7B). Surface water discharge into the R-2 Pond is monitored at Outfall 018 in Area II (Figure 1-3). Surface water flow patterns for the Group 7 Reporting Area are shown in Figures 2-7B and 2-7C, and described in more detail below for each RFI site.

B4029 RFI Site

Surface water runoff around Building 4029 flows to a topographic low point, just outside the southeast corner of the building (Figure 2-7C). At this location, a 4-inch polyvinyl chloride (PVC) drain line conveys flow approximately 6 feet southeast, where it discharges via sheet flow onto a south-facing slope leading to the south-southwest. Surface water runoff on the Building 4029 access road collects in a natural swale along the north side of the road, and flows west until the access road turns north, approximately 150 feet west of the building. Surface water discharge then flows underneath the road via a below grade pipeline, which discharges on the southwest side of the road. Surface water runoff then continues south-southwest via sheet flow within the Group 5 Reporting Area, ultimately leading to a natural drainage that discharges into a concrete-lined drainage south of Silvernale Reservoir (SWMU 6.8). Similarly, any surface water runoff south of Building 4029 and access road drains via sheet flow to the south, leading to the drainage below Silvernale Reservoir. Surface water discharge from the drainage south of the Silvernale Reservoir is to the R-2 Pond (SWMU 5.26), where it is monitored at NPDES Outfall 018.

B4133 RFI Site

Surface water at the B4133 RFI Site, outside of the facility area discharges by sheet flow to the west to an east-west trending drainage north of RMHF, which in turn flows north onto the BBC (Figure 2-7B). Surface water discharge from the B4133 RFI Site is monitored at NPDES Outfall 003 at the RMHF Site. Surface water in the bermed asphalt area surrounding Building 4133 flows to the northeast and northwest corners of the area where it is captured by two approximately 1.5 foot by 1.5 foot by 2.5 foot deep below grade sumps located at each corner of the facility. These sumps are collection features and do not drain to any other location; surface water collected in these sumps has been and continues to be pumped out.

During operations at Building 4133, a 4-inch PVC drain pipe conveyed treated waste solutions from the former Building 4133 Neutralizing Pit to an asphalt-lined drainage ditch east of the B4133 RFI Site. The asphalt-lined drainage ditch (located at the SRE RFI Site in Group 6) directed surface water flow to a concrete-lined ditch that discharged into the southeastern portion of the SRE Pond, where surface water was pumped and discharged to a asphalt-lined drainage in the southern portion of the Old Conservation Yard RFI Site located in the Group 6 Reporting Area (MWH, 2006b). The natural drainage north of the SRE Pond leads to the Meier Canyon drainage which discharges to Arroyo Simi in Simi Valley. The Neutralizing Pit drain pipe at B4133 RFI Site was permanently plugged in 1986 after an expandable plug failure at the Neutralizing Pit led to the release of approximately 1,000 gallons of sodium hydroxide solution to the SRE RFI Site (MWH, 2003c).

RMHF RFI Site

Surface water within the RMHF fenced area generally flows from east to west across the site by sheet flow to a storm drain culvert located along the western perimeter of the site (Figure 2-7B). Surface water flow to the northern perimeter drains into an asphalt-lined swale that leads to the storm drain culvert. Prior to 2006, the culvert drained to an asphalt-lined channel that conveyed surface water to the RMHF Catch Basin. Following the removal of the Catch Basin and asphalt-lined drainage channel in 2006, the culvert drains into an aboveground pipeline that conveys water to a 1,500-gallon polyurethane storm water AST. Storm water runoff is collected and then pumped from the AST to a pipeline that discharges to a lined drainage along 17th Street (located in the Group 5 Reporting Area). From this discharge point, surface water flows down 17th Street to G Street (Boeing, 2009a). Surface water discharge then continues through both lined and unlined drainages to the unlined 17th Street Pond (included in the Process Development Unit [PDU] RFI Site in Group 5), which in turn discharges via natural drainages to the R-2 Pond (SWMU 5.26). Surface water discharge from the R-2 Pond is monitored at NPDES Outfall 018.

The area north of the RMHF fenced area is unpaved and surface water is conveyed via sheet flow to a natural drainage north of the site that discharges through Outfall 003. The former Catch Basin area, located west of the RMHF fenced area, drains via sheet flow to a natural drainage that discharges into the inlet of Outfall 003. Further to the southwest of RMHF, north of the Group 5 boundary, surface water discharge is conveyed by sheet flow to two natural drainages that converge and lead offsite to the north onto BBC property. Offsite, this drainage first converges with a drainage from the Group 8 RFI Reporting Area, and then

converges with the Outfall 003 drainage leading from RMHF. This drainage in turn leads to the Meier Canyon drainage, which discharges into the Arroyo Simi in Simi Valley.

The only portion of the RMHF RFI site that naturally drains to the south is a small portion south of the RMHF fence yard. The area south of the RMHF Mixed Waste Storage Yard is unpaved and surface water is conveyed via sheet flow to a south-facing slope which drains into concrete-lined drainage channel which discharges into a storm drain culvert.

There are two storm drains (upper and lower) at the former location of Building 4028. Storm water runoff that enters these drains comes from a drainage north the Building 4024 which receives surface water runoff from the areas east of Building 4024, the asphalt area around Building 4024, and from the slope between RMHF and nearby rock outcrops. The former locations of Building 4032 and 4023 also have storm drain systems that are now unused and covered with welded steel plates.

Prior to the 2006 Catch Basin removal, the Building 4028 culvert drained to a pipeline and surface water was conveyed to the RMHF Catch Basin. Since the Catch Basin removal in 2006, surface water flow has been redirected away from the storm drains and currently drains around the former Catch Basin and converges with the drainage that runs north of the RMHF and enters drainage monitored by NPDES Outfall 003.

The storm water AST that replaced the RMHF Catch Basin currently only contains storm water runoff from the paved surface area of the RMHF. The Catch Basin was originally built only to contain discharges from Building 4028, not RMHF. It was modified in approximately 1961 to also receive surface water runoff from RMHF.

The southern portion of the Building 4024 area also drains to the storm drain that runs from east to west along “B” Street, along the road immediately to the south of Building 4024. Discharge from this storm drain flows into Silvernale Reservoir, which is monitored at NPDES Outfalls 018 and 002.

Historically, surface water from the Filter/Blower Area between Buildings 4021 and 4022 collected in three concrete-lined trenches. Drains in these trenches discharged to the RMHF northern slope via a 4-inch below-grade pipeline, which, as described above, discharged to the natural drainage north of the site. At some time during the RMHF operational period, the drain was plugged, although the reason or timing of this action is not specified in the

reviewed historical documents. The drains are currently in place, but not used. Currently, surface water from the Filter/Blower Area is conveyed to the west via sheet flow to the area of the former RMHF Catch Basin or the storm water AST.

2.5 GROUNDWATER

A description of the groundwater system and monitoring network in the Group 7 Reporting Area is presented in Appendix D. A conceptual diagram depicting groundwater conditions at the SSFL is shown on Figure 2-8. Figure 2-9 shows the locations of wells and piezometers that are used to monitor groundwater in the Group 7 Reporting Area. Figures 2-10 and 2-11 depict groundwater conditions for perched and Chatsworth formation groundwater. Figure 2-11 provides hydrogeologic cross-sections for the Group 7 Reporting Area.

Groundwater at the SSFL occurs in alluvium/colluvium, weathered bedrock, and unweathered bedrock. Since mid-2001, groundwater that is present in either alluvium/colluvium and/or weathered bedrock has been referred to as "near-surface groundwater" (NSGW) for the purposes of human health and ecological risk assessments. Chatsworth formation groundwater is defined as groundwater that occurs in unweathered bedrock beneath the SSFL. Depending upon location at the SSFL, the NSGW can either be perched above, or vertically continuous, with the Chatsworth formation groundwater. In response to comments provided by the DTSC on the Group 6 RFI Report (DTSC, 2007a), the description of groundwater at SSFL has been modified in an attempt to clarify these relationships. Appendix D presents the revised groundwater definitions, which distinguish between groundwater that may be perched versus groundwater that is vertically continuous. As shown in Figure 2-8, perching typically occurs near the transition from the weathered bedrock to unweathered bedrock, due to the reduction in the bulk hydraulic conductivity of the unweathered bedrock.

For purposes of presenting groundwater monitoring data in this volume and in Appendices A, B, C, and D, the terms NSGW and CFOU groundwater are used consistent with the definitions approved by DTSC (DTSC, 1999; 2007b). Perched versus continuous groundwater occurrence is described for NSGW and CFOU groundwater as appropriate for characterization, transport and fate, and risk assessment. Appendix D provides a more detailed description of the occurrence of these conditions for Group 7.

Both NSGW and CFOU groundwater are present in the Group 7 Reporting Area. NSGW is present in localized areas across the SSFL. However, CFOU groundwater is a regional unit and is present throughout the entire SSFL. The general relationship between the NSGW and CFOU groundwater units in the Group 7 Reporting Area is shown on Figure 2-8. Groundwater is regularly sampled at the SSFL, and the data are published in annual and quarterly groundwater reports (H&A, 2008a; 2008b; 2008c; 2008d).

The monitoring wells, piezometers, and springs in and near the SSFL have been divided into 11 RFI Group Reporting Areas and provide more than 400 unique monitoring locations. Well assignments for each of the Reporting Areas and individual RFI sites were made based on location and proximity to site operations and direction of groundwater flow. Generally, wells located in or near an RFI site were assigned to that RFI site. Similarly, wells within the Group Reporting Area boundaries (if onsite) or near the Group Reporting Area (if offsite) were assigned to that Group. Data from the assigned wells are used to evaluate chemical impacts and transport and fate at each RFI site and within each Group Reporting Area. Similarly, springs or seeps have been assigned to RFI sites and Group Reporting Areas based on their presence in or proximity to the Group Reporting Areas. Data from both onsite and offsite wells are evaluated, and discussions of such are included in the Group 7 RFI Report (Appendix D).

NSGW and CFOU groundwater occurrence and quality for the Group 7 Reporting Area are described in the following sections. It is important to note that the groundwater characterization program at the SSFL is ongoing and incomplete as of the date of this report. As such, groundwater discussions included in this report do not completely describe all of the elements of an RFI report for groundwater, as uncertainty remains with respect to the extent of chemical impacts to groundwater. Therefore, descriptive elements of the groundwater flow system and the direction of chemical transport have been intentionally kept to a minimum in this report until such time as additional data are collected to reduce the uncertainty. Additional characterization work was approved by DTSC (DTSC, 2007c; 2007d), and an RFI work plan to complete the groundwater characterization program at the SSFL was submitted to and approved by the DTSC (MWH, 2008a; DTSC, 2009). Upon completion of the groundwater RFI, the uncertainty inherent in this report and its impact on the risk assessment will be evaluated. It should be noted, however, that a conservative approach has been taken in the risk assessment for the direct exposure pathway. As such, any resultant modification in the characterization of groundwater will not likely affect the

risk assessment. If necessary, the risk assessments will be revised, and the results will be reported in the final Site-Wide Groundwater RFI Report.

2.5.1 Near-Surface Groundwater

Detailed information regarding the occurrence and perching of NSGW within alluvium and/or weathered bedrock in the Group 7 RFI Reporting area can be found in Appendix D. NSGW is intermittently persistent at the B4029, B4133, and RMHF RFI Sites. NSGW appears perched above Chatsworth formation groundwater at the B4029 and B4133 RFI Sites, although at the RMHF RFI Site groundwater is vertically continuous. Where it is more extensive, the lateral component of NSGW flow at the SSFL appears to generally follow topography. Localized interpretations of the hydraulic gradient are not appropriate at most Group 7 RFI sites, since it is not laterally continuous. The following sections contain a brief description of NSGW occurrence for each of the Group 7 RFI sites.

B4029 RFI Site

NSGW at the B4029 RFI Site is monitored by one shallow well (RS-24) and three piezometers screened in weathered bedrock, including monitoring well RS-24 and piezometers PZ-055, PZ-112, and PZ-113 (Figure 2-9). Although none of these monitoring locations are within the Group 7 Reporting Area boundary, all are located less than 500 feet from the B4029 RFI Site. The NSGW occurrence at these piezometers is intermittent. The historical data suggest that NSGW at the site is perched above Chatsworth formation groundwater during periods of heavy seasonal precipitation. When present, NSGW at RS-24 and PZ-112 is encountered at depths ranging from 2 to 22 feet bgs, which is approximately 20 to 30 feet shallower than water levels measured in nearby Chatsworth formation wells RD-16 and RD-92. Groundwater elevations at these monitoring locations generally range between approximately 1786 and 1818 feet msl (approximately 8 to 32 feet bgs).

B4133 RFI Site

NSGW at the B4133 RFI Site is monitored by one shallow well, RS-25, screened in weathered bedrock (Figure 2-9). Monitoring well RS-25 is located at the northern edge of the paved area surrounding Building 4133. NSGW is typically present in RS-25 during the rainy season, but occasionally subsides during periods of low precipitation. When present, NSGW is measured at depths ranging from 12 to 15 feet bgs (1848 to 1851 feet msl). On average, water levels in RS-25 are about 70 feet higher than those measured at nearby

Chatsworth formation well RD-19, suggesting that NSGW is perched above Chatsworth Formation groundwater near Building 4133.

RMHF RFI Site

NSGW is intermittently present at the RMHF RFI Site, as indicated by shallow well RS-28 and piezometer PZ-116, screened in weathered bedrock. When present, NSGW has been measured at depths ranging from ground surface to 24 feet bgs (1730 to 1770 feet msl). NSGW at this location appears to be perched above Chatsworth formation groundwater and at other times vertically continuous with Chatsworth formation groundwater. When Chatsworth formation groundwater rises into weathered bedrock near RMHF, water levels measured in PZ-116 and RS-28 are within several feet of those measured at RD-34A and RD-30 and exhibit nearly identical temporal trends. Perched conditions appear to exist for only a short time and often precede the rise of Chatsworth formation groundwater into weathered bedrock.

2.5.2 Chatsworth Formation Groundwater

Chatsworth formation groundwater is monitored at 27 locations within and around the Group 7 Reporting Area. Nine Chatsworth formation groundwater monitoring locations are located outside of the SSFL on property owned by the BBC. Chatsworth formation groundwater within the Group 7 Reporting Area is encountered at average depths ranging from 1725 to 1790 feet msl (10 to 73 feet bgs). Water levels measured in offsite wells are significantly lower, ranging from 1313 to 1381 feet msl. Although groundwater elevations are significantly lower at these locations, the topographic difference is comparable and depths to groundwater measured at offsite wells are even shallower than those typically measured within the Group 7 Reporting Area. Artesian conditions are observed at several of the offsite wells and are associated with a number of ephemeral groundwater seeps in the area.

Temporal variations in Chatsworth formation groundwater elevations are represented on hydrographs included in Figures D-5a through D-5c, which depict water levels measured over the period of record for wells assigned to the Group 7 Reporting Area. Variations in groundwater elevations associated with precipitation events are apparent in hydrographs for the majority of wells within the Group 7 Reporting Area, and water levels at some of these locations may rise or fall by up to 40 feet in a single season. Wells that exhibit the strongest responses to seasonal rainfall are those that are located within the major east-west drainage north of RMHF that runs through the Group 7 Reporting Area. Wells located outside of this

drainage generally exhibit more subtle responses, which is likely a result of lower local recharge conditions.

B4029 RFI Site

Chatsworth formation groundwater at the B4029 RFI Site is monitored by wells RD-16 and RD-92 (Figure 2-9). Groundwater elevations at these monitoring wells range from 1755 to 1780 feet msl (37 feet to 64 feet bgs) and are typically 10 to 15 feet higher at RD-92. Water levels in RD-16 are more responsive to seasonal rainfall than those at RD-92, and can vary up to 15 feet throughout the seasons.

B4133 RFI Site

Chatsworth formation groundwater near the B4133 RFI Site is monitored by two wells, RD-19 and RD-85 (Figure 2-9). RD-19 is located approximately 125 feet west of Building 4133 and RD-85 is located to the northeast of Building 4133 at the former Sodium Reactor Experiment (SRE) RFI site. Groundwater elevations measured at RD-19 typically range between 1764 to 1788 feet msl (45 feet to 90 feet bgs), but may rise by up to 40 feet (over 1800 feet msl) following periods of heavy precipitation. Groundwater elevations at RD-85 are typically 5-15 feet higher than those measured at RD-19, but exhibit similar temporal trends.

RMHF RFI Site

Chatsworth formation groundwater at the RMHF RFI Site is monitored by 14 wells (RD-27, RD-30, RD-34A, RD-34B, RD-34C, RD-63, RD-87, RD-88, RD-89, RD-90, RD-94, RD-96, RD-97, and RD-98) (Figure 2-9). The depth to Chatsworth formation groundwater near the RMHF RFI Site generally ranges between 40 and 55 feet bgs (1765 and 1790 feet msl), but often rises into weathered bedrock at monitoring locations within the drainage to the north (RD-30 and RD-34A). Several offsite wells (OS-02, OS-03, OS-04, OS-5, OS-5A, OS-06, RD-59A, RD-59B, and RD-59C) are used to monitor groundwater conditions down-gradient of the RMHF RFI Site. Groundwater elevations measured in these wells are hundreds of feet lower than those measured at wells within the RMHF RFI Site, which is likely due to the significant topographic decline. Artesian conditions are observed in several of these wells and are responsible for the presence of a number of springs that have been identified nearby.

2.5.3 Springs and Seeps

There are four offsite groundwater springs and seeps that are included within or near the Group 7 Reporting Area (S19, S20, S21, and FDP-424). These springs/seeps are located to the northwest of the SSFL property boundary on property owned by BBC. Groundwater emerging at these spring/seeps is described further in Appendix D and in Sections 4 and 5 below. Samples have been collected from many of these spring/seeps, and analyzed for both site-related and naturally occurring chemical constituents as described in the seep/spring sampling report (Boeing, 2007b), and the *Site-Wide Groundwater Characterization Work Plan* (MWH, 2008a). Data reduction and interpretation of results from the geochemical analysis are ongoing and will be described in a future report.

2.6 BIOLOGY

Biological conditions at the three Group 7 RFI sites as they existed prior to the 2005 Topanga Fire, along with recent vegetation changes, are shown on Figure 2-12 which depicts vegetation types and sensitive species. In June 2007, reconnaissance-level vegetation mapping was conducted at the Group 7 RFI sites in support of the site-specific ecological risk assessment, and the vegetation map is included as Attachment E11 of Appendix E.

During the September/October 2005 Topanga Fire most of the vegetation at the B4029 and B4133 RFI Sites was burned and significant ash was deposited across the Group 7 Reporting Area. Generally, in areas with limited vegetation (e.g., bedrock outcrops or developed areas), effects of the fire were minimal. Areas with more vegetation (e.g., trees and chaparral), including surface water drainages, were impacted significantly by burning and deposition of ash. Currently, the plant community in these burned areas is in a transitional state, and early post-fire plant species are growing. It is expected that the plant community will continue to grow and transition until a more stable plant community is established.

The majority of the former operational areas of the Group 7 RFI sites is comprised of ruderal habitat, non-native grassland, coast live oak woodland, rock outcrops and developed land. Other vegetation types include chaparral and native scrub. Coastal scrub, coast live oak woodland, and chaparral vegetation is predominant along the hillside and the drainage areas north of the RMHF RFI Site.

Sensitive species present at and near the Group 7 RFI sites are the Santa Susana tarplant, the Coastal Western Whiptail, legless lizard, ring-neck snake, rufous-crowned sparrow, and sage sparrow.

3.0 GROUP 7 SITE HISTORY AND CHEMICAL USE

This section presents a summary of historical operations, current site conditions, and significant changes to site conditions. It also describes known or potential chemical uses in the Group 7 Reporting Area. Additional details are presented in the RFI Site Reports in Appendices A, B, and C. A Group 7 RFI map, including surface features, buildings, and monitoring wells, is shown as Figure 3-1. Changes to RFI site conditions (e.g., building locations, soil disturbance areas, etc.) are shown on Figure 3-2. Site histories and chemical use summaries presented in this section represent information gained through a comprehensive review of historical documents generated during facility operations or in subsequent environmental investigations. Over 23,000 records (provided in the documents submitted in conjunction with this report [Boeing, 2009d]) were reviewed, including facility operational reports, maps and drawings, internal and external correspondence, regulatory compliance information, historical and aerial photographs, facility personnel interview records, and previous environmental reports.

Section 3.1 provides site history information for each of the Group 7 RFI sites. The sites are presented in Section 3.1 in the order they are described in Appendices A, B and C. The reader is referred to a particular RFI site appendix for more details regarding operations, site features, chemical use areas, and information sources. Potential chemical use areas at each of the three RFI sites have been identified and used to target sampling conducted under DTSC-approved work plans (Ogden, 1996; 2000a; 2000b; GRC, 1995a; 1995b; Montgomery Watson, 2000b; MWH, 2003c; 2005b; 2005c; MWH, 2008b; 2008c), or as requested by DTSC during the RFI. The known and potential chemical use areas for the Group 7 Reporting Area are described briefly in this section and combined into seven general categories:

- Solvents
- Petroleum Hydrocarbons
- Oils/Polychlorinated Biphenyls (PCBs)
- Metals/Inorganic Compounds (excluding debris areas)
- Debris Areas
- Leach Fields
- Potential (areas screened for possible chemical use/impacts)

Table 3-1 summarizes the types of facility operations generally associated with each of these categories and provides typical chemical groups analyzed during the RFI at these locations. Areas of confirmed or potential chemical use are listed for each RFI site in Table 3-2 and are shown on Figure 3-3. Areas screened for possible chemical use include those areas where the operations or type of chemical use is uncertain, as well as areas where the types of chemicals possibly used are uncertain. In addition, other compounds and chemicals were possibly used or stored at the Group 7 RFI sites, and are briefly described in Section 3.3.8.

3.1 RFI SITE HISTORIES

The following sections summarize operational histories for each of the three RFI sites included in the Group 7 Reporting Area.

Site operations and history information were compiled during a comprehensive records review of facility documents described above (Boeing, 2009d). Primary previously published sources of information include the RFA (SAIC, 1991; 1994); the Current Conditions Report (CCR) (ICF, 1993); the RFI Work Plan Addendum (Ogden, 1996); historical aerial photographs (USEPA, 1997); The Area IV Historical Site Assessment (HSA) (Sapere, 2005); and site investigation reports, work plans, and permitted unit closure plans (MWH, 2003a; 2003b; 2003c; 2004a; 2004b; 2005c; 2008b; 2008c). Detailed historical and reference information is presented in the RFI Site Reports (Appendices A, B, and C). Historical documents for the RFI sites included in Group 7 are provided to DTSC in conjunction with this report (Boeing, 2009d).

3.1.1 B4029 RFI Site

The B4029 RFI Site is approximately 0.3 acres in the central portion of Area IV at the SSFL, and includes Building 4029 (SWMU 7.11) and the Former Old Conservation Yard Tank Pipeline, which ran along the southern end of G Street through the Group 7 Reporting Area north of Building 4029 (Figure 3-1). From 1959 to 1974, Building 4029 was known as the Radiation Measurements Facility, or the Old Calibration Facility, and was used to store radioactive source materials for use in calibrating radiation detection equipment. During operations from 1978 to 1997, Building 4029 was known as the Hazardous Waste Storage Facility (HWSF), and along with the Hazardous Waste Treatment Facility (HWTF) (Building 4133), was a component of the Hazardous Waste Management Facility (HWMF).

The radioactive materials stored at Building 4029 were radium-226 (Ra-226), cesium-137 (Cs-137), cobalt-60 (Co-60), polonium beryllium (PoBe), and plutonium beryllium (PuBe) (NAA, 1959). Radioactive materials were stored in three below grade concrete structures within Building 4029. The structures included a 10 foot deep concrete well with three separate source storage areas (used to store Ra-226 and later Cs-137), a 14 foot concrete well (4 feet of which was above grade) with lead lining (used to store Co-60), and a 33.25 inch by 33.25 inch by 1 foot deep concrete pit (used to store PoBe and PuBe) (NAA, 1959).

During operations in March 1964, a plastic capsule containing Ra-226 was fractured, and radioactive material was released into the source storage well. After Building 4029 was decontaminated, the Ra-226 sources were replaced by Cs-137 (NAA, 1964). In 1974, when the Radiation Measurements Facility was shut down, all radioactive source materials were removed from the building. In 1988, the below grade structures were excavated and disposed of as low level radioactive waste and non-contaminated debris (following radiological survey), and the areas were backfilled with gravel and concrete (Rockwell, 1988a; Rockwell, 1990b).

In 1978, the HWMF (Building 4029 and Building 4133) was activated in order to store and treat reactive alkali metals, and metal contaminated equipment, so that waste could be disposed of offsite. The HWSF (Building 4029), or the Reactive Metals Storage Yard, provided non-radioactive hazardous waste storage for ETEC operations in Area IV that generated alkali metal wastes. The waste material and associated contaminated equipment/components were then transferred to the HWTF (Building 4133) for treatment when capacity and/or funding became available (MWH, 2003c). The predominant alkali metal wastes stored at Building 4029 were sodium (Na) and sodium-potassium (NaK) alloy, but forms of potassium (K), lithium (Li), and zirconium (Zr) were also stored (Rockwell, 1991; MWH, 2003c). Containers used for storage of sodium, potassium, lithium, and zirconium included drums and container boxes, while NaK (a liquid at room temperature) was usually stored in 30-gallon drums placed inside 85-gallon overpack drums (Rockwell, 1993).

In 1983, the HWMF was permitted as a RCRA hazardous waste treatment and storage facility for non-radiological chemical wastes generated onsite. The RCRA permit was renewed in 1988 and 1993 (MWH, 2003c). In 1988, Rocketdyne performed a radiological survey of Building 4029 measuring the gamma exposure rate at the building, surrounding area, and entrance road identify areas needing further radiological inspection or requiring

remedial action. The survey concluded that, with the exception of the radiological source storage wells, the facility was clean of any residual radioactive contamination (Rockwell, 1988a). In 1993, the Oak Ridge Institute for Science and Education (ORISE) conducted an independent verification survey of Building 4029 which consisted of surface scans for radiation. Results of the survey did not indicate any locations of elevated direct radiation. Based on these results, and the 1988 survey, ORISE recommended that the Building 4029 be released without radiological restrictions (ORISE, 1993). In 2001, the USEPA conducted an oversight verification survey of Building 4029 in which swipe and dust samples were collected and analyzed for alpha and beta contamination. The USEPA field measurements confirmed the results of the previous surveys conducted by Rocketdyne and ORISE (USEPA, 2002a;2002b). A certification docket was prepared and Building 4029 was released for unrestricted use by DOE in 1997 (DOE, 1997b and 1997c).

In 1997 the HWMF was deactivated and all operations at Buildings 4133 and 4029 were halted. During this deactivation all remaining hazardous waste stored at Building 4029 was removed. In 2007, implementation of the HWMF Closure Plan began after approval by DTSC in 2006. At Building 4029, this initial effort included sampling of equipment and structures for verification of decontamination levels as required by the Closure Plan (MWH, 2003c), and will provide the basis of management of building material and equipment for the future demolition of Building 4029. Final closure, decontamination, and demolition for the HWMF is currently on hold.

3.1.2 B4133 RFI Site

The B4133 RFI Site is approximately 1.5 acres located in the northeast portion of Area IV at the SSFL, and includes one SWMU, Building 4133 (SWMU 7.2), the Former Building 4654 Interim Storage Facility (ISF), and debris areas west of the B4133 RFI Site boundary. Building 4133 was designed as a non-radiological sodium metal treatment facility in August 1977. It is comprised of two rooms, a Treatment Room and a Control Room, and sits in the middle of an approximately 6,600 square foot asphalt lot, which is surrounded by an asphalt berm. Prior to the 1970s, the Building 4133 area was unpaved and used as a drum and equipment storage area (SAIC, 1994).

From 1978 to 1997, Building 4133, along with Building 4029, operated as part of the Hazardous Waste Management Facility (HWMF), a RCRA permitted hazardous waste treatment and storage facility for site-generated reactive alkali metal waste and equipment contaminated by those metals. Building 4133, known then as the HWTF, treated alkali metal

wastes that were used as heat transfer media at onsite ETEC facilities in Area IV. The predominant alkali metal wastes treated were sodium (Na) and sodium-potassium (NaK) alloy, though reactive forms of potassium (K) and lithium (Li) were also treated and stored (Rockwell, 1991; MWH, 2003c). There is no record of zirconium hydride (ZrH_2) powder being treated; however, it is assumed that it was treated at the site due to records of zirconium hydride storage at Building 4029 (Rockwell, 1991).

Alkali metal wastes and components were treated in the Treatment Room. The resulting aqueous caustic solution, mainly sodium hydroxide (NaOH) and potassium hydroxide (KOH), was then directed via an indoor sump through underground piping to one out of the two below grade storage vessels (the Neutralizing Pit and Tank T-1) located north of Building 4133 at different times during the facility's period of operation. South of Building 4133 is the Size Reduction Area, where contaminated equipment too large to fit in the burn pan was cut into smaller pieces. The Size Reduction Area was also used to store kerosene and mineral oil used in the cutting process.

Originally, all caustic solution wastes generated by the treatment process at Building 4133 was collected in a 12 by 6 by 6 feet deep below grade Neutralizing Pit, located north of the building, where it was neutralized with acid. A 4-inch PVC pipe connected to the Neutralizing Pit would then drain the waste to an asphalt culvert east of the B4133 RFI Site that discharged to an asphalt-lined drainage ditch that discharged to the SRE Pond (Rockwell, 1977a; Rockwell, 1977b). It is unknown if this process was ever used, and the drain pipe was permanently sealed in 1986 following a caustic solution spill at which an expandable plug failed and the drain pipe facilitated the release of approximately 1,000 gallons of sodium hydroxide to the asphalt-lined drainage ditch (MWH, 2003c). The culvert was later flushed and vacuumed (MWH, 2003c). Prior to that spill, in 1984 approximately 1,500 gallons of 12 percent sodium hydroxide solution spilled due to a pipe nipple failure in a scrubbing solution storage tank. Thirteen drums of contaminated soil were removed from the site (Rockwell, 1984a; 1984b).

Between 1987 and 1988, the Neutralizing Pit was replaced by Tank T-1, a 1,318 gallon underground storage tank (UST), used for storage of wastes generated by the treatment process. When the Neutralizing Pit was removed several feet of soil surrounding the pit were also excavated, although the removal volumes were not reported. A temporary UST located north of the asphalt berm was used to store caustic wastes generated by the treatment process

while Tank T-1 was being installed. Tank T-1, a steel UST inside of a concrete secondary containment, was placed in the same location as the former Neutralizing Pit (MWH, 2003c).

In late 1989, the ETEC officially took over control of HWMF operations from Atomics International (AI) (Rockwell, 1989b). In 1990, Tank T-3, a 5,190-gallon AST, was installed at the site and used to store caustic waste when Tank T-1 reached capacity. The contents of caustic waste storage tank T-3 would be removed by vacuum truck for offsite management at a permitted facility (MWH, 2003c). NaK was stored in a 300 gallon AST (Tank T-2) and was kept under cover of argon gas due to its reactivity with air; Tank T-2 also acted as a feeder system to transport the alloy to the burn pan.

In 1997, the HWMF was deactivated and all operations at Buildings 4133 and 4029 ceased. During this deactivation all remaining hazardous waste stored at Building 4133 was removed. In 1999, Boeing, ORISE and the DHS performed radiologic surveys of Building 4133 and found that all release criteria were met (ORISE, 2000; DHS, 2000). In 2003, a 15 by 15 foot area northwest of Building 4133 was excavated to a depth of 1 foot due to elevated levels of Cs-137 (Boeing, 2003). In 2007, implementation of the HWMF Closure Plan began after approval by DTSC in 2006. At Building 4133, this initial effort included disassembling and sampling of equipment and structures for verification of decontamination levels as required by the Closure Plan (MWH, 2003c), and will provide the basis of management of building material and equipment for the future demolition of Building 4133. Final closure, decontamination and demolition for the HWMF is on hold.

3.1.3 RMHF RFI Site

The RMHF RFI Site is approximately 4.1 acres located in the northern central portion of Area IV at the SSFL. The operational area of the RMHF was identified as SWMU 7.6, and the Building 4021 Leach Field (also referred to as the RMHF Leach Field) was identified as an Area IV AOC (SAIC, 1994). The adjacent operational areas included in the RMHF RFI Site include the former Building 4028 Shield Test Irradiation Reactor (STIR) / Liquid Metal Fast Breeder Reactor (LMFBR) Test Facility and the former Building 4811 Mechanical Support Pad.

RMHF

The RMHF was constructed in 1959 to store fuel and process liquid and solid wastes generated at the Sodium Reactor Experiment (SRE), the various System for Nuclear Auxiliary Power (SNAP) facilities, and other radiological facilities in Area IV. The RMHF has subsequently been used to support all SSFL nuclear operations and radioactive waste processing at ETEC, including the Organic Moderated Reactor Experiment (OMRE), the Sodium Graphite Reactor (SGR), and Rockwell International Hot Laboratory (RIHL) D&D, and fuel fabrication and decladding programs (Rockwell, 1983; 1985b; 1989c; 1994; Rocketdyne, 2000). Until the mid-1990s, the RMHF was referred to as the Radioactive Materials Disposal Facility (RMDF).

As defined in the 2006 RMHF Closure Plan (H&A, 2006), the RMHF contains three RCRA Part A (Interim Status) permitted facilities: Building 4021, Building 4022, and Building 4621 including the Mixed Waste Storage Yard. Building 4021, the RMHF Decontamination and Packaging Facility, was constructed in 1959. Operations at Building 4021 included radioactive component cleaning, component size reduction, radioactive liquid waste processing (evaporation/solidification), decontamination services, and waste packaging (Rockwell, 1983). Building 4022, the RMHF Radioactive Storage Building, was constructed in 1959 and designed to store materials that contained mixed fission products and nuclear fuels (Sapere, 2005; Rockwell, 1983). Building 4022 contains seven below grade, concrete vaults for radioactive materials storage. Building 4621, constructed in the mid-1960s, is used for the interim storage of source materials used in research activities and for low-specific activity (LSA) containerized waste (SAIC, 1994; Boeing, 2007c). Building 4621 and the adjacent Mixed Waste Storage Yard are also used for the storage of mixed waste and contaminated equipment (SAIC, 1994; Rockwell, 1981).

The area between Buildings 4021 and 4022, referred to as the Filter/Blower Area, contained filtration equipment used to filter all air from Buildings 4021 and 4022 (Rockwell, 1988b; AI 1959a; 1959b; 1959c). The Filter/Blower Area contained three utility trenches used to support the ventilation ducts, with a floor drain connected to a pipeline that conveyed the surface water to the RMHF north slope, bypassing the RMHF Catch Basin (DMJM, 1958). Buildings 4021 and 4022 included a radioactive liquid waste treatment system used to collect and treat water produced at the SRE, RIHL, RMHF, and other ETEC facilities (Rockwell, 1983). Liquid radioactive wastes were stored at RMHF in a 5,000-gallon holding tank (also identified as T-1), located west of Building 4021. Following an overflow of holding

Tank T-1 in 1978, the system was modified to replace the AST with UT-15, an 8,000-gallon UST located in Building 4022 Vault 2 (Rockwell, 1978a; 1978b; 1978c; 1990a).

Tanks associated with the treatment of radioactive water were present at Buildings 4021, 4022, and 4664, the Low Level Radioactive Waste (LLRW) Processing Building. A 500-gallon transfer AST used to transfer LLRW water to the RMHF was stored in the Mixed Waste Storage Yard (SAIC, 1994; Rockwell, 1989a). A former diesel AST was located southeast of the Filter/Blower Area adjacent to Building 4021 (Rockwell, 1990a; DOE, 1970). All ASTs and USTs have been removed with the exception of the 1,500-gallon polyethylene AST used to collect surface water at the RMHF RFI Site. The AST was installed in 2006 to store site surface water runoff after removal of the Catch Basin (referred to as Building 4614 in facility drawings) and discharge channel (Cabrera, 2007).

As described above, the RMHF Catch Basin was used to contain surface water runoff from the RMHF operational area, with site discharges channeled to a lined discharge channel west of the site. During excavation of the Catch Basin, approximately 260 cubic feet (approximately 10 cubic yards) of soil were removed approximately 10 feet north of the former RMHF Catch Basin due to elevated Cs-137 radiological results (Cabrera, 2007). Similarly, approximately 80 cubic feet (approximately 3 cubic yards) of soil were removed during the excavation of the drainage channel (Cabrera, 2007). Neither area was graded or backfilled following the removals.

The Building 4021 Leach Field was identified during the RFA as an inactive sanitary leach field (SAIC, 1994). The leach field was constructed as an excavation that was backfilled with about 4 feet of gravel and consisted of a 3,400-square foot transpiration bed with two parallel perforated pipes that extended 100 feet to a concrete distribution box (SAIC, 1994). The distribution box was gravity fed from the 1,500 gallon septic tank located underneath the top of an embankment forming the north side of the RMHF site (Rockwell, 1982a; 1982b).

The leach field, septic tank, and associated piping were installed in 1959 for the disposal of sanitary waste in support of RMHF, which then consisted of Buildings 4021 and 4022 (ICF, 1993; Rockwell, 1982a; 1982b). A second connection to the leach field, bypassing the septic tank, was made from the radioactive water processing system holding tank (T-1) via the Building 4021 Sump located on the western side of Building 4021 (Rockwell, 1982a; 1982b; DMJM, 1958). Water from the holding tank was reportedly discharged to the leach field only after the water was analyzed and determined to be within acceptable limits of

radiation (Rockwell, 1982a). During a site survey in 1975, vegetation growing on the abandoned Building 4021 Leach Field site was discovered to be contaminated with radioactivity (Rockwell, 1982a). The Building 4021 Leach Field was excavated in 1978 to mitigate elevated levels of radioactivity (Rockwell, 1982a). Approximately 28,000 cubic feet (about 1,037 cubic yards) of excavated material (soil, bedrock, and leach field material) was disposed at the licensed Nuclear Energy Company disposal site (U.S. Ecology) located in Beatty, Nevada. Approximately 8,000 cubic feet (approximately 296 cubic yards) of waste was sent to the DOE Hanford disposal site in Washington State (Rockwell, 1982b). Following excavation, a portion of the exposed bedrock beneath the former leach field was coated with a tar-like substance to seal bedrock fractures, and the area backfilled with soils removed from the excavation that had been cleared for radioactive contamination and some additional soil from an undocumented source (Rockwell, 1982b). Removal of the septic tank has not been documented and is assumed to be still in place. Building 4664 was constructed atop the area of the septic tank (Rockwell, 1982b).

Currently the RMHF is only used for storage and shipments. Buildings 4022, 4621, and the Mixed Waste Storage Yard are currently active. Building 4021 became inactive in 2007 and all equipment was removed from the building (Boeing, 2009c). Final closure, decontamination and demolition for the RMHF will be implemented under the 2006 RMHF Closure Plan (H&A, 2006), following DTSC approval.

In addition to the permitted facilities, the RMHF RFI Site includes several support buildings: Buildings 4034, 4044, 4075, 4658, 4663, 4665, and 4688. According to historical documentation, other than Building 4075, these remaining buildings were not generally used for radioactive waste storage (Boeing, 2007c), although Building 4044 occasionally contained radioactive waste samples (Rockwell, 1990c). Building 4075, the Contaminated Equipment Storage Building, was constructed in 1971 and served as a storage area for radioactive wastes prior to shipment to offsite disposal locations (Rockwell, 1983c; SAIC, 1994; Boeing, 2007b). Building 4075 has been inactive since 2001 (Boeing, 2007b; Sapere, 2007). Most of the remaining buildings present at the RMHF RFI Site are currently inactive (Buildings 4075, 4563, 4658, and 4665). The remaining active buildings are used for: office space and controlled site entry point (Building 4034); a break room and health physics counting laboratory (Building 4044); a covered canopy area used for equipment and hazardous waste storage (Building 4688), and; a former building foundation (Building 4663) used as a storage pad.

Building 4028

The Building 4028 STIR / LMFBR Test Facility, located southwest and adjacent to the fenced portion of the RMHF, housed the Shield Test Irradiation Reactor, used for SNAP shield testing experiments, between 1961 and 1972 (DOE, 1997). Building 4811, the Mechanical Support Pad, located adjacent to Building 4028, included a cooling tower, heat exchanger, ventilation equipment, and an air-cooled condenser, and was used to support operations at Building 4028 (Sapere, 2005). From 1977 to 1981, Building 4028 was operated as the LMFBR, or Arc Melt Facility, to investigate the behavior of molten uranium dioxide relative to simulated reactor accidents, particularly related to flooring and structural materials (DOE, 1997). Building 4028 contained a fuel storage vault used to store approximately 300 pounds of normal and depleted uranium oxide (DOE, 1997). In 1984, molten uranium dioxide operations were terminated (DOE, 1997).

The decommissioning of Buildings 4028 and 4811 in 1988 included the removal of surplus normal and depleted uranium oxide; decontamination and removal of equipment and electrical components; removal of radioactive ducting system; building surface decontamination; and a final radiological survey of the facility (DOE, 1997). The above-ground portion of Building 4028 and 4811 were demolished in 1989, leaving the concrete foundation and a below-grade test vault (DOE, 1997). In 1997, Building 4028 was released for unrestricted use, and the building foundation and below-grade vault were demolished (Rockwell, 1997).

3.1.4 Non-RFI Site Report Area

As described in Section 1, the RFI site boundaries depicted on maps in this Group 7 RFI Report are shown as representative outlines that encompass historical site operations. The creation of these RFI site boundaries did not limit characterization, and potential chemical use was evaluated within the entire Group 7 Reporting Area. Debris areas and transformers located in areas outside of RFI site operational boundaries have been identified as potential chemical use areas and are discussed in Section 3.3.5. Review of historical documents, including historical and aerial photographs for the remainder of the Group 7 Reporting Area, and various site reconnaissance inspections did not indicate the existence of any additional chemical use areas.

As described in Section 1, the area outside of the Group 7 RFI Report boundary is occupied by the American Jewish University BBC, formerly known as the Brandeis-Bardin Institute. The BBC is zoned as rural agricultural on Ventura County zoning maps. This designation permits a wide range of agricultural uses. The specific land use permit conditions for the BBC indicate that this property contains religious, teaching, and camping facilities.

3.2 CURRENT SITE CONDITIONS AND SIGNIFICANT ALTERATIONS

The focus of this Group 7 RFI Report is to characterize current conditions of the Group 7 Reporting Area with respect to chemical contamination. Current conditions at most of the Group 7 RFI sites are generally similar to past operating conditions. This section summarizes how current conditions differ from past operating conditions. For the majority of the Group 7 characterization activities (i.e., sampling), site conditions remained approximately constant. The 2005 Topanga Fire caused considerable impacts in some portions of the Group 7 Reporting Area, but most sampling within Group 7 has occurred following the fire. Any changes in site conditions affecting RFI sample information are described and detailed in the RFI Site Reports provided in Appendices A, B, and C. Soil disturbance areas within the Group 7 Reporting Area include building removal areas, excavation and backfill areas, and grading areas. Group 7 soil disturbance areas are shown on Figure 3-2. The following describes current conditions and soil disturbance areas within the Group 7 Reporting Area.

B4029 RFI Site

The B4029 RFI Site is currently inactive and vacant. There is one remaining structure, Building 4029, and three adjacent concrete pads. In 1988, the below grade structures, including the Ra-226 source storage well, the Co-60 source storage well, and the concrete pit, were removed and disposed of as hazardous waste, and the areas were backfilled with gravel and concrete (Rockwell, 1988a). In 1997, all operations and all remaining hazardous waste stored at Building 4029 was removed.

B4133 RFI Site

The B4133 RFI Site is currently inactive and vacant. The remaining structures at Building 4133 are a 462 square foot galvanized steel building mounted on a concrete slab, an air scrubber system and the Size Reduction Area. In 1997, Building 4133, then the HWTF, was deactivated and all operations at Buildings 4133 and 4029 ceased. During this deactivation all remaining hazardous waste stored at Building 4133 was removed. After 1997 the only

ongoing operation conducted at Building 4133 was the site weed abatement program (DTSC, 2000). In 1984/1985, Building 4654 was removed and areas containing radioactive contamination were excavated, with a total of 168.5 cubic meters (approximately 220 cubic yards) of soil, rock, and waste were packaged and sent offsite for disposal (Rockwell, 1985b). Excavation areas were later backfilled (partially with native soils which were surveyed for radioactivity and determined to be free of contamination, and partially with fill soils from an undocumented source), and the site was returned to natural grade. In 2003, 15 by 15 foot area northwest of Building 4133 was excavated to a depth of 1 foot due to elevated levels of Cs-137 (Boeing, 2003). In 2007, the NaK tank at B4133 was disassembled as part of the initial phase of implementing the HWMF Closure Plan.

RMHF RFI Site

The RMHF RFI Site is currently only used for storage and waste shipments. Buildings 4022, 4621, and the Mixed Waste Storage Yard are currently active. Building 4021 became inactive in 2007, and all equipment was removed from the building (Boeing, 2009c). Building 4075 has been inactive since 2001 (Boeing, 2007c; Sapere, 2005). The remaining active buildings are used for: office space and controlled site entry point (Building 4034); a break room and health physics counting laboratory (Building 4044); a covered canopy area used for equipment and hazardous waste storage (Building 4688); and, a former building foundation (Building 4663) that is currently a storage pad. All ASTs and USTs have been removed with the exception of the 1,500-gallon polyethylene AST used to collect surface water at the RMHF RFI Site. Remaining structures at Buildings 4028 and 4811 were removed in 1997, and the area recontoured to be consistent with pre-existing drainage conditions with flow generally toward the north.

The Building 4021 Leach Field was excavated in 1978 to mitigate elevated levels of radioactivity detected during a site survey (Rockwell, 1982a). The area was backfilled with non-radiologically impacted overburden and some additional soil from an undocumented source, and the area graded to a level approximately 3 feet below the previous grade at the site. The septic tank was abandoned in place. The RMHF Catch Basin and associated Drainage Channel were removed in 2006 as part of ongoing D&D activities. The Catch Basin was replaced by a 1,500-gallon polyethylene storm water AST, and the drainage channel replaced by an above-ground pipeline.

Several shallow excavations have been performed at and near RMHF, primarily to mitigate elevated mixed fission products (primarily Cs-137) detected during site surveys. These include: three small excavation areas south of the Mixed Waste Storage Yard, one area adjacent to the asphalt swale along the northern perimeter of the fenced area, and two areas near the former Catch Basin and drainage channel. In 2003, due to elevated levels of Cs-137, three shallow excavations were performed at the area south of the Mixed Waste Storage Yard, measuring 125 by 13 feet, 5 by 7 feet, and 7 by 12 feet, respectively (Boeing, 2004). Excavation depths were approximately 0.5 feet deep, with approximately 130 cubic yards of soil removed. In 2006, an approximately 100 square-foot area in the RMHF northern slope adjacent to the asphalt swale was excavated to approximately 0.5 feet bgs, reportedly removing approximately 50 cubic feet of soil (about 2 cubic yards) (Cabrera, 2006). In 2007, approximately 260 cubic feet (about 10 cubic yards) of soil were removed from an excavation located approximately 10 feet north of the former RMHF Catch Basin, and approximately 80 cubic feet (about 3 cubic yards) of soil were removed from an excavation of the drainage channel. Due to the shallow nature of the excavations, they were not graded or backfilled following the removals. As warranted based on slope and erosion potential, storm water BMPs were put in place.

Ten debris areas and one soil disturbance area were identified within or adjacent to the RMHF RFI Site during the 2008 Waste Debris Survey (Appendix F) or in historical photographs (AI, 1965; 1969; 1976a; 1976b). The soil disturbance area, first noted in a 1964 aerial photograph, was most recently observed to contain soil piles and hummocks during a 2008 site survey. Observed debris areas most often contained construction debris, including concrete, asphalt, and metallic debris. Containers, such as 55-gallon or 5-gallon drums, and piping sections were observed in four of the identified debris areas.

3.3 CHEMICAL USE

As described above, potential chemical use areas have been grouped into general categories (Table 3-1). For Group 7, these are: solvents, petroleum hydrocarbons, oils/PCBs, metals/inorganic compounds (excluding debris areas), debris areas, leach field, and potential (areas screened for possible chemical use). Descriptions of each chemical use area category and typical analytical suites used for RFI characterization are included in Table 3-1. The summary is generalized and is not meant to define all sampling requirements for each Group 7 RFI site. Table 3-1 is meant to provide the reader with context when reviewing the sampling results provided in Section 4. Site-specific sampling rationale and detailed discussions of analytical results are provided in Appendices A, B, and C.

The RFI sampling program targeted known or suspected chemical use areas at the three RFI sites, and included screening in other areas where chemical use may have occurred. As described above, these were identified during a review of extensive historical records for the Group 7 Reporting Area (Boeing, 2009d). Figure 3-3 depicts all potential chemical use areas identified for the Group 7 Reporting Area. Figures 3-4 through 3-9 show individual chemical use areas for each chemical group represented at the Group 7 RFI sites. Table 3-2 provides a list of potential chemical use areas present for each RFI site. The following sections provide a summary of the known or potential chemical use areas in the Group 7 Reporting Area.

It should be noted that chemicals used for construction activities are not included in the RFI as potential chemical use areas. Construction materials include asphalt, concrete, or small quantities of explosives that may be used at building sites where bedrock modifications were needed. Building insulation materials (including asbestos) are also excluded as a chemical use category unless these materials were disposed of at a site. Energetic chemicals used as surface or subsurface explosives for construction or demolition purposes would have been used during short events, and the chemicals would typically have been consumed upon detonation. As described in Section 4 and Appendix D, groundwater monitoring is conducted for many of these chemicals, but they have not been generally targeted for routine analysis in the surficial media investigation.

3.3.1 Solvents

Solvent use or disposal may have occurred at all three RFI sites in the Group 7 Reporting Area. During the 1950s and 1960s, the primary solvent used in terms of quantity and frequency at the SSFL was TCE (SAIC, 1994; ICF, 1993; MWH, 2004a). Potential solvent chemical use areas in the Group 7 RFI sites are shown on Figure 3-4 and include the following:

- B4029: No solvent chemical use areas were identified at this site.
- B4133: No solvent use areas were identified at this site. It is worth noting that the RFA reported Freon and chlorinated solvent use at this site, but this reported use was not confirmed in the other historical records reviewed (SAIC, 1994)
- RMHF: Ten solvent use areas were identified or screened at the RMHF RFI Site and adjacent areas. Identified areas include waste storage areas (Buildings 4022, 4621, and the Mixed Waste Storage Yard), decontamination and waste reduction area (Building 4021), the Waste Receiving Yard, and RMHF Catch Basin and surface water conveyance system. Solvent waste documented as stored at the RMHF RFI Site includes benzene, 1,1,1-trichloroethane (TCA), methyl ethyl ketone (MEK),

acetone, and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113). Solvent use was documented at Building 4021, where a Turco™ degreaser was used to clean equipment.

3.3.2 Petroleum Hydrocarbons

Areas where petroleum hydrocarbons may have been potentially stored or used in the Group 7 Reporting Area are associated primarily with diesel fuel oil tanks (along with associated pumps, filters, piping, and sumps), kerosene use as a lubricant, and areas where wastes were stored and handled. In the event of accidental spills or leaks, petroleum products could potentially be discharged to down-slope soil, drainage ditches, and channels. Potential petroleum use areas in the four Group 7 RFI sites are shown on Figure 3-5 and include the following:

- B4029: One petroleum fuels chemical use area was identified at this site. Diesel fuel oil was conveyed through a former pipeline north of Building 4029 along G Street. This former aboveground pipeline connected two large fuel oil ASTs located at the Old Conservation Yard Site in Group 6 to a third AST located in the Group 5 Reporting Area.
- B4133: One petroleum hydrocarbons chemical use area was identified at this site. Kerosene and mineral oils were used as lubricant in metals cutting operations at the Building 4133 Treatment Building and Size Reduction Area. At the B4133 RFI Site, petroleum fuel use other than kerosene is not documented in historical records reviewed, but some type of gasoline use is suspected based on sampling results with elevated benzene (see Section 4.1).
- RMHF: Sixteen petroleum hydrocarbons chemical use areas were identified at this site. Identified areas include a former diesel AST, waste and/or equipment storage areas (Buildings 4022, 4621, 4663, and the Mixed Waste Storage Yard), decontamination and waste reduction areas (Buildings 4021, 4664, and 4665), the Waste Receiving Yard, and the RMHF Catch Basin and surface water conveyance system. Petroleum hydrocarbons were documented as stored at the RMHF RFI Site. Additionally, the site contained equipment, including generators, which likely used diesel fuels.

VOCs, including benzene, toluene, ethylbenzene, and xylenes (BTEX), are potential components of gasoline. Semi-volatile organic compounds (SVOCs) polynuclear aromatic hydrocarbons (PAHs) are potential components of some of the diesel/oil range petroleum hydrocarbons. The petroleum use areas identified for the Group 7 Reporting Area have been screened for potential impacts related to these chemical compounds. BTEX constituent screening at these locations was conducted for the RFI.

3.3.3 Oils/PCBs

Hydraulic, lubricating, and insulating oils were used, handled or stored at the RMHF RFI Site in the Group 7 Reporting Area. PCBs and terphenyl compounds were used as insulation against heat buildup in Area IV reactors and transformers, with associated waste products stored and/or handled at RMHF. Also, transformers manufactured before 1980 may have used insulating oils containing PCBs. Areas in the Group 7 Reporting Area where oils/PCBs may have been used are shown on Figure 3-6 and include the following:

- B4029: No oils/PCB chemical use areas were identified at this site.
- B4133: No oils/PCB chemical use areas were identified at this site.
- RMHF: Three oil/PCB chemical use areas were identified at this site related to potential use in transformers and substations. Also, seven areas were screened for PCBs on the basis of documented storage of ballasts and waste oils containing PCBs at the site. These areas included Buildings 4021, 4022, 4621, 4663, the Mixed Waste Storage Yard, the Waste Receiving Yard, and the RMHF Catch Basin,

3.3.4 Metals/Inorganic Compounds

Metal wastes can be associated with either site operations (e.g., engine testing, machining activities, laboratory waste streams, etc.) or the degradation of scrap metal debris. Because these two types of occurrences are different, potential metal use areas in the Group 7 Reporting Area have been divided into two categories: metal wastes associated with site operations (including storage of metal wastes), and metal wastes associated with debris areas. This section focuses on metal wastes associated with site operations, while Section 3.3.5 focuses on debris areas. Included in this category are other types of inorganic compounds that were used or potentially used for site operations. For the Group 7 Reporting Area, these include fluoride compounds.

Site operations that could generate metals or other inorganic wastes include photographic processing, high-energy propellant testing, scrubber systems, various machine shop and laboratory operations, or the use/storage of possibly corrosive liquids. Within Group 7, metals use included reactive metal treatment and neutralization, and storage of metals waste. Potential metal processing waste areas associated with site operations are shown on Figure 3-7 and include the following:

- B4029: One metals/inorganic compounds chemical use area was identified at this site. Reactive metals compounds, including sodium, sodium-potassium alloy, and lithium and zirconium hydrides, were stored at Building 4029 while awaiting treatment at Building 4133.

- B4133: Seven metals/inorganic compounds chemical use areas were identified at this site. These include Building 4133, rinse tanks T-4A and T-4B, and the lithium hydride reaction vessel, where reactive forms of lithium, sodium, potassium, and contaminated equipment were treated via oxidation, resulting in the generation of caustic solutions. Caustic waste solutions, including sodium and potassium hydroxides, were stored at Tanks T-1, T-3, and the temporary storage tank. Tank T-2 was used to store the reactive metal compound sodium-potassium alloy.
- RMHF: Eighteen metals/inorganic compounds chemical use areas were identified at this site. Twelve areas (Buildings 4021, 4022, 4075, 4563, 4621, 4663, 4664, 4665, the Filter/Blower Area, the Radioactive Water Treatment System, the Mixed Waste Storage Yard, and the Waste Receiving Yard) were identified within the RMHF fenced-area based on association with storage of metallic wastes (including arsenic, cadmium, copper, chromium, lead, and mercury), and treatment or storage of LLRW water from ETEC radiological facilities. Four areas, including the RMHF Catch Basin, drainage swale, drainage channel, and discharge pipeline, were identified due to storage or conveyance of surface water from identified waste storage and treatment areas. Two areas adjacent to the RMHF RFI Site (Buildings 4028 and 4811) were identified due to the operation and support of a radiological test facility and storage of enriched and depleted uranium.

3.3.5 Debris Areas

Debris areas are generalized locations where small amounts of solid waste have been identified at the Group 7 RFI sites. The debris typically includes paint chips/cans, scrap metal, drums, construction debris (asphalt, concrete, etc.), small equipment pieces, or burned materials. These areas are typically targeted for a wider range of sample analyses than the areas containing metals wastes described in Section 3.3.4 because the former use and/or contents of some of the debris is not documented (Tables 3-1 and 3-2). Debris areas in the Group 7 RFI sites are shown on Figure 3-8 and include the following:

- B4029: No debris areas were identified at this site.
- B4133: One debris area was identified at this site. It was observed to contain debris consisting of concrete, scrap metal, and empty drums.
- RMHF: Ten debris areas were identified at this site and adjacent areas. Nine of the identified debris areas were observed to contain construction debris, including concrete, asphalt, metal wire or other metallic debris. One debris area contained metal piping, and three debris areas contained 55-gallon drums or 5-gallon metallic containers.

3.3.6 Leach Fields

Sanitary leach fields were identified as AOCs during the RFA (SAIC, 1991; 1994). Leach fields can be potential down-gradient receptors for spilled or leaking chemicals used in the

building associated with the leach field. Sanitary leach fields were generally operational and used prior to 1961, when the SSFL sewer system was installed (ICF, 1993). Leach field areas in the Group 7 RFI sites are shown on Figure 3-9 and include the following:

- B4029: No leach fields were identified at this site.
- B4133: No leach fields were identified at this site.
- RMHF: One leach field, the Building 4021 Leach Field, was identified at this site. This leach field received sanitary waste water from toilets and sinks in Building 4021 Hot and Cold Change Rooms. The leach field also received radioactive process water from Tank T-1 after radiological clearance sampling. During a 1975 site survey, the Building 4021 Leach Field and surrounding area were observed to be contaminated with radioactivity (strontium-90 and yttrium-90 with some cesium-137). The leach field and surrounding area were subsequently excavated in 1978, and the area backfilled with soils from the excavation once cleared for radioactivity. The septic tank was abandoned in place.

3.3.7 Areas Screened for Potential Chemical Use or Disposal

Several additional areas at the Group 7 RFI sites were or may have been used for chemical or equipment storage, handling, or disposal. Screening areas include drum or equipment storage areas, excavations, or possible discharge areas (suspect ponds). Confirmed chemical storage areas are included in this category if the types of chemicals stored at the locations were not well documented (e.g., drum storage areas). Since chemical use in the potential locations can vary based on site history information, or on up-gradient chemical use areas, analytical suites for RFI assessment of potential areas can also vary. The Group 7 RFI areas screened for potential chemical use are shown on Figure 3-13 and include the following:

- B4029: The Building 4029 access road was identified as a potential chemical use area at this site, since it was the location of loading/unloading activities and may have been used for temporary storage.
- B4133: Three potential chemical use areas were identified at this site. These include a large storage and staging area used to support SRE operations, a radiological excavation area (15 x 15 foot, 1 foot bgs) to the northwest of the Building 4133 operational area, and the Interim Storage Facility (ISF), a storage area for equipment and dummy and spent fuel elements from nearby AI nuclear facilities in Area IV. As described above, use of this site for equipment storage or as the ISF pre-dated use of the area as the HWMF.
- RMHF: Seven potential chemical use areas were identified at this site. These include the Buildings 4034 and 4622 (office/counting building), Building 4044 (counting laboratory), and Building 4688 (equipment storage area), and three shallow radiological excavation areas (1 foot bgs or less), and a large disturbed soil area near the former Catch Basin.

3.3.8 Other Compounds/Constituents

At the B4133 RFI Site, caustic solutions (primarily sodium hydroxide [NaOH] and potassium hydroxide [KOH]) were stored and neutralized using acidic solutions.

At the RMHF RFI Site, chemical use documentation is extensive since RMHF site operations included receipt, storage, and shipment of hazardous, radioactive, and/or mixed wastes from ETEC and other SSFL facilities. Additional chemicals documented to have been received or stored at the RMHF RFI Site include pyridine, acidic and caustic liquids, morpholine, tetralin, hydroquinone, morphaline, and nicotine (DOE, 1994; Rockwell, 1985c; 1988c; RTK, 2009).

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4.0 NATURE AND EXTENT OF CHEMICALS IN GROUP 7

This section provides an overview of nature and extent findings for environmental media within the Group 7 RFI Reporting Area. The characterization overview provides a description of group-wide chemical concentrations for investigated media. Section 5, Contaminant Transport and Fate, is based on these findings. A discussion of characterization completeness within individual chemical use areas and site action recommendations are provided in Appendices A, B, and C.

Defining the nature and extent of chemicals in environmental media follows a weight-of-evidence process. The information used in this process has been summarized in the previous sections and presented in detail in Sections 2 and 3 of Appendices A, B, and C. This information includes historical site operations, physical site configuration, knowledge of chemical use, and insight gained from other SSFL investigations. The result is a sampling and analysis strategy that targets those locations where chemicals are suspected or known to have been used, and where they might be today. The sampling results are also used to determine if further sampling is needed, and if the nature and extent of impacts have been defined.

Characterization results for Group 7 RFI Sites are presented by the six major chemical groups included in the Group 7 RFI laboratory analytical program:

- VOCs
- SVOCs
- Total Petroleum Hydrocarbons (TPH)
- PCBs/Terphenyls
- Dioxins
- Metals/Inorganics

The six chemical groups listed above represent the primary targeted RFI sampling suites for the types of known or potential chemical use identified in the Group 7 Reporting Area as described in Section 3. As described in the RFI Site Reports (Appendices A, B, and C), approximately 470 soil, 70 soil vapor, and 4 surface water samples have been collected to assess chemical impacts at the Group 7 RFI sites. Characterization of the Group 7 RFI sites included implementation of the RMHF RFI Work Plan, RFI data gap sampling for the B4133 and B4029 RFI Sites, and unaffiliated buildings and debris areas south and west of RMHF. In addition, sampling was conducted in accessible areas of all three sites to collect samples

proposed in the RMHF and HWMF Closure Plans (H&A, 2006; MWH, 2003c). Early closure plan sampling was performed as part of the RFI because these data are needed for the RFI to assess potential chemical releases from these areas. In total, 14 of the 15 closure plan locations at the B4029 RFI Site, 29 of the 37 closure plan locations at the B4133 RFI Site, and 17 of the 56 closure plan locations at the RMHF RFI Site were sampled. One closure plan location at Building 4029 could not be sampled due to shallow bedrock refusal. It should be noted, that remaining closure plan sampling, or any additional closure plan sampling required once the RMHF Closure Plan is approved by DTSC, will be performed once D&D activities are completed and access to the locations available. As described above, implementation of the RMHF and HWMF Closure Plans is on hold.

Figures 4-1 through 4-6 present results for the chemical groups listed above. The purpose of these figures is to present a summary of characterization findings in the context of site information including the overall sampling locations, surface water flow directions, comparison to risk-based screening levels (RBSLs), and site action recommendation areas.

The site action recommendation areas shown in Figures 4-1 through 4-6 include CMS Areas and No Further Action (NFA) Areas. CMS Areas are those portions of the RFI sites that are recommended for further consideration and evaluation of chemicals impacts in the next phase of the RCRA corrective action process. NFA Areas are the areas outside of the CMS Areas. These recommendations are based on the results of historical record review, characterization sampling, and risk assessment based on currently approved methodologies as described in the RFI Site Reports in Appendices A, B, and C. CMS Area recommendations and the criteria used in making those decisions are presented in Section 7. Portions of Group 7 outside of the CMS Areas are recommended for NFA, and investigation in these areas is considered complete.

Soil sampling results are shown using color-coded symbols on Figures 4-1 through 4-6, which depict data for various chemical groups; if samples were not analyzed for the chemical group, the symbols are depicted in gray. Changes in color generally reflect concentration gradients for detected compounds, and sample symbol color-coding reflects a comparison of results to background (for metals and dioxins) and RBSLs. RBSLs are chemical-specific, back-calculated concentrations that represent ‘acceptable’ risk levels based on risk assessment parameters, methodologies, and receptors detailed in the SRAM and in this report. A description of RBSL derivation is provided in Appendix E. As part of the first Group RFI report review, DTSC reviewed the RBSLs and found them acceptable for use in

screening and interpretation of the data for the receptors evaluated. RBSLs do not replace risk assessment data evaluation or other evaluation such as assessment of chemical gradients; rather RBSLs are designed to aid in interpretation and presentation of the sampling results. The color coding basis for each chemical group is described in more detail on each figure.

The following presents a summary of the basis used to generate the colored symbols shown for soil sampling data on Figures 4-1 through 4-6:

- Colors are assigned to show the most conservative result (i.e., the concentration with the greatest ratio to its lowest RBSL) if multiple samples from one location (e.g., samples from different depths) contain detectable chemical concentrations, or if multiple analytes (e.g., individual VOCs) are detected at a sampling location.
- Chemical concentrations are compared to RBSLs that have been determined for both human and ecological receptors. Colors are assigned by comparing to the analytical result for a chemical to the lowest of the residential, recreational, or ecological RBSL for the chemical.
- For metals, color coding is based on a two-step comparison. First, the analytical result is compared to the DTSC-approved background comparison value (MWH, 2005c). If background is exceeded, the concentration is then divided by the lowest of the RBSLs, and the associated color is assigned based on its ratio.
- For dioxins, color coding is assigned based on a comparison of the sample's toxicity equivalent (TEQ) concentration to the DTSC-approved background TEQ concentration. TEQ concentrations reflect the sum of multiple dioxin congener results adjusted based on relative toxicity.
- For four PCB Aroclors (1254, 1260, 1262, and 1268), five metals (antimony, cadmium, copper, nickel, and silver), eight SVOCs (2,4,5-trichlorophenol, 4-nitrophenol, carbazole, dibenzofuran, fluoranthene, pentachlorophenol, pyrene) and perchlorate, ecological RBSLs were adjusted to account for available baseline toxicity reference values (baseline TRVs) or higher trophic levels (see Appendix F). The baseline TRVs are used to estimate risk to ecological receptors and make ecological-based CMS recommendations. To depict these RBSL comparisons consistently with risk assessment findings, the adjusted RBSLs based on baseline TRVs or trophic levels were used to prepare Figure 4-2 (SVOCs), Figure 4-4 (PCBs) ,and Figure 4-6 (metals).

Consistent with RFI work plans (Ogden, 1996; 2000a), RBSLs are used as screening tools (along with background data for metals) to determine the extent of soil sampling that is required to complete site characterization. Data presented in the RFI site reports in Appendices A, B, and C are described in text and depicted on figures in relation to the RBSLs that were developed using the risk assessment work plan criteria for potential residential, recreational, and ecological receptors. The comparisons to RBSLs presented in

this section of the Group 7 Report, however, vary from those described in Appendices A through C because of the application of baseline TRVs or higher trophic levels for the SVOCs, PCBs, metals, and perchlorate compounds listed above.

The following sections present a description of RFI sampling results by chemical group. In addition to the six primary chemical groups listed above (VOCs, SVOCs, TPH, PCBs, dioxins, and metals), glycols, terphenyls, fluoride, perchlorate, and inorganics were targeted for sampling at Group 7 RFI sites. Glycol RFI sampling results are described below with SVOCs in Section 4.2, and results are included on Figure 4-2. Inorganics sampling results are described with metals in Section 4.6, and results are included on Figure 4-6. Additional analyses at some RFI sites include pesticides, herbicides, and perchlorate, which are further described in Section 4.9, in the Site Report Appendices A, B, and C, and in Groundwater Appendix D.

Groundwater information depicted on Figures 4-1 through 4-6 represents recent groundwater monitoring data for the group. Data are presented compared to regulatory levels or site criteria, such as Maximum Contaminant Levels (MCLs) and Groundwater Comparison Concentrations (GWCCs). These criteria are listed in Appendix D. Because there are limited groundwater impacts and few wells within or near the Group 7 Reporting Area, NSGW and Chatsworth formation groundwater descriptions are combined in the following sections. Also, it is worth noting that assessment of bedrock for chemical impacts is being performed to assess contaminant transport to groundwater at representative locations throughout SSFL and will be described in the Site-Wide Groundwater RFI Report. Information regarding bedrock impacts is presented in the RFI Group reports only if sampling for that chemical was performed within the Group Reporting Area. Since no bedrock sampling has been performed in the Group 7 Reporting Area, this section is not included in this RFI Report.

Additional chemicals have been monitored in groundwater as required by DTSC. These results are described in Appendix D and consist of general minerals or other inorganic compounds that are indicative of general water quality (e.g., sulfate, bicarbonate, total dissolved solids, etc.).

4.1 VOLATILE ORGANIC COMPOUNDS

4.1.1 Soil/Sediment

A total of 64 soil vapor samples and 154 soil matrix samples from the Group 7 Reporting Area were analyzed for VOCs. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 7 VOC sampling results are depicted on Figure 4-1. Each sample location is represented by a color corresponding to a maximum ratio of detected VOC concentrations to the lowest RBSL at that location.

VOCs were detected in all Group 7 RFI sites, with the highest concentrations located at the Building 4133 RFI Site. Soil matrix and soil vapor sampling was conducted within the Group 7 Reporting Area in order to characterize current conditions at the three RFI sites, assess the impacts of historical operations, and confirm the results of historical samples. Due to shallow soils across the three RFI sites (in many areas less than 3 feet bgs), proposed soil vapor probes could not be established; in these instances, soil matrix samples were collected.

VOC soil vapor and soil matrix sampling results for the RFI sites within the Group 7 Reporting Area are summarized as follows:

<u>B4029 RFI Site:</u>

- Methylene chloride was detected at 4.38 micrograms per kilogram (µg/kg), slightly above the RBSL, at the topographic low point/drainage area southeast of Building 4029. Other VOCs detected at the site include styrene and toluene at concentrations below RBSLs.

<u>B4133 RFI Site:</u>

- Several VOCs were detected in soil above RBSLs at one location in the unpaved area northeast of Tank T-3. These include cumene, n-propylbenzene, and 1,2,4- and 1,3,5-trimethylbenzene, and up to 19,200 µg/kg for 1,2,4-trimethylbenzene. Benzene (0.11 micrograms per liter [µg/L]) and toluene (0.27 µg/L) were detected above their RBSLs in soil vapor collected at the same location. VOCs were not detected, or detected below RBSLs, in surrounding samples.
- Methylene chloride was detected above the RBSL at concentrations up to 8.41 µg/kg at two locations in and around the Western Drainage Debris Area. Other VOCs detected in this area included toluene and styrene below RBSLs, and VOCs did not exceed RBSLs in downstream samples.

RMHF RFI Site:

- Methylene chloride was detected at two locations east of the Waste Receiving Yard up to 8.57 µg/kg, above the RBSL. Other detected VOCs, including styrene and methyl ethyl ketone, were below RBSLs.
- Tetrachloroethene (PCE) was detected at 0.47 µg/kg in one sample, slightly above the RBSL, at a debris area identified northwest of the RMHF RFI Site. Methylene chloride, m-xylene, and p-xylene were also detected below RBSLs at this location. A second sample within this debris area was non detect for VOCs.
- Methylene chloride was detected at 4.67 µg/kg, above the RBSL, in one sample collected at the former Building 4021 Leach Field. Ethylbenzene was detected in four historical samples collected at the former Building 4021 Leach Field at concentrations up to 8 µg/kg, above the RBSL, but was not detected in more recent samples.
- PCE was detected up to 0.57 µg/L in soil vapor, above the RBSL, north of Building 4021.
- Acetone and methylene chloride were detected in samples collected in 1992 within the drainages north and west of RMHF (west of Outfall 003, in the southwest drainage, and at the confluence of the Outfall 003 drainage with the drainage from Group 8) (McLaren/Hart, 1993). Methylene chloride was detected above RBSLs at all three drainage locations, ranging up to 73 µg/kg at the Group 8 drainage confluence, and lower detections (7 µg/kg) at the north and southwest drainages. Samples collected at the north and southwest drainages during the recent sampling event did not contain VOCs.

4.1.2 NSGW and Chatsworth Formation Groundwater

Approximately 480 samples have been collected from groundwater monitoring locations within and around the Group 7 Reporting Area and analyzed for VOCs. Analytical results for groundwater are summarized as follows:

B4029 RFI Site:

- VOCs have been detected below established MCLs groundwater wells in the vicinity of the site, although detections are infrequent and generally accompanied by many samples wherein VOCs were not detected. Each of the following VOCs have been detected on a single occasion: TCE (RD-16), chloromethane (RD-16), carbon disulfide (RD-16), ethylbenzene (RD-16), toluene (RD-92), and methylene chloride (PZ-112). Acetone was detected on one occasion in both PZ-112 and RD-92.

B4133 RFI Site:

- TCE, chloromethane, and methylene chloride have been infrequently detected at RD-19. TCE is the only VOC that was detected at concentrations up to 5.1 µg/L, above its MCL (5 µg/L), but this result is not considered to be representative of

typical groundwater conditions since TCE was not detected in an associated duplicate sample or in any of the 53 other samples collected from this location. Chloromethane and methylene chloride detections were near the detection limit, below established MCLs (no MCL exists for chloromethane), and not replicated in over 50 other samples collected from RD-19.

- Acetone, benzene, and carbon disulfide were detected below established MCLs in a sample collected from RD-85 following its installation. These compounds were not detected in a subsequent sample collected from RD-85.

RMHF RFI Site:

- TCE, cis-1,2-dichloroethene (DCE), trans-1,2-DCE, and/or 1,1-DCE have been detected above MCLs in the NSGW well (RS-28) and Chatsworth formation groundwater wells (RD-30, RD-34A, RD-34B, RD-63, RD-88, RD-90). Within the past 3 years, only TCE (up to 11 µg/L) and 1,1-DCE (up to 17 µg/L) have been detected above their respective MCLs.
- 1,1-DCA was detected above the MCL in an early sample collected from NSGW well RS-28. 1,1-DCA has not been detected above the MCL since 1989.
- VOCs that have been detected below their respective MCLs in the vicinity of the RMHF RFI Site include: PCE, Freon 113, chloroform, chloromethane, acetone, toluene, MIBK, MEK, ethylbenzene, carbon disulfide, benzene, 2-hexanone, methylene chloride, 1,4-dichlorobenzene, and 1,1,1-trichloroethane.

4.1.3 Surface Water

In 1992, two surface water samples were collected west of the RMHF RFI Site as part of the McLaren/Hart offsite study in the drainage north of the RMHF fenced area (McLaren/Hart, 1993). VOCs were not detected in either of the samples.

As part of NPDES monitoring program, storm water discharges are routinely sampled at Outfall 003 in the drainage north of the RMHF RFI Site and west of the B4133 RFI Site. VOCs have not been detected in NPDES samples at these locations (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.1.4 Completeness of Characterization

Soil and soil vapor samples were collected from known or potential solvent source areas and downstream discharge areas within Group 7 and analyzed for VOCs. In addition, soil vapor screening was conducted at representative locations to provide characterization of potential VOC impacts at the Group 7 RFI sites. The VOCs predominantly detected above RBSLs in Group 7 sampling were methylene chloride and BTEX constituents. Methylene chloride was detected at all three RFI sites, with concentrations ranging up to 8.57 µg/kg at the RMHF

RFI Site. BTEX constituents were detected at the highest concentrations at the B4133 RFI site, with concentrations in soil ranging up to 8 µg/kg for ethylbenzene and 19,200 µg/kg for 1.2.4-trimethylbenzene. Benzene was also detected above the RBSL in soil vapor at the B4133 RFI Site, with concentrations ranging up to 0.11 µg/L. TCE, although not detected in soil sampling, has been commonly detected at elevated concentrations in groundwater at the RMHF RFI Site, with historical concentrations ranging up to 91 µg/L (currently up to 11 µg/L). As described above, excavation of soils from a potential source area, the Building 4021 Leach Field, occurred in 1978 without characterization of removed materials for VOCs. This feature is considered a likely source of the observed TCE in groundwater based on the similarity of current groundwater concentrations detected in this portion of the site, including the well adjacent to the former leach field. Also, based on extensive historical document review and VOC soil sampling results throughout the RMHF and B4133 RFI Sites, no other potential TCE source has been identified.

VOC-related chemical use areas are characterized sufficiently for RFI risk assessment of residential, recreational, and ecological receptors, and evaluation of potential groundwater impacts as detailed in Appendices A through D.

For the purposes of risk assessment, Chatsworth formation well RD-30 was selected for evaluation of direct exposure to chemicals in groundwater since it is the most impacted well within the Group 7 Reporting Area (primarily on the basis of its VOC detections). Similarly, for assessment of indirect exposures, the following wells were selected for evaluation based on their shallow depth to water and VOC detections: RD-92 (B4029); RD-19 (B4133); and RS-28 (RMHF).

4.2 SVOCs

4.2.1 Soil/Sediment

A total of 193 soil/sediment samples were collected from within the Group 7 Reporting Area and analyzed for SVOCs. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 7 Reporting Area SVOC sampling results are depicted on Figure 4-2. Each sample location is represented by a color corresponding to a maximum detected SVOC concentration in that sample relative to respective RBSLs.

SVOCs were detected in soils at all Group 7 RFI sites. SVOC detections were all at low concentrations below RBSLs, with the exception of one benzo(a)pyrene detection at RMHF. The most prevalent SVOCs detected were polyaromatic hydrocarbons (PAHs), including benzo(a)pyrene (BaP), and phthalates. SVOC soil matrix sampling results for the RFI sites within the Group 7 Reporting Area are summarized as follows:

B4029 RFI Site:

- Phthalates were detected at two locations up to 5.35 µg/kg (di-n-phthlate) at the Building 4029 access road. No PAHs were detected at this site.

B4133 RFI Site:

- SVOCs, including BaP, were detected at concentrations below RBSLs throughout this site, ranging up to 537 µg/kg (naphthalene). BaP was detected up to 11.7 µg/kg, below the RBSL, at the Western Drainage Debris Area.

RMHF RFI Site:

- BaP was detected at two locations, up to 154.1 µg/kg, slightly above the RBSL, south of the Mixed Waste Storage Yard in a former radiological excavation area. Other SVOCs detected at the site were below RBSLs, ranging up to 181 µg/kg (fluoranthene) at the Building 4663 Equipment Storage Area.
- Glycols were not detected in soil samples at the RMHF RFI Site. Screening for glycols was performed in storage areas and down-gradient discharge locations, including the Catch Basin and Building 4021 Leach Field.
- SVOCs were detected in samples collected in 1992 within the drainages north and west of RMHF (west of Outfall 003, in the southwest drainage, and at the confluence of the Outfall 003 drainage with the drainage from Group 8) (McLaren/Hart, 1993). Three phthalates were detected in samples collected at the north and southwest drainages at concentrations up to 150 µg/kg (bis(2-ethylhexyl) phthalate), below the RBSL. In recent samples, phthalates were detected at one location in the north drainage at concentrations up to 83.5 µg/kg (bis(2-ethylhexyl)phthalate), below RBSLs, and not detected in the southwest drainage.

4.2.2 NSGW and Chatsworth Formation Groundwater

Approximately 16 samples have been collected from NSGW and Chatsworth formation groundwater monitoring locations within and around the Group 7 Reporting Area and analyzed for SVOCs. Di-n-butyl phthalate and bis(2-ethylhexyl) phthalate were detected with concentrations of 4.8 µg/L and 20 µg/L, respectively, in a single sample collected at RD-16 in 1996. These compounds were not detected in two subsequent samples collected

from this location or at any other Group 7 groundwater monitoring locations. No other SVOCs, including PAHs, were detected in Group 7 groundwater samples.

4.2.3 Surface Water

In 1992, two surface water samples were collected west of the RMHF RFI Site as part of the McLaren/Hart offsite study in the drainage north of the RMHF fenced area (McLaren/Hart, 1993). One SVOC, fluoranthene, was detected in these samples at 0.3 µg/L.

As part of NPDES monitoring program, storm water discharges are routinely sampled at Outfall 003 in the drainage north of the RMHF RFI Site and west of the Building 4133 RFI Site. SVOCs have not been detected in NPDES samples at these locations (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.2.4 Completeness of Characterization

Soil samples were collected from known or potential SVOC source areas and downstream discharge areas within the Group 7 Reporting Area. PAHs are the SVOCs most commonly detected in Group 7 soil samples, with all but one detected concentration below RBSLs. One PAH was detected above RBSLs (BaP up to 154.1 µg/kg) at two locations in an unpaved area south of the RMHF fence line in a former radiological excavation area. PAHs were not detected in groundwater samples, and phthalates were detected in one well (RD-16) in historical samples but not detected in recent samples.

SVOC-related chemical use areas are characterized sufficiently for risk assessment of residential, recreational, and ecological receptors, and evaluation of potential groundwater impacts, as detailed in Appendices A through D.

4.3 TPH

4.3.1 Soil/Sediment

A total of 336 soil samples were collected from within the Group 7 Reporting Area and analyzed for TPH. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 7 TPH sampling results are depicted on Figure 4-3. Each sample location is represented by a color corresponding to a maximum ratio of detected TPH concentrations to the lowest RBSL in that sample.

Locations with maximum detections of petroleum hydrocarbons exceeding RBSLs in soils at Group 7 RFI sites are described below. Since the RBSLs for TPH are based on the potential presence of benzene for gasoline-range hydrocarbons, or PAHs for all other hydrocarbon fractions, the following descriptions include information about these related compounds in collocated or nearby samples.

B4029 RFI Site:

- Lubricant oil range organics (C21 – C30) were detected at several locations, primarily along the Building 4029 Access Road, ranging up to 493 milligrams per kilogram (mg/kg), below the RBSL. No other TPH ranges were detected at the site.

B4133 RFI Site:

- Gasoline range organics (C08 – C11) were detected at 1,410 mg/kg and kerosene range organics (C12 – C15) were detected at 2,460 mg/kg, both above RBSLs, northeast of Tank T-3. The maximum concentrations were detected at 5.5 feet bgs; and TPH was not detected in the surface sample. Benzene was detected in a collocated soil vapor sample at 0.11 µg/L, PAHs were detected below RBSLs at the location (up to 537 µg/kg naphthalene).
- Gasoline range organics (C08 – C11) were detected up to 4.81 mg/kg in 5 of 11 samples, above the RBSL, in the Western Debris Area. Other TPH ranges were also detected below RBSLs, up to 29.4 mg/kg lubricant oil range organics (C21 - C30). TPH did not exceed RBSLs in downstream samples. Benzene was not detected at any of these locations.
- Lubricant oil range organics (C21 – C30) were detected at locations below RBSLs throughout the asphalt-lined drainage ditch east of the site, ranging up to 717 mg/kg. No other TPH ranges were detected in the asphalt-lined drainage ditch. Additional characterization in the asphalt-lined drainage ditch is planned as part of the follow-on phase for the Group 6 RFI (in progress).

RMHF RFI Site:

- Gasoline range organics (C08 – C11) were detected at one location west of the Waste Receiving Yard at 1.5 mg/kg, slightly above the RBSL. Benzene was not detected in this sample, or any depths at this location.
- Diesel range (C15 – C20) and/or lubricant oil range (C21 – C30) organics were detected in the six sampled locations in the north and southwest drainages up to 10.2 mg/kg, below RBSLs. PAHs were not detected at or near this location.
- Lubricant oil range organics (C21 – C30) were detected across the RMHF fenced yard and adjacent areas at concentrations below RBSLs, typically at concentrations less than 100 mg/kg. Four detected concentrations ranged between 500 mg/kg and 1,030 mg/kg. The highest detection of lubricant oil range organics was detected east of the Building 4663 Equipment Storage Area. As described above, PAHs were

detected at concentrations well below RBSLs at locations where elevated TPH occurs.

4.3.2 NSGW and Chatsworth Formation Groundwater

Petroleum hydrocarbons have been analyzed for TPH at RD-19, RD-30, RD-98, and RS-28. Petroleum hydrocarbons were not detected in any of these samples. RS-25, the well closest to the gasoline range organics detections in soil north of Building 4133, has not been sampled for TPH although it has been sampled for BTEX constituents. Benzene has not been detected in samples from this NSGW well. Additional TPH samples are recommended for RS-25, however, to reduce uncertainty regarding potential contaminant migration to groundwater.

4.3.3 Surface Water

For the RFI, surface water sample were not analyzed for petroleum hydrocarbons.

As part of NPDES monitoring, storm water discharge has been routinely sampled for Oil and Grease (the heaviest carbon fraction of TPH) at Outfall 003 in the drainage north of the RMHF RFI Site. Oil and Grease have not been detected above permit limits at NPDES Outfall 003 (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.3.4 Completeness of Characterization

Soil samples were collected from known or potential TPH source areas and downstream discharge areas within the Group 7 Reporting Area. The highest concentrations were detected in soil at localized areas near a former storage area/tank location and in a debris area at the B4133 RFI Site. TPH was not detected in groundwater within the Group 7 Reporting Area. As noted above, additional TPH samples are recommended at RS-25 to assess groundwater conditions near a TPH soil impact area.

Where soil TPH concentrations exceeded RBSLs, collocated or nearby soil samples were analyzed for the potential risk constituents, benzene and PAHs. It is worth noting that the gasoline range TPH RBSL conservatively assumes the presence of benzene, and is just above a typical, low laboratory reporting limit (about 1 mg/kg). Some recent TPH detections in Group 7 contain low, estimated concentrations of gasoline range hydrocarbons (Figure 4-3). However, except at the B4133 RFI Site where BTEX constituents were identified at high concentrations, these low detections of gasoline hydrocarbons are not considered significant based on the age of hydrocarbon releases at these sites and absence of collocated detections in soil vapor.

TPH-related chemical use areas are characterized sufficiently for risk assessment of residential, recreational, and ecological receptors, and evaluation of potential groundwater impacts as detailed in Appendices A through D. Also, TPH is not used in the risk assessment since the estimated risk relies on specific VOC and SVOC concentrations for TPH-related compounds (i.e., benzene and PAHs), and many analytical results for those compounds are available for the Group 7 Reporting Area.

4.4 PCBS AND TERPHENYLS

4.4.1 Soil/Sediment

A total of 152 soil samples were collected and analyzed for PCBs within the Group 7 Reporting Area. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Also, 27 samples were collected and analyzed for m-, n-, and o-terphenyls, and polychlorinated terphenyls at representative storage and down-gradient receiving locations within Group 7. Group 7 Reporting Area PCB and terphenyl sampling results are depicted on Figures 4-4. Each sample location is represented by a color corresponding to the maximum ratio of detected PCB concentrations at that location relative to respective RBSLs. As described in Section 4.0, color depictions for PCB samples represent comparisons with adjusted RBSLs for three Aroclors (1016, 1254 and 1260). These RBSLs were adjusted using baseline TRVs that were used in the ecological risk assessment (Appendix E).

PCBs were detected at generally low concentrations or were not detected in samples collected within the Group 7 Reporting Area, and all terphenyl sampling results were non detect. Detected PCBs primarily consisted of Aroclor 1248, 1254, and 1260. PCB sampling results for the RFI sites within the Group 7 Reporting Area are summarized as follows:

<u>B4029 RFI Site:</u>

- PCBs were not detected in the TPH-impacted fill identified beneath the access road.

<u>B4133 RFI Site:</u>

- The highest detection of PCBs at this site was in the unpaved area north of Building 4133. At this location, Aroclor 1254 was detected at 380 µg/kg, above the RBSL. This elevated detection of PCBs is collocated with elevated sodium (see Section 4.6), which decreased in concentration down-gradient.
- PCBs were generally not detected or detected at concentrations below RBSLs elsewhere at this site, ranging between 20 µg/kg and 90 µg/kg. Low concentrations of PCBs were detected in the areas southeast and southwest of Building 4133.

RMHF RFI Site

- Aroclor 1260 was detected at 6,710 µg/kg, above the RBSL, south of the fenced yard in a former radiological excavation area. PCBs were detected at decreasing concentrations surrounding this location.
- In the remaining portions of the site and in the areas west of the site, PCBs were generally not detected or detected at concentrations below RBSLs, typically ranging between 15 µg/kg and 50 µg/kg. Low concentrations of PCBs were detected near Building 4621, the Building 4021 septic tank and former leach field, the Building 4021 sump, the RMHF Catch Basin Drainage Channel, and the drainage north of the site. Within the drainage, the highest PCB detections are in upslope samples (20.7 µg/kg Aroclor 1254) and decrease to non-detect down drainage.

4.4.2 NSGW and Chatsworth Formation Groundwater

One groundwater sample was collected from RD-19 and analyzed for PCBs in 2008. PCBs were not detected.

4.4.3 Surface Water

For the RFI, surface water sample were not analyzed for PCBs.

As part of NPDES monitoring, storm water discharge has been routinely sampled for PCBs at Outfall 003 in the drainage north of the RMHF RFI Site. PCBs have not been detected in these samples (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.4.4 Completeness of Characterization

Soil samples were collected from known or potential PCB source areas and in downstream discharge areas within the Group 7 Reporting Area. Aroclor 1260 is the most prevalent PCBs detected in samples collected in the Group 7 Reporting Area, with concentrations ranging up to 6,710 µg/kg at the RMHF RFI Site in the area south of the fenced yard. PCBs were not detected in groundwater well RD-19 located at the RMHF RFI Site.

PCB chemical use areas are characterized sufficiently for risk assessment or residential, recreational, and ecological receptors, and evaluation of potential groundwater impacts, as detailed in Appendices A through D. Additional PCB soil sampling is warranted for CMS planning purposes to refine the down-slope extent of detections north of the Building 4133 operational area, but this area is sufficiently characterized for risk assessment since concentrations would be expected to decrease down-gradient.

4.5 DIOXINS

4.5.1 Soil/Sediment

A total of 17 soil samples were collected and analyzed for dioxins based on historical operations and potential site impacts. Group 7 dioxin sampling results are depicted on Figure 4-5. Each sample location is represented by a color corresponding to the maximum TEQ concentration from that location (dioxin congeners and TEQ definition are provided in the list of abbreviations and acronyms).

Dioxin sampling results for the RFI sites within the Group 7 Reporting Area are summarized as follows:

B4029 RFI Site:

- Dioxins were not analyzed at samples collected at this site since no historical burning operations occurred and debris areas containing burnt materials were not observed.

B4133 RFI Site:

- Dioxins were analyzed in two samples west of the Western Drainage Debris Area to assess up-gradient drainage conditions east of Outfall 003. Both samples had calculated 2,3,7,8-TCDD Toxic Equivalent (TEQ) values significantly less than the background comparison value and RBSLs. One sample contained OCDD at 165 nanograms per kilogram (ng/kg); slightly above the background concentration for this dioxin congener (140 ng/kg).

RMHF RFI Site:

- Dioxin samples were collected in the vicinity of a former incinerator within the RMHF fenced yard, with all TEQs less than background (TEQ 0.87 ng/kg).
- Dioxin samples were also collected in the drainage above and below the NPDES Outfall 003 location since dioxins have exceeded NPDES permit limits in surface water samples collected at this outfall. Within the drainage, soil sampling results at one drainage location down-slope of the former Building 4021 Leach Field were slightly above background, ranging up to 1.0 ng/kg, and below RBSLs. TEQ sampling results further down-drainage were below background.

4.5.2 NSGW and Chatsworth Formation Groundwater

Dioxins have not been analyzed in samples collected from Group 7 groundwater monitoring locations.

4.5.3 Surface Water

RFI surface water samples collected at Group 7 RFI Sites were not analyzed for dioxins.

As part of NPDES monitoring, storm water discharge has been routinely sampled for dioxins at Outfall 003 in the drainage north of the RMHF RFI Site. Dioxins were detected above the permit limits at NPDES Outfall 003 twice in 2004, and are considered likely the result of ash from the Piru Fire in 2003 which approached within approximately 1 mile of the SSFL (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.5.4 Completeness of Characterization

Soil samples were collected from areas known or potential dioxin source areas and downstream discharge areas within the Group 7 Reporting Area. Dioxins were detected only at low concentrations, below or consistent with background comparison concentrations. Dioxins have not been analyzed in groundwater based on the low detections in soil. Surface water detections are considered likely the result of naturally occurring fire ash in entrained sediments included in the surface water samples.

Dioxin-related chemical use areas are characterized sufficiently for risk assessment of residential, recreational, and ecological receptors, and evaluation of potential groundwater impacts as detailed in Appendices A through D.

4.6 METALS/INORGANICS

4.6.1 Soil/Sediment

A total of 396 soil samples were collected from the Group 7 Reporting Area and analyzed for metals and/or inorganics. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 7 metal sampling results are depicted on Figure 4-6. Each sample location is represented by a color corresponding to a maximum ratio of detected metal concentrations to the lowest RBSL in that sample if the concentration is above background. As noted in Section 4.0, color depictions for metals samples represent adjusted RBSLs for five metals (antimony, cadmium, copper, nickel, and silver). The RBSLs were adjusted using baseline TRVs that were used in the ecological risk assessment (Appendix E). The sodium results described below are compared to background since no RBSL exists for this metal (it is considered an essential nutrient and not included in risk assessment).

Fluoride results are also presented in this section since background concentrations have been developed for this inorganic chemical (MWH, 2005b). Figure 4-6 includes presentation of fluoride results. Within the Group 7 Reporting Area, approximately 37 samples were collected and analyzed for fluoride. Detected concentrations exceeded the background level at one location in the former Building 4021 Leach Field, where fluoride was detected at 7.51 mg/kg, slightly above background (6.7 mg/kg).

Metals in the Group 7 Reporting Area were detected above background in approximately 256 samples collected from all three RFI sites. Eighteen (18) metals were detected at concentrations exceeding background: arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and zirconium. Sodium was the metal most frequently detected above its background comparison level (97 out of the 256 background exceedances, or 38%), followed by zinc (26 out of the 256 background exceedances, or 10%), followed by selenium (9 out of the 256 samples, or 4%), followed by boron and cadmium (6 out of the 256 background exceedances, or 2%, each). All other metals were detected above background in less than 5 of the 256 samples (or less that 2%) that exceeded background concentrations. Hexavalent chromium was detected in 25 out of 146 samples analyzed (or 17%) at concentrations up to 0.69 mg/kg.

Metals sampling results for the RFI sites within the Group 7 Reporting Area are summarized as follows:

B4029 RFI Site:

A total of 23 samples were collected for metals analysis throughout the B4029 RFI Site, with 16 samples containing metals detections above background. Although several metals were detected above background at this site, there was not a pattern to their distribution. Detections above ecological RBSLs include barium, lithium, nickel, and zinc. There were no metals detections above residential RBSLs. A summary of these detections include:

- Five metals were detected above background concentrations within and near Building 4029. The highest metals concentrations were generally detected at one location beneath a foundation crack in Building 4029, which contained barium (185 mg/kg; background 140 mg/kg), lithium (60.8 mg/kg; background 37 mg/kg), nickel (37.9 mg/kg; background 29 mg/kg), sodium (220 mg/kg; background 110 mg/kg), and thallium (0.51 mg/kg; background 0.46 mg/kg).

- Sodium was detected above background 10 of 16 sample locations across the site, up to 245 mg/kg (background 110 mg/kg).
- Zinc was detected up to 328 mg/kg (background 110 mg/kg), the maximum located at the topographic low point/drainage area southeast of Building 4029. The downstream sample was within background range for zinc.
- Barium (up to 165 mg/kg), and sodium (up to 144 mg/kg) were detected above background in samples collected along the Building 4029 Access Road.

B4133 RFI Site:

A total of 146 samples were collected for metals analysis throughout the B4133 RFI Site, with 27 samples containing metals concentrations above background ranges, primarily sodium. Detections above ecological RBSLs include arsenic, barium, boron, cadmium, copper, cobalt, lead, selenium, and zinc. Cobalt was the only metal detected above residential RBSLs (in the asphalt swale east of Building 4133, in the SRE RFI Site). A summary of these detections include:

- Sodium was detected above background (110 mg/kg) throughout the site, ranging up to 6,900 mg/kg in historical samples collected during 1987/1988 soil removal action at the Neutralizing Pit. In recent samples, sodium was detected up to 2,660 mg/kg just north of the site boundary.
- Arsenic, barium, boron, cadmium, selenium and zinc were detected just above background at scattered, isolated locations within and near main Building 4133 operational areas. Of these metals, all were above ecological RBSLs.
- Metals decrease to within background range in down-slope and drainage samples to the west.
- Cadmium, cobalt, copper, lead, sodium, and zinc over background at locations throughout the asphalt-lined drainage ditch located east of Building 4133, at the SRE RFI Site. Additional characterization in the asphalt-lined drainage ditch is planned as part of the Group 6 RFI (in progress).

RMHF RFI Site:

A total of 216 samples were collected for metals analysis throughout the RMHF RFI Site with 73 samples containing metals concentrations above background ranges, primarily sodium and zinc in the fenced yard at RMHF. Detections above ecological RBSLs include boron, cadmium, cobalt, copper, selenium, vanadium, zirconium, zinc, and hexavalent chromium. Cobalt was the only metal detected at a concentration above the residential RBSL. A summary of these detections include:

- Several metals were detected above background concentrations in the Mixed Waste Storage Yard and Building, and Building 4663 Equipment Storage Area. Cobalt was

detected above the RBSL (22.7 mg/kg). Boron, cobalt, copper, and vanadium detections in this area were above background and ecological RBSLs:

- Boron up to 17.6 mg/kg (background = 9.7 mg/kg)
- Cobalt at 29 mg/kg (background 21 mg/kg)
- Copper at 62.7 mg/kg (background = 29 mg/kg)
- Hexavalent chromium up to 0.69 mg/kg (no background concentration)
- Sodium up to 537 mg/kg (background = 110 mg/kg)
- Thallium up to 0.6 mg/kg (background = 0.46 mg/kg)
- Vanadium at 75.3 mg/kg (background 62 mg/kg)

- Four metals were detected above background concentrations in the Filter/Blower Area and at the Filter/Blower Area discharge pipeline. Cadmium, lead, zinc, and zirconium were detected above background and ecological RBSLs:
  - Cadmium at 4.8 mg/kg (background = 1 mg/kg) at the pipeline discharge
  - Lead at 44.1 mg/kg (background = 34 mg/kg) at the pipeline discharge
  - Sodium up to 202 mg/kg (background = 110 mg/kg)
  - Zinc up to 1,240 mg/kg (background = 110 mg/kg) with the maximum detected concentration at the pipeline discharge
  - Zirconium at 14.2 mg/kg (background = 8.6 mg/kg)
- Several metals were detected above background concentrations along the RMHF Asphalt Drainage Swale. Chromium, cobalt, lead, selenium, and zinc were detected above background and ecological RBSLs. Metals were not detected above background at the RMHF Drainage Channel or RMHF Catch Basin, which receive surface water from the swale.
  - Chromium at 37.7 mg/kg (background = 36.8 mg/kg)
  - Cobalt at 48 mg/kg (background = 21 mg/kg)
  - Hexavalent chromium at 0.225 mg/kg (no background concentration)
  - Lead at 35.4 mg/kg (background = 34 mg/kg)
  - Selenium at 0.76 mg/kg (background = 0.655 mg/kg)
  - Sodium at 559 mg/kg (background = 110 mg/kg)
  - Zinc up to 520 mg/kg (background = 110 mg/kg)
- Five metals were detected above background at the storm water culvert near Building 4028. Cobalt was detected above the residential RBSL (22.7 mg/kg), and copper, sodium, silver and zinc were detected above background and ecological RBSLs. Except for silver, these metals were also detected above background inside the RMHF operations area, but not within the area south of the fence line. These detections included:

  - Cobalt at 152 mg/kg (background = 21 mg/kg)
  - Copper at 39.3 (background = 29 mg/kg)
  - Silver at 9.95 mg/kg (background = 9.95 mg/kg)
  - Sodium at 151 mg/kg (background = 110 mg/kg)
  - Zinc at 329 mg/kg (background = 110 mg/kg)

- Selenium was detected at the RMHF Catch Basin Discharge Pipeline at 2.7 mg/kg, above background (0.655 mg/kg) and the ecological RBSL. No metals were detected above background at the down-slope sampling locations or at the pipeline discharge location.
- Zinc was detected up to 173 mg/kg at the excavation area north of the RMHF Catch Basin, exceeding background (110 mg/kg) and the ecological RBSL. Zinc was not detected above background concentrations at down-slope drainage locations.
- Sodium was detected above background (110 mg/kg) at several locations across the site and in adjacent areas at concentrations up to 655 mg/kg. Concentrations above background levels occurred in the RMHF fenced area, in the disturbed soil area west of the Catch Basin, and at the former Building 4028 operational area.
- Metals concentrations were detected below background in samples collected in 1992 within the drainages north and west of RMHF (west of Outfall 003, in the southwest drainage, and at the confluence of the Outfall 003 drainage with the drainage from Group 8) (McLaren/Hart, 1993). During recent sampling, zinc was detected at 120 mg/kg, slightly above the background concentration (110 mg/kg), at one location in the north drainage, above the ecological RBSL. All other detected metals concentrations were below background.

4.6.2 NSGW and Chatsworth Formation Groundwater

Approximately 98 samples have been collected and analyzed for metals from 15 groundwater monitoring locations within and around the Group 7 Reporting Area. In summary, metals detected above their respective GWCCs include:

- Building 4029: Manganese (1x), molybdenum (1x), selenium(1x), and vanadium (1x)
- Building 4133: Copper (1x), manganese (3x), and selenium (1x)
- RMHF: Barium (1x), beryllium (1x), cadmium (4x), cobalt (1x), copper (2x), lead (4x), molybdenum (2x), manganese (1x), selenium (1x), and thallium (2x)

It should be noted that the detection of metals above their respective GWCC does not imply site-relatedness. A detailed evaluation of analytical results for metals dissolved in groundwater and their relationship to site operations and soil sampling data is provided in Appendix D, and described further in Section 5.3.5 below.

4.6.3 Surface Water

In 1992, two surface water samples were collected west of the RMHF RFI Site as part of the McLaren/Hart offsite study in the drainage north of the RMHF fenced area (McLaren/Hart, 1993). Metals were not detected in any of the surface water samples.

As part of NPDES monitoring, storm water discharge has been routinely sampled for metals at Outfall 003 in the drainage north of the RMHF RFI Site. Copper and antimony were each detected above the permit limit in a single sample collected in 2005 at 17 µg/L (copper, permit limit 14 µg/L) and 35 µg/L (antimony, permit limit 6 µg/L), respectively. pH was measured outside of the permit limit specified range (6.0 – 8.5) in 2004, 2006, and 2007, up to 9.6. These exceedances are considered related to natural processes (fire ash) or BMP construction activities (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.6.4 Completeness of Characterization

Soil samples were collected and analyzed at known or potential metals source areas and in downstream discharge areas. The most frequently detected metals in soil at concentrations above background are sodium and zinc. The only metal detected above its residential RBSL was cobalt, with one detection at the RMHF Mixed Waste Storage Yard, one at the storm water culvert south of RMHF, and one within the asphalt swale east of Building 4133 at the SRE RFI Site. Several metals were detected at concentrations that exceeded the ecological RBSLs (established below background levels), including: arsenic, barium, boron, cadmium, cobalt, copper, lead, lithium, selenium, vanadium, zirconium, and zinc. Also, copper, cobalt, and lead were detected above ecological RBSLs in the asphalt swale east of Building 4133 at the SRE RFI Site. With the exception of sodium and zinc, metals concentrations above background within the Group 7 Reporting Area were generally low and isolated, scattered detections without a spatial distribution pattern.

Based on historical operations, groundwater concentrations and temporal data distribution, and number, magnitude and proximity of soil concentrations exceeding background, no detected metals in groundwater are considered likely to be related to site operations. This evaluation is summarized in Section 5 and a detailed evaluation of site related metals is presented in Appendix E, Tables E-24 through E-32.

Metals-related chemical use areas are characterized sufficiently for risk assessment of residential, recreational, and ecological receptors, and evaluation of potential groundwater

impacts, as detailed in Appendices A through D. Additional characterization of metals in soil near the storm water culvert south of the RMHF is recommended to delineate soil impacts and assess potential sources.

4.7 OTHER COMPOUNDS

In addition to the chemical analytical suites described above, several other chemicals/ materials were analyzed in the Group 7 Reporting Area to assess potential chemical use at the RFI sites. These results are presented in more detail in the RFI Site Reports (Appendices A through C), and in the detailed groundwater descriptions (Appendix D). The following summarizes the notable occurrences of pesticides and herbicides, asbestos containing materials (ACM), glycols, terphenyls, perchlorate, and inorganic compounds. ACM results are only provided for soil/sediment and surface water results since this constituent is typically limited to surficial soils.

4.7.1 Soil and Sediment

Pesticides/Herbicides

- Pesticides were analyzed at seven locations at the B4029, B4133, and RMHF RFI Sites, targeting building corners and potential drainage pathways from operational areas. Pesticides were detected at two sample locations:
  - In the RMHF fenced-yard, 4,4'-dichloridiphenyl trichloroethane (4,4'-DDT) was detected up to 5.25 µg/kg.
  - In the drainage north of RMHF, 4,4'-dichlorodiphenyl trichloroethene (4,4'-DDD) at 200 µg/kg, above RBSLs. 4,4'-DDT at this location was detected below RBSLs. Pesticides were not detected at other locations.
- Herbicides were analyzed at seven locations at the B4029, B4133, and RMHF RFI Sites, targeting building corners and potential drainage pathways from operational areas. Herbicides were not detected at the sampled locations.

Asbestos

- The RMHF Discharge Pipeline, constructed of transite pipe, was a potential source of ACM. Five samples were collected at five locations along the former pipeline to assess the potential for ACM. Asbestos was not detected at any of the five sample locations.

Glycols

- Glycols were analyzed at 26 locations at the RMHF RFI Site, primarily in the Mixed Waste Storage Yard and the former Building 4021 Leach Field, based on reported chemical storage at the RMHF RFI Site (including dowanol and antifreeze). Glycols were not detected at the sampled locations.

Perchlorate

- Perchlorate was analyzed at 24 locations at the RMHF RFI Site to assess potential use. Perchlorate was not detected at the 24 sampled locations.

Other Inorganic Compounds

- Inorganic compounds, including nitrate, chloride, bromide, and phosphate, were analyzed at 16 sampled locations at the RMHF RFI Site based on documented storage of acids and acidic wastes at the RMHF. Chloride, sulfate, and/or nitrate were detected at the 16 sampled locations. There are no established RBSLs for these inorganic constituents:
  - Chloride: up to 8.76 mg/kg
  - Nitrate: up to 5.86 mg/kg
  - Sulfate: up to 51.3 mg/kg

4.7.2 NSGW and Chatsworth Formation Groundwater

Among the compounds discussed in this section, the most notable detections in groundwater are of inorganic constituents such as chloride, fluoride, nitrate, and sulfate. Fluoride was detected in one sample collected from RD-63 at roughly two times the established MCL (0.8 mg/L), but was not detected above the MCL in any of the wells surrounding RD-63. Chloride, nitrate, and sulfate were all detected below established MCLs.

Perchlorate was detected at an estimated concentration of 2.1 µg/L in one sample collected in 2003 from RS-25, located at the B4133 RFI Site. Perchlorate was not detected in three samples collected at a subsequent sampling event. This well has been predominantly dry.

4.7.3 Surface Water

RFI surface water samples have not been analyzed for pesticides, herbicides, ACM, glycols, terphenyls, perchlorate, or other organic compounds.

With the exception of ACM, these constituents have been monitored in storm water discharges at NPDES Outfall 003. 4,4'-DDT was detected at NPDES Outfall 003 in one 2004 at 0.3 µg/L, but was not detected subsequently. There is no permit limit established for 4,4'-DDT (Boeing, 2005a; 2006; 2007a; 2008; 2009b).

4.8 SUMMARY OF POST-TOPANGA FIRE BACKGROUND SAMPLING

The potential contribution of the 2005 Topanga Fire to the concentrations of metals in soil has been evaluated as part of the characterization of the nature and extent of chemicals as part of the Group 7 RFI Report. RFI Site specific discussions of the post-Topanga Fire data evaluation are presented in Appendices A, B, and C. RFI samples analyzed for dioxins or metals were evaluated to determine if concentrations above background for dioxin TEQs or metals collected after the fire could be due to the presence of ash and burned materials deposited in surficial soil. Only those surficial soil samples that were collected between 0 and 12 inches bgs after the fire were considered in this evaluation. Soil background sampling data collected immediately following the 2005 Topanga Fire are reported in the first RFI Group Report (MWH, 2006b) and were used for comparison of soil data collected at the RFI sites following the fire.

Approximately 298 soil samples were collected from shallow soils in unpaved areas and analyzed for metals following the 2005 Topanga Fire in the Group 7 Reporting Area. Of these, 11 samples contained metals above the maximum DTSC-approved background concentrations that may be influenced by post-Topanga Fire impacts. Similarly, one dioxin sample contained concentrations above background concentrations that may have been influenced by post-fire impacts. RFI site-specific discussions of the post-Topanga Fire data evaluation are presented in Appendices A, B, and C.

These comparisons were made to assist future CMS or remedial planning, and no post-fire data were discounted or ignored for site action recommendations presented in this report.

5.0 CONTAMINANT TRANSPORT AND FATE

This section presents a discussion of chemical contaminant transport and fate mechanisms and evaluation results. Transport and fate evaluation is a process used to assess contaminant migration and relationships between the various environmental matrices (i.e., soil, groundwater, air, and surface water) at the SSFL. The transport and fate evaluation considers both past migration (e.g., are groundwater concentrations site-related?) and potential future migration.

Section 5 is divided into three main topics. Section 5.1 describes the Conceptual Site Model (CSM) for the Group 7 Reporting Area based on environmental matrices and migration pathways included in the transport and fate evaluation. Using the CSM, Section 5.2 describes the various tools (i.e., models) used in the transport and fate evaluation. Section 5.3 describes key transport and fate findings for the Group 7 Reporting Area.

5.1 CONCEPTUAL SITE MODEL

A CSM[i] describes the various environmental matrices characterized at a site, their interrelationships, and exposure pathways to potential receptors. The CSM is developed as a basis for characterization and risk assessment, and identifies potential contaminant migration pathways to be considered in the transport and fate evaluation. The current CSM for the Group 7 RFI Reporting Area is shown on Figure 5-1.

The following list identifies potential migration pathways for site chemicals evaluated in the RFI. Each pathway was evaluated for all appropriate chemical groups (VOCs, SVOCs, TPH, PCBs, dioxins, metals, and perchlorate), except where noted.

Contaminants in soil/sediment may migrate:

- In soil/sediment to down-slope and/or down-drainage locations
- As vapor into indoor or outdoor air (VOCs only)

[i] The conceptual site model described in this section of the report is comprehensive of all environmental matrices, exposure pathways, and potential receptors. It is worthy to note that a detailed descriptive site conceptual model for the transport and fate of contaminants in groundwater at the SSFL was issued in July 2007 (Cherry, McWhorter, and Parker, 2007). Thus, the reader is directed to that document for information on contaminant transport and fate within the groundwater system.

- As soil leachate to groundwater
- Associated with dust/particulates to outdoor air
- As uptake into leaves and stems of edible plants

Contaminants dissolved in surface water may migrate:

- In surface water to down-stream soil and sediment
- As recharge to groundwater

Contaminants in groundwater may migrate:

- As vapor into indoor or outdoor air (VOCs only)
- As vapor or in water to soil
- Within groundwater to down-gradient locations
- To surface water as seeps/springs
- From NSGW to Chatsworth formation groundwater

5.2 TRANSPORT AND FATE TOOLS USED FOR EVALUATION

The transport and fate evaluation of chemicals for the Group 7 Reporting Area uses both quantitative evaluations (i.e., models) and qualitative evaluations (i.e., data review and interpretation). This section provides a description of the various transport and fate evaluation tools used in the Group 7 RFI Report, including both quantitative and qualitative tools.

5.2.1 Quantitative Tools

Transport and fate models have been used to evaluate many of the chemical sources and potential migration pathways identified in the CSM and in the above list. This section provides a brief description of these models, and the reader is referred to the more detailed descriptions provided in Appendices D and E.

5.2.1.1 Physical and Chemical Properties of Environmental Media

The physical and chemical properties of various environmental media are needed as input parameters for the quantitative transport and fate modeling tools. This section lists the environmental matrices at the SSFL that have physical and chemical properties identified for use in the models.

5.2.1.1.1 Soil

Soil physical and chemical properties are used in transport and fate modeling. Both SSFL site-specific and generic soil parameters are presented. These parameters are used in the Johnson-Ettinger vapor flux model, and listed in spreadsheets in Appendix E, Attachment E-6.

5.2.1.1.2 Bedrock

Bedrock physical and chemical properties are used in transport and fate modeling. Both SSFL site-specific and generic bedrock parameters are presented, and are used in the Johnson-Ettinger vapor flux model. The parameters are listed in spreadsheets in Appendix E, Attachment E-6.

5.2.1.1.3 Air

Key parameters that describe transport and fate in air are presented. The transport and fate models include dust generation/dispersion and dispersion of VOC vapors in air. Input parameters for these models are presented in spreadsheets in Appendix E, Attachment E-6.

5.2.1.2 Transport and Fate Models

Several transport and fate models have been used in this evaluation. These are briefly described in the following sections.

5.2.1.2.1 Johnson-Ettinger Vapor Migration Model

Two versions of the Johnson-Ettinger vapor migration model are used for the RFI. The first is the published, standard version that has been used to predict indoor air concentrations using VOC concentrations in contaminated soil or NSGW as a source term. This version of the model is run for VOCs in soil vapor using either measured or estimated concentrations. The indoor air concentrations are then used as exposure point concentrations in the residential exposure scenario.

The second is a modified version that has been used to predict indoor air concentrations using VOC concentrations in Chatsworth formation groundwater as a source term. The model estimates the transport of VOCs through bedrock and any overlying soil to the ground surface and then to indoor or outdoor air. The indoor air concentrations are then used as exposure point concentrations in the residential exposure scenario. Note that only the highest

of either soil-vapor-based or groundwater-based indoor air concentration risks are included in cumulative risks.

This modified version has been the subject of field validation. Validation methodologies are described in the *Vapor Migration Modeling Validation Study Work Plan* (MWH, 2005c). A report describing the results of this study has been submitted to DTSC (MWH, 2007b). The vapor validation study report concludes that the proposed model conservatively over-predicts migration from Chatsworth formation groundwater based upon flux chamber measurement results. Field validation results will be incorporated into the application of the model following DTSC review and approval of that report, and if necessary, risk assessments and reports will be revised. Further descriptions of the standard and modified Johnson-Ettinger vapor migration models are provided in the SRAM (MWH, 2005b).

5.2.1.2.2 Dust Generation Model

Airborne dust levels are predicted so that potential exposure to airborne contamination can be estimated. The model predicts the airborne concentration of dust that has as its source contaminated surficial soil. Either the reasonable maximum exposure (RME) or central tendency exposure (CTE) soil concentrations are used as a source term for this model for the RME and CTE exposures, respectively. The risk assessment uses a model that is endorsed by the USEPA and described in Appendix E. The model assumes both mechanical and wind-generated dust levels and utilizes a factor that directly converts soil concentration in mg/kg to airborne concentrations in milligrams per cubic meter (mg/m^3).

5.2.1.2.3 Airborne Dispersion Model

Once volatile chemicals migrate from the subsurface to the soil surface, they may enter the air and disperse as they migrate downwind. The downwind airborne concentrations of these volatile compounds are used as the exposure point concentrations for the human exposure scenarios. The highest of soil concentrations in either the 0- to 2-foot or 1- to 10-foot bgs horizons are used as the input source concentration for this modeling. Calculations are presented in the risk assessment spreadsheets in Appendix E.

Two dispersion models are used for SSFL risk assessments as described in the SRAM Rev2. The first is a conservative screening model from the USEPA. This model predicts downwind concentrations under relatively stable conditions. The second is an SSFL site-specific air dispersion model based on measurements that have been taken as described in the *Surface*

Flux and Ambient Air Monitoring Work Plan (MWH, 2005a). The dispersion factors developed from these measurements can be applied to predict downwind airborne concentrations of contaminants as a refinement to the screening approach. The screening approach was used in the Group 7 RFI Human Health Risk Assessments (HRAs).

5.2.1.2.4 Groundwater Transport

Groundwater transport evaluations can predict future groundwater concentrations based on migration of groundwater contaminants. The evaluations may include models and parameters for groundwater flow and contaminant transport through fractured bedrock, as described in the Site Conceptual Model Update (Montgomery Watson, 2000a; Cherry, McWhorter, and Parker, 2007) and in the *Perchlorate Source Evaluation and Technical Report* (MWH, 2003a).

Based on groundwater contaminant concentrations within and surrounding the Group 7 RFI sites, groundwater elevations, hydraulic conditions, and aquifer and source characteristics, location-specific modeling was deemed unnecessary for risk assessment, and current concentrations were used as future concentrations. Transport model results previously presented in the Perchlorate Report were used to support the use of current concentrations for future concentrations as a conservative assumption. This assumption is conservative because concentrations within source areas decrease over time, hence future concentrations will be lower. A description of this decision for the Group 7 Reporting Area is presented in Appendix D.

5.2.2 Qualitative Tools

Several qualitative tools have been used to evaluate potential contaminant migration at the Group 7 RFI sites. These are described in this section.

5.2.2.1 Surficial Soil/ Sediment Transport

Chemical migration in soil and sediment in surface water drainages, or across slopes, has been evaluated for Group 7 RFI site-related contaminants. Sampling and analysis to assess chemical distributions in surficial soils and sediments considered potential down-slope or down-drainage migration. An evaluation of chemical transport and fate via surficial migration, based on observed nature and extent (Section 4), is presented in Section 5.3.4.

5.2.2.2 Soil to Groundwater Migration

The relationship between soil chemicals and groundwater has been evaluated to assess whether soil chemical concentrations have affected groundwater quality. Soil chemical concentrations were reviewed and compared with appropriate (i.e., collocated) groundwater concentrations. The evaluation was based on chemical concentrations, DTSC-approved soil background concentrations (metals and dioxins only), spatial relationships, groundwater elevations and hydraulic gradients, and other hydrogeologic relationships (e.g., potential recharge). The evaluation provides conclusions regarding soil sources for chemicals detected in groundwater (i.e., is soil a source of groundwater contamination?).

For metals (and some other select inorganic compounds), groundwater concentrations were compared to DTSC-approved GWCCs which are considered conservative screening values that are at or below background (MWH, 2005b). As such, concentrations below GWCCs were considered naturally-occurring or background (i.e., not site-related). Groundwater metals concentrations above GWCCs were further evaluated. Based on soil concentrations compared to DTSC-approved background ranges, spatial relationships, historical site operations, groundwater elevations and hydraulic gradients, and other hydrogeologic relationships, conclusions were made regarding the potential for each metal to be site-related. This evaluation is summarized below in Section 5.3.5 and presented in more detail in Appendices A through C. In particular, the reader is referred to Tables 3-2B in Appendices A through C, and Tables D-21 through D-23 in Appendix D.

5.3 TRANSPORT AND FATE FINDINGS FOR SITE-RELATED GROUP 7 CHEMICALS

The following sections provide a brief summary of transport and fate evaluation findings for the Group 7 Reporting Area for the evaluation tools previously listed. Each of these summaries has a more detailed description in either Appendix D (Groundwater) or Appendix E (Risk Assessment). For surficial soil/sediment migration, the entire evaluation is described in Section 5.3.4 and not in any of the appendices. Therefore, Section 5.3.4 contains more detail in this volume of the report than the other sections.

5.3.1 Vapor from Groundwater

Several VOCs, including TCE and its daughter products, were detected in groundwater in the Group 7 Reporting Area. The indoor and outdoor air concentrations of these and other VOCs have been predicted using the modified Johnson-Ettinger model. The predicted indoor air

concentrations are listed in the risk assessment spreadsheets that are provided in Appendix E, Attachment E-6.

5.3.2 Vapor from Soil

Several VOCs, including PCE, TCE, 1,1-dichloroethene (DCE), and benzene, were detected in soil in the Group 7 Reporting Area. The indoor and outdoor air concentrations of these VOCs have been predicted using the Johnson-Ettinger model. The predicted indoor air concentrations are listed in the risk assessment spreadsheets that are provided in Appendix E, Attachment E-6.

5.3.3 Migration Within Groundwater

As discussed in Appendix D, bedrock matrix diffusion (for all chemicals soluble in water), coupled with other physical, chemical, and biological processes, slows the transport of these soluble chemicals relative to the average linear groundwater velocity. This understanding of contaminant migration in groundwater (see Cherry, McWhorter and Parker, 2007 for details) is the basis for the description provided below of how groundwater concentrations representing future site conditions have been selected.

Based on an evaluation of hydrogeologic characteristics, chemical concentrations, source input locations, and well positions, chemical concentrations characterized by well RD-30 (north of the RMHF RFI Site) are considered representative of a source input location (i.e., those that are the highest within an area of impacted groundwater). As such, chemical concentrations in this well were selected to represent concentrations for current direct exposure scenarios. This well was also selected to represent concentrations for future hypothetical exposures that include direct exposure to chemicals in groundwater. However, this is a conservative assumption because current concentrations within source areas are predicted to diminish over time as clean groundwater flows through the source zone.

Further analysis of the transport of chemicals in groundwater was not required for this group report since “source conditions” are characterized by existing wells and have been selected to conservatively represent exposure concentrations. Dissolved concentrations of chemicals in groundwater flowing away from source zones will be lower than those at the source; therefore, the application of any modeling would result in predicted concentrations in plumes lower than those measured in the selected well (RD-30) due to its position at or near the source input location.

This approach is also considered conservative because impacts to groundwater beneath the Group 5 Reporting Area, the closest neighboring area of significant groundwater VOC contamination, are not expected to influence future exposure concentrations within the Group 7 Reporting Area for several reasons:

- Water table gradients and TCE concentration gradients suggest that any expansion of the Process Development Unit (PDU) plume has historically occurred towards the south, away from the Group 7 Reporting Area;
- Groundwater extraction is no longer performed at Group 5 monitoring wells RD-24, RD-25, RD-28, or RD-63, which will further reduce the tendency for chemicals within the PDU plume to migrate toward the Group 7 Reporting Area, and;
- A surface flow divide runs along the boundary between these reporting areas.

As described in Section 1.2.3, groundwater conditions and risk assessment results presented in this report will be re-evaluated when the site-wide groundwater characterization program is complete. Similarly, contaminant migration from Group 7 into surrounding areas, including offsite, will be considered as appropriate in the Site-Wide Groundwater RFI Report.

5.3.4 Surficial Soil/Sediment Migration

A transport and fate discussion is presented here for the Group 7 Reporting Area based on the distribution of site chemicals summarized in Section 4 and presented in the RFI Site Reports (Appendices A through C). Surface water drainage patterns, as shown on Figure 2-7B, were used to evaluate surficial migration for each chemical group.

It should be noted that stormwater Best Management Practices (BMPs) have been installed in the drainage north of RMHF at NPDES Outfall 003. BMPs are intended to remove organic constituents, metals, and suspended solids such that stormwater meets discharge permit standards. An 8 foot gabion (wall) was built to capture stormwater, and direct it through mesh bag filter media filled with activated carbon. Straw wattles have been installed on the hillsides north of RMHF for soil stabilization.

Results presented on Figures 4-1 through 4-6 are described below to illustrate chemical distribution relationships as a basis for a transport and fate discussion. As noted in Section 4, data are presented on figures relative to the lowest appropriate RBSL for the receptors evaluated in this report and/or DTSC-approved background concentration as reference points for overall data distribution. Areas recommended for further consideration in the CMS (see

Section 7) are also shown on these figures to illustrate spatial relationships between these areas and chemical data. Following a description of surface water flow, an evaluation of soil and sediment migration is presented by chemical group.

Surface water flow patterns are described in detail in Section 2 of this report and depicted on Figure 2-7B. A summary of flow patterns is presented here to support the transport and fate evaluation below. All surface water within the Group 7 Reporting Area exists only as intermittent discharge resulting from rain events.

There are two surface water catchment basins represented within the Group 7 Reporting Area (Figure 2-7B). In the north, surface water discharge from the RMHF and B4133 RFI Sites is toward the west, through NPDES Outfall 003 and offsite to BBC and Arroyo Simi in Simi Valley. A drainage originating west of RMHF discharges offsite to BBC and converges with a drainage originating in the Group 8 RFI Reporting Area before converging with the Outfall 003 drainage. In the south, surface water discharges from the Building 4029 RFI Site out the southeast and southwest corners of the site, and flows southwest to the drainage south of Silvernale Reservoir leading to the R-2 Pond (SWMU 5.26).

Surface water has also been discharged from the RMHF Catchment Basin/Stormwater AST to a pipeline that discharges into a lined drainage along 17th Street (Group 5 Reporting Area). Water then flows down 17th Street to G Street and to the unlined 17th Street Pond, which in turn ultimately discharges to the R-2 Pond. Any potential migration of site chemicals in these drainages is addressed in the Group 5 RFI Report.

Surface water is monitored at two established NPDES monitoring locations (Figure 2-7B), Outfall 003 north of the RMHF RFI Site and Outfall 018 south of R-2 Ponds. Flow to the south through Outfall 018 also drains into Bell Canyon and is monitored at Outfall 002, and ultimately flows to the Los Angeles River.

5.3.4.1 VOCs

Group 7 RFI soil VOC results are summarized in Section 4.1 and depicted on Figure 4-1. Detailed evaluations of VOC sampling results by chemical use area are provided in each RFI Site Report (Appendices A through C).

As shown on Figure 4-1 and described in Section 4, VOCs are present at generally low concentrations at several locations within the Group 7 Reporting Area, including BTEX constituents in the area northeast of Building 4133 Tank T-3, methylene chloride and PCE in debris areas, low concentrations of methylene chloride and PCE within the RMHF fenced area and former Building 4021 Leach Field, and low concentrations of methylene chloride at the Building 4029 low spot/discharge area. Drainage samples collected west of Building 4133 and north of RMHF contained low concentrations of styrene (a naturally occurring chemical detected well below RBSLs), but did not contain VOCs detected at these RFI sites. Based on localized VOC impacts at the RFI sites and non detect data in the drainage, surface migration of VOCs in the northern portion of the Group 7 Reporting Area is not indicated. In the southern portion, VOCs are limited to a single detected low concentration in one sample at Building 4029; therefore, the potential for migration to the south via surface transport is considered very low.

5.3.4.2 SVOCs

As described in Section 4.2 and shown on Figure 4-2, SVOCs were mostly either not detected or detected below RBSLs throughout the Group 7 Reporting Area, with only two samples outside the southern RMHF fence line containing benzo(a)pyrene at up to 154 µg/kg. Since drainage samples north of RMHF are either non detect or below RBSLs, sampling data do not indicate significant migration of SVOCs.

5.3.4.3 TPH

As described in Section 4.3 and shown on Figure 4-3, TPH was detected above RBSLs at a few localized areas within the Group 7 Reporting Area, including gasoline range and kerosene range organics northeast of Building 4133, at the nearby Western Debris Area, and at the RMHF. Lubricant oil range organics were detected at widespread locations at all three RFI sites, below RBSLs (up to 493 mg/kg within the Building 4029 access road fill). Lubricant oil range and diesel range organics were detected at very low concentrations (< 5 mg/kg) in the drainage north of RMHF indicating very little migration from the B4133 and RMHF RFI Sites. Lubricant oil range organics detected along the Building 4029 access road are all below RBSLs, and appear largely limited to the swale on the north side of the road.

5.3.4.4 PCBs

As described in Section 4.4 and shown on Figure 4-4, elevated PCB concentrations above RBSLs were detected at three isolated locations at B4133. One area south of the RMHF fence line had three locations with PCBs above the RBSLs. Based on PCB concentrations below RBSLs or non detect results in surrounding samples, and/or downstream drainage samples, sampling data indicate limited migration of these chemicals.

5.3.4.5 Dioxins

As described in Section 4.5 and shown on Figure 4-5, dioxins have been detected at or near background ranges within the Group 7 Reporting Area. Although NPDES monitoring data have exceeded the permit limit twice, site-related source areas are not indicated by the soil sampling data. The NPDES dioxin exceedances are considered likely related to naturally occurring fire ash entrained in sediments following the 2003 Piru Fire.

5.3.4.6 Metals

As described in Section 4.6 and shown on Figure 4-6, concentrations of metals above background were detected at all three Group 7 RFI sites, most prominently sodium and zinc. However, except for these metals, most soil detections above background were generally low and isolated, scattered occurrences without a spatial distribution pattern. Metal concentrations in the drainage north of RMHF were within background ranges; therefore, metals sampling data do not indicate metals migration. At the B4029 RFI Site, with the exception of sodium and zinc, concentrations of metals above background are limited to beneath the building foundation (along cracks). At this site, zinc was detected above background at the low spot/discharge area but decreases to background range a short distance down-slope. South of RMHF, additional characterization of metals near the storm water culvert area is recommended to assess potential contaminant sources.

5.3.4.7 Other Chemicals

One pesticide, 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD), was detected above the RBSL at 200 µg/kg, in an historical sample collected adjacent to the natural drainage north of the RMHF RFI Site, west of NPDES Outfall 003. Pesticides were either not detected or detected below RBSLs in samples collected upstream and downstream within the drainage, indicating that surface water migration of pesticides is not significant. Herbicides were not detected in any screened locations.

5.3.5 Migration from Soil to Groundwater

Group 7 Reporting Area groundwater occurrence and quality are described in Appendix D, which includes an evaluation of potential migration from soil to groundwater for chemicals detected in Group 7 Reporting Area soils. A brief summary is presented below.

VOCs

VOCs, primarily TCE and its breakdown products, were detected in soil and groundwater (above MCLs) and are considered related to site activities at two locations near the RMHF RFI Site. Based on site history and groundwater VOC data, groundwater VOCs are considered related to historical releases at former Building 4021 Leach Field and the former RMHF catchment basin. Groundwater VOCs detected at other Group 7 locations are isolated and sporadic and, based on soil data, are not related to activities at the B4133 or B4029 RFI Sites.

SVOCs

The potential for significant migration of SVOCs from soil to groundwater is considered minimal because they are not very soluble, and only very low, sporadic and non repeatable concentrations have been detected in groundwater. Phthalates are common laboratory contaminants and are not considered related to RFI site activities in Group 7. PAHs have not been detected in Group 7 groundwater.

TPH

The potential for significant migration of TPH is considered low based on the type of hydrocarbon fraction detected in soil (primarily lubricant oil range organics). Gasoline-, diesel-, and kerosene-range hydrocarbons are relatively mobile, while lubricant oil range hydrocarbons are large organic molecules with low mobility, similar to PAHs, PCBs, and dioxins. Groundwater samples have been collected from RD-19 (Building 4133), RD-30, RD-98, and RS-28 (RMHF) for TPH analysis. TPH was not detected in any of these locations. Based on elevated gasoline range organics detected in soil near Building 4133, TPH sampling of RS-25 is recommended since this well has not been sampled for this analysis.

PCBs

The potential for significant PCB migration from soil to groundwater is considered minimal due to the low mobility of PCBs within the subsurface and infrequent, localized detections in soil. In addition, PCBs have historically been analyzed in groundwater samples from recharge areas with high PCBs concentrations in soil (MWH, 2006b), and PCBs were not detected in groundwater.

Nonetheless, groundwater samples were collected from the RMHF RFI Site in August 2008 for PCBs analysis. PCBs were not detected.

Dioxins

Dioxins were detected at concentrations consistent with background in Group 7 soils, so groundwater sampling for dioxins was unwarranted and not performed at Group 7 groundwater wells.

Metals

Because metals have low solubility and high retardation in soils, dissolved metals in groundwater are only considered site-related where:

1) Soil analyses indicate that metals are present in soil with sufficient mass and extent to dissolve and migrate in appreciable quantity;
2) Soil impacts are located where physical conditions (i.e. recharge) or chemical conditions (low pH) are likely to facilitate migration of dissolved metals through the vadose zone into groundwater (e.g. leach fields, ponds, or areas were acids were used and disposed);
3) Groundwater concentrations exhibit spatial trends that are consistent with migration from a potential source in soil (i.e. concentrations are significantly above the GWCC at wells or piezometers that are most likely to be affected based on the location of soil impacts);
4) Groundwater concentrations exhibit temporal trends demonstrating that concentrations above GWCCs are representative of actual groundwater conditions (i.e. not analytical variability).

With the exception of zinc and sodium, soil metals above background in the Group 7 Reporting Area were isolated and sporadic, with individual metals exceeding background in only one or two locations. Moreover, groundwater metals exceedances of GWCCs were also sporadic and not repeated in individual wells. Zinc and sodium were not detected in

groundwater above GWCCs. Based on these data metals in groundwater within the Group 7 Reporting area are not considered site related.

Perchlorate

Perchlorate has not been detected in soil samples collected from 20 RMHF locations. A single sample collected from RS-25 northeast of RMHF contained a reported 2.1 µg/L perchlorate (perchlorate was not used at this site). Perchlorate was not confirmed in subsequent samples, and is not considered related to current site conditions at Group 7 RFI sites.

5.3.6 Airborne Dispersion

VOCs detected in the subsurface were modeled to enter the air and disperse downwind. The exposure point concentrations for outdoor air VOCs are presented in the risk assessment spreadsheets that are provided in Appendix E, Attachment E-7.

5.3.7 Dust Generation

SVOCs, PCBs, dioxins, and metals in soil were modeled in airborne dust generated from soil within the Group 7 Reporting Area. The exposure point concentrations for these chemical classes in dust are presented in the risk assessment spreadsheets provided in Appendix E, Attachment E-7.

6.0 RISK ASSESSMENT SUMMARY

This section presents and integrates the risk assessment findings for the Group 7 Reporting Area following current DTSC-approved methodologies and receptors. Human health and ecological risks for the three Group 7 RFI sites are presented in Appendix E. Summaries of the site-specific risk findings are presented in Section 4 in each of the RFI Site Reports (Appendices A through C). The details of how the risk assessments have been performed are presented in the SRAM Work Plan, Revision 2 (MWH, 2005b), and in Appendix E of this report.

Two types of potential risks are presented in the RFI site reports and in this section:

1) Human health risks based on total exposures: surficial media (e.g., soil and sediment) plus indirect groundwater (i.e., vapor migration).
2) Ecological hazard estimates.

The receptors included in the human health risk assessment (HRA) are the current potential trespasser, and the future resident and recreator. Since the current potential trespasser and future recreator have the same exposure parameters, they are presented together as the recreator. While both direct (drinking water) and indirect (vapor) exposures were evaluated in the risk assessment (Appendix E), only indirect exposures are presented here because there is no current or planned future use of groundwater for drinking water. A generalized conceptual site model (CSM) for human receptors is shown on Figure 6-1.

As described in the SRAM, both central tendency exposures (CTE) and reasonable maximum exposures (RME) are evaluated to provide risk managers with a range of results. The CTE is defined as the most appropriate (data-specific) mean of the data and the RME is defined as the 95 percent upper confidence limit on the most appropriate (data-specific) mean. The risk dataset is a subset of the entire RFI site dataset screened for data-usability. Both non cancer Hazard Indices (HIs) and Incremental Lifetime Cancer Risks (ILCRs) are presented as totals for all chemicals evaluated in the risk assessment.

The Ecological Risk Assessment (ERA) was designed to assess exposures and potential risks to terrestrial plant communities, soil invertebrate communities, and wildlife (i.e., birds and mammals) populations, as appropriate for each RFI site. Representative species were identified to further focus the ERA analysis. The ecological receptors included in the ecological risk assessment (ERA) are terrestrial plants, the deer mouse (*Peromyscus*

maniculatus), hermit thrush (*Catharus guttatus*), red-tailed hawk (*Buteo jamaicensis*), bobcat (*Lynx rufus*), mule deer (*Odocoileus hemionus*), and soil invertebrates for terrestrial areas. Since there is no aquatic habitat at the Group 7 RFI Sites, aquatic receptors were not evaluated. A generalized CSM for ecological receptors is shown on Figure 6-2.

During the September/October 2005 Topanga Fire, most of the vegetation at the B4029, B4133, and RMHF RFI Sites was burned, and significant ash was deposited across the Group 7 Reporting Area, especially in drainages. Generally, in areas with limited vegetation (e.g., rock outcrops or developed areas), effects of the fire were minimal. Areas with more vegetation (e.g., trees and chaparral), including surface water drainages, were impacted significantly by burning and deposition of ash. Currently, the plant community in these burned areas is in a transitional state, and early post-fire plant species are growing. It is expected that the plant community will continue to grow and transition until a more stable plant community is established.

The majority of the former operational areas of the RFI sites is comprised of ruderal habitat, non-native grassland, coast live oak woodland, bedrock outcrops and developed land. Other vegetation types include chaparral and native scrub. Ruderal vegetation predominantly occurs near the B4029 and B4133 RFI Sites. Coastal scrub, coast live oak woodland, and chaparral vegetation occur north and west of the RMHF RFI Site.

Sensitive species present at and near the Group 7 RFI sites are the Santa Susana tarplant, the Coastal Western Whiptail, legless lizard, ring-neck snake, rufous-crowned sparrow, and sage sparrow. To conduct a protective assessment, either Ecological Screening Levels (ESLs) or chronic no-observable-adverse-effect-level-equivalent (NOAEL-equivalent) TRVs were used to evaluate potential risks. Ecological risks are presented as hazard quotients (HQ) for all chemicals and total HI for specific chemical groups (i.e., PAHs, Aroclors, dioxins and furans, and PCB congeners) evaluated in the ERA.

Receptors with large home ranges (e.g., hawk, bobcat, and mule deer) may be exposed to chemicals at multiple RFI sites both within and outside Group 7 as well as spending time in non-contaminated areas. The estimated risks to the hawk, bobcat, and mule deer, presented in this RFI report, assume that these species spend all of their time at the RFI site. This assumption is unlikely to be true and it results in overestimates of potential risks to these species. The reported foraging ranges for these species are at least one order of magnitude larger than the contaminated areas of the RFI sites.

Potential risks have been calculated for each of the three Group 7 RFI sites separately. The reader may also want to refer to Figure 5-1, which is a diagrammatic representation of an illustrated CSM for the SSFL, including the contaminant sources, direct and indirect exposure pathways and receptors. RFI site-specific human health and ecological CSMs are presented in Attachments E1 through E3 of Appendix E.

In the following sections, estimated potential risks for each of the three Group 7 RFI sites are presented. Table 6-1 and Table 6-4 present information regarding chemicals evaluated in the risk assessment, Tables 6-2 and 6-5 present human and ecological risk estimates, respectively, and Tables 6-3 and 6-6 present uncertainties in the Group 7 RFI risk evaluation.

6.1 ACCEPTABLE RISKS

Acceptable risks for humans are summarized in the following statements. For comparison purposes, theoretical excess upper bound ILCRs of 1×10^{-6}, or less, associated with multi-media exposures are considered acceptable. The 1×10^{-6} risk level is the generally-accepted point of departure for selection of remedial alternatives. Potential risk estimates that are between 1×10^{-6} and 1×10^{-4} require risk management decisions. Risk estimates greater than 1×10^{-4} usually require remediation to reduce potential exposures. Likewise, non-cancer HI values less than 1 are considered acceptable, and HI values greater than 1 usually require remediation to reduce potential exposures (DTSC, 2006; USEPA, 1993). Blood lead concentrations less than 10 micrograms per deciliter (µg/dL) are generally considered acceptable, while concentrations greater than 10 µg/dL usually require remediation to reduce exposures (DTSC, 1992).

Acceptable risks for ecological receptors are summarized in the following statements. For comparison purposes, HQ or HI values less than 1 represent conditions that would not cause unacceptable ecological impacts. HQ or HI values greater than 1 typically require additional evaluation, and may be deemed acceptable or unacceptable by risk managers.

These criteria are provided to assist the reader in interpreting the risk estimates presented in this report, as they served as the basis for the CMS site action recommendations.

6.2 CONSERVATISM AND UNCERTAINTY IN RISK ASSESSMENT RESULTS

Both human and ecological risk assessment are based on a series of assumptions and parameters. There is inherent and intentional conservatism in the use of these assumptions

and parameters and also uncertainty. To assist interpretation of the risk assessment results presented in this section, the main sources of conservatism and uncertainty are listed below and in Tables 6-3 and 6-6:

- As described in Section 1.0, some additional soil samples were collected at the B4029 and RMHF RFI Sites after the site risk assessment was completed. Data for these additional samples could not be assessed quantitatively, which results in some uncertainty. Uncertainties associated with these findings include:
  - At the B4029 RFI Site, the additional samples were analyzed for SVOCs, PCBs, and TPH. No SVOCs or PCBs were detected in these samples, and the concentrations of detected TPH compounds were within the range of concentrations previously detected and evaluated in the risk assessment. Consequently, including the additional data in the quantitative evaluation would not significantly change risk calculations or overall risk assessment conclusions for this site.
  - At the RMHF RFI Site, the additional samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH, and metals. VOC, TPH, and pesticide compounds were detected at concentrations similar or lower than the concentrations detected previously, and PCBs were detected at substantially lower concentrations. Therefore, including the additional data for these compounds would not affect the overall conclusions of the risk assessment. Several PAHs and a few metals were detected in the additional samples at concentrations greater than those detected previously. As a result, risk estimates for these compounds were likely underestimated for this site. However, the additional samples with higher concentrations of PAHs and metals are located in areas proposed for further evaluation during the CMS.
- A number of inorganics (e.g., cadmium, cobalt, copper, selenium, and zinc) were statistically consistent with background concentrations, but were included as soil chemicals of potential concern (COPCs) and/or chemicals of potential ecological concern (CPECs) because maximum detected concentrations were approximately 2 times the maximum detected background concentration. (conservatism)
- Where TPH-gasoline was selected as a COPC and/or CPEC, BTEX was assumed to be present and was addressed appropriately in the risk assessment. (conservatism)
- Where TPH-kerosene, diesel, and lubricant oil were selected as COPCs and/or CPECs, PAHs were assumed to be present. Extrapolation of TPH concentrations to individual PAHs is likely conservative when PAHs are not directly detected in soil samples. (conservatism)
- Burrow air concentrations likely result in an overestimation of risk because the model is conservative and the use of deeper soil vapor concentrations does not account for attenuation. (conservatism)
- The maximum detected concentration of each COPC detected in groundwater was used as the exposure point concentration (EPC). (conservatism)

- Vapor migration from groundwater was estimated using a model not yet validated for the SSFL. However, a report of field validation tests has been submitted to the DTSC, and migration estimates may change once the model is approved. (uncertainty)
- The HRA assumes that all carcinogens do not have a threshold below which carcinogenic responses do not occur. (conservatism)
- The USEPA uses the linearized multistage (LMS) mathematical model to extrapolate animal toxicological data for carcinogens in the HRA. The LMS model assumes that there is no threshold for carcinogenic substances. Several factors inherent in the LMS model that result in conservative carcinogenic potency include: (1) any exaggerations in the extrapolation that can be produced by some high dose responses (if they occur) are generally neglected; (2) upper confidence limits on the actual response observed in the animal study are used rather than the actual response, resulting in upper-bound low dose extrapolations, which can greatly overestimate risk; and (3) non-genotoxic chemicals (i.e., threshold carcinogens) are modeled in the same manner as highly genotoxic chemicals. (uncertainty)
- Dermal and inhalation exposure pathways for surface-dwelling animals were not included in the ERA. (uncertainty)
- The estimated risks to large-home range receptors (e.g., hawk, bobcat, and mule deer) assume that these species spend all of their time at an individual RFI site. There is a high degree of uncertainty in this assumption, and it substantially overstates the risks to these species. Estimates to large-home range receptors will be addressed once sufficiently large areas of SSFL have been evaluated and the results have been presented in this and other Group RFI Reports. Potential cumulative exposures and risks will be reported in the Site-Wide Large Home Range Risk Assessment Report. (uncertainty)
- Extrapolation of toxicological data from animal tests is one of the largest sources of uncertainty in a HRA. In the establishment of the non-carcinogenic criteria, conservative multipliers, known as uncertainty factors, are used. For example, an uncertainty factor of 1,000 means that the dose corresponding to a toxicological effect level is divided by 1,000 to establish a safe, or “reference,” dose. The purpose of the uncertainty factor is to account for the extrapolation of toxicity data from animals to humans and to ensure the protection of sensitive individuals. (uncertainty)
- Some data collected following the 2005 Topanga Fire contained potentially elevated concentrations of metals related to ash. All data were included in the risk assessment. (conservatism)

6.3 SUMMARY OF RFI SITE RISKS

A summary of the individual RFI site potential risks is presented below. This includes the human health risks for the residential and recreational scenarios. For ecological risks, terrestrial and avian receptors have been evaluated, as appropriate, for the given site conditions. Risks from contaminants in surficial media are presented by RFI site.

6.3.1 B4029 RFI Site Risk Estimates

RME ILCR estimates (for all terrestrial surficial media, plus indirect exposure to VOCs in groundwater) ranged from 5 x 10^{-8} (for future child recreator) to 2 x 10^{-7} (for future child resident). RME HIs ranged from <0.001 (for future adult recreator) to 0.07 (for future child resident). These estimated risks are below the acceptable risk range typically used for CMS decisions.

Lead in soil was not selected as a COPC for the B4029 RFI Site; therefore, blood lead levels associated with soil exposures were not calculated.

Ecological hazard estimates have also been estimated for the B4029 RFI Site. The deer mouse, hermit thrush, red-tailed hawk, and bobcat had estimated HQs that are greater than 1, while the mule deer had estimated HQs and HIs below 1. Chemicals with HQs greater than 1 include barium and zinc. Estimated HQs for soil invertebrates are all less than 1. No adverse effects on the health or productivity of native plant species were observed within areas potentially impacted by chemicals of potential ecological concern (CPECs).

6.3.2 B4133 RFI Site Risk Estimates

RME ILCR estimates (for all terrestrial surficial media, plus indirect exposure to VOCs in groundwater) range from 2 x 10^{-7} (for future adult and child recreator) to 7 x 10^{-7} (for future child resident). RME HIs ranged from 0.009 (for adult recreator) to 0.4 (for future child resident). These estimated risks are below the acceptable risk range typically used for CMS decisions.

Lead in soil was not selected as a COPC for the B4133 RFI Site; therefore, blood lead levels associated with soil exposures were not calculated.

Ecological hazard estimates have also been estimated for the B4133 RFI Site. The deer mouse, hermit thrush, and mule deer had estimated HQs and HIs that were greater than 1, while the red-tailed hawk and bobcat had estimated HQs and HIs below 1. Chemicals with HQs or HIs greater than 1 include total Aroclors and cadmium. Estimated HQs for soil invertebrates are all less than 1. No adverse effects on the health or productivity of native plant species were observed within areas potentially impacted by chemicals of potential ecological concern (CPECs).

6.3.3 RMHF RFI Site Risk Estimates

RME ILCR estimates (for all terrestrial surficial media, plus indirect exposure to VOCs in groundwater) ranged from 1 x 10^{-6} (for future child recreator) to 5 x 10^{-6} (for future child resident). RME HIs ranged from 0.007 (for future adult recreator) to 0.3 (for future child resident). The ILCR estimates are above the acceptable risk range typically used for CMS decisions. The chemical with the greatest contribution to these potential risks was Aroclor 1260 in soil. The estimated HIs are below the acceptable risk range typically used for CMS decisions.

Lead in soil was not selected as a COPC for the RMHF RFI Site; therefore, blood lead levels associated with soil exposures were not calculated.

Ecological hazard estimates have also been estimated for the RMHF RFI Site. The deer mouse, hermit thrush, red-tailed hawk, and mule deer had estimated HQs and HIs that were greater than 1, while the bobcat had estimated HQs and HIs below 1. Chemicals with HQs or HIs greater than 1 include total Aroclors, cadmium, copper, selenium, and zinc. Estimated HQs for soil invertebrates are all less than 1. No adverse effects on the health or productivity of native plant species were observed within areas potentially impacted by chemicals of potential ecological concern (CPECs).

6.4 CHEMICAL RISK-DRIVERS

A few chemicals significantly contribute to the estimated human and ecological risks within the Group 7 Reporting Area. The identified chemical risk-drivers, and significant risk contributors, are used as a basis for the CMS site action recommendations. Since the estimated risks are different for the various receptors (residential, recreational, and ecological) and for the various environmental matrices (soil/sediment versus groundwater – indirect exposures), the chemical risk drivers and contributors for the Group 7 Reporting Area are summarized below using these divisions.

Residential

- The only soil/sediment risk driver is Aroclor 1260. There are no groundwater risk drivers. For soil/sediment, risk contributors include benzene, methylene chloride, gasoline range organics, 1,2,4-trimethylbenzene, BaP, and Aroclor 1254. New sampling results, not quantitatively addressed in the risk assessment, indicate that cobalt may also be a risk contributor.

Recreational

- There are no risk drivers for recreator pathways. Aroclor 1254 is identified as a risk contributor.

Ecological

- Soil/sediment risk drivers include total Aroclors, barium, cadmium, copper, selenium, and zinc, and cobalt is identified as a risk contributor. New sampling results, not quantitatively addressed in the risk assessment, indicate that silver may also be a risk contributor.

6.5 CONCLUSIONS

The HRAs and ERAs completed for the three Group 7 RFI sites were based on the characterization findings presented in Appendices A B, and C. The risk assessments have estimated human health and ecological risks both below and within the acceptable range typically used in the CMS. These risk estimates and identified risk drivers and contributors are appropriate for use in CMS decision-making for the residential, recreational, and ecological receptors evaluated following currently approved methodologies.

7.0 GROUP 7 RFI REPORT SUMMARY AND SITE ACTION RECOMMENDATIONS

This section presents a summary of RFI reporting requirements as they apply to the Group 7 RFI Report. Section 7.1 describes how this report meets current RFI reporting requirements, particularly the identification of areas for further work, or 'site action' recommendations. The process and criteria used for making site action recommendations is described in Section 7.2, and site action recommendations for the Group 7 Reporting Area are summarized in Section 7.3.

7.1 RFI REPORTING REQUIREMENTS

As described in regulatory guidance documents for the SSFL RCRA Corrective Action Program (see Section 1.2.3), the purposes of the RFI are to: (1) characterize the nature and extent of contamination, and identify potential source areas; (2) assess potential migration pathways; (3) estimate risks to actual or potential receptors; and (4) gather necessary data to support the CMS (DTSC, 1995). The RFI Report is required to: (1) present findings regarding the above information; (2) describe completeness of the investigation; and (3) indicate if additional work is needed. Regulatory guidance indicates that additional work can be identified as a second phase of the RFI, as part of the CMS, or as interim corrective measures to stabilize source areas and control potential contaminant migration (DTSC, 1995).

The Group 7 RFI Report accomplishes these requirements for the receptors evaluated using currently approved risk assessment methodologies by:

- Presenting detailed source area identification, characterization findings, and investigation completeness determinations by media and by chemical class for chemical use areas and, when appropriate, associated down-drainage locations for each of the three RFI sites in the Group 7 RFI Reporting Area. Section 4 summarizes the overall characterization of chemical contamination nature and extent, potential source areas, and an assessment of investigation completeness for the entire reporting area. Assessments of investigation completeness have been made for the known or potential chemical use areas identified in this report based on sampling results, using professional judgment, and considering historical site operations, chemical data concentration gradients or trends, and RBSLs and risk assessment findings for residential, recreational, and ecological receptors. The RFI site characterization details are provided in Appendices A, B, and C.

- Presenting summaries of the groundwater migration pathways for the entire reporting area and presenting a detailed, group-wide surface water pathway evaluation in Section 5. Details of the groundwater migration pathway are presented in Appendix D, and other potential transport pathways in Appendix E.
- Identifying potential receptors (residential, recreational, and ecological) and estimating potential risks at each RFI site in Appendix E. Estimated risks are also summarized by RFI site in Appendices A, B, and C, and presented for the entire reporting area in Section 6.
- Identifying areas requiring further work by RFI site for chemicals in surficial media in Appendices A through C, and for the entire reporting area in this section. Section 7.2 describes the process and criteria used to develop site action recommendations, and Section 7.3 presents the result of applying this process for the Group 7 Reporting Area.

Regulatory guidance for RFI reporting also requires that field procedures used for the investigation, quality assurance program effectiveness, data validation results, and sampling or laboratory 'upset' conditions be described (DTSC, 1995). This information is provided for the surficial media investigation in the RFI Program Report (MWH, 2004a). Additional site-specific application of general procedures, recent laboratory and validation reports, and data quality assessments are provided for each Group 7 RFI site in Appendices A, B, and C.

7.2 BASIS FOR SITE ACTION RECOMMENDATIONS

Site action recommendations include identification of areas requiring further work as required by regulatory guidance for RFI reporting (DTSC, 1995), and identification of areas where NFA is warranted. Additional work can be completed as a second phase of the RFI, as part of the CMS, or as interim corrective measures to stabilize source areas and prevent contaminant migration. In the Group RFI Reports, evaluation of potential remediation areas is recommended for the CMS, and interim corrective measures for some CMS Areas are recommended to stabilize source areas while cleanup plans are prepared. These recommendations are consistent with the RCRA Corrective Action Program goals and serve to move the project forward to cleanup.

Following regulatory requirements (DTSC, 2007b), a CMS work plan that describes actions to be conducted during the CMS has been prepared for agency review and approval[ii]. During the CMS, site areas recommended for further consideration will undergo additional

[ii] As described in Section 1.2, the regulatory framework for cleanup at the SSFL is expected to transition to the RI/FS process, so the CMS Work Plan was submitted as a FS Work Plan (MWH, 2009x); RCRA terminology is retained in this RFI Report for consistency with other Group reports.

evaluation to determine if cleanup is needed, how much cleanup is necessary (if any), and which cleanup technologies should be used during the CMI phase.

As noted in Section 1.2.1, the determination of characterization and risk assessment requirements associated with SB990 is ongoing. Once these determinations are made, RFI Group documents (including the site action recommendations provided herein), will be reviewed and revised as appropriate. The evaluation and site action recommendations presented below are based on an evaluation of chemical impacts and risk assessment findings for residential, recreational, and ecological receptors performed using currently approved RFI work plans for characterization and risk assessment.

In summary, site action recommendations for chemicals in surficial media included in the Group 7 RFI Reports identify areas for:

- Further evaluation in the CMS (CMS Areas).
- NFA Areas.
- Interim corrective measures to stabilize source areas and control contaminant migration (Stabilization Areas).

Site action recommendations are based on information in historical documents, site characterization data, and risk assessment findings. Historical document review findings are used to determine areas of potential chemical use and identify areas for additional RFI sampling and characterization. Characterization findings provide definition of the nature and extent of site chemical contaminants, based on chemical data and transport and fate evaluation. Risk assessments evaluate chemical characterization data and estimate human health and ecological risks based on specified land use scenarios, and identify chemicals that drive or contribute to those risks.

Based on the review and evaluation of extensive historical records and environmental sampling data collected prior to and during the RFI, additional sampling was performed in areas where chemicals were potentially used, handled, stored, or released within the Group 7 Reporting Area. Samples were also collected in areas where the existing chemical analytical data were considered to be inadequate for site characterization and/or risk assessment (including down-gradient locations). Similarly, for areas where no historical chemical use, storage, or handling was indicated in the historical documents (i.e., for areas determined to have very limited or no potential for environmental concern), no samples were collected.

Based on the documents reviewed and nearby sampling results, if any, these non-chemical use areas are recommended for NFA based on the current evaluation.

CMS or NFA Area recommendations for areas sampled within the Group 7 Reporting Area are based on an integrated evaluation of characterization and risk assessment results for the receptors evaluated. Information in the historical documents indicating past chemical use practices and areas, coupled with site characterization data indicating environmental impacts or lack thereof, provide a solid basis for the NFA and CMS recommendations for chemicals in surficial media made in this report. Stabilization Area recommendations rely on characterization evaluations, including transport and fate analysis, and comparison to risk-based levels. The recommendations process for the sampled areas is described further below.

CMS and NFA Area Site Action Evaluation Process

CMS or NFA site action recommendations for chemicals in surficial media are based on a 4-step process, described below, that evaluates risk assessment results for residential, recreational, and ecological receptors in the context of characterization results and considers potential migration from identified source areas. Site action recommendations are made in this Group Report for surficial media based on characterization and risk assessment results from all media. However, because groundwater characterization is ongoing, CMS recommendations for groundwater will be made in the Site-Wide Groundwater Report as described in Section 1.

- **Site Action Evaluation Step 1.** Risk assessment results for current or potential human and ecological receptors are compared to "acceptable" levels published by the USEPA or DTSC as guidance for site managers (DTSC, 1992; USEPA, 1992). In cases where acceptable risks are specified as a range of values (see Section 6.1), the low end of the risk range (i.e., 1×10^{-6}, or 1 in 1,000,000) is used to conservatively estimate the aerial extent that is recommended for further evaluation in the CMS for the receptors evaluated. During the CMS, data for these recommended areas will be further evaluated using the entirety of the acceptable risk ranges specified in regulatory guidance to make appropriate recommendations for cleanup.
- **Site Action Evaluation Step 2.** When estimated RFI site risks are greater than 1×10^{-6} (cancer risks) or HI values are greater than 1 (non cancer and ecological risks), each RFI site's risks are reviewed on a chemical-by-chemical basis to identify risk drivers and significant risk contributors to cumulative, total risk for each evaluated receptor. Risk drivers are detected chemicals with associated risks greater than 1×10^{-6} or HI values above 1. Risk contributors are those chemicals that contribute to total risk, but where individual chemical-associated risk is less than 1×10^{-6} or HI values are less than 1. Individual chemical contribution to total risk was conservatively considered at risk levels of approximately 2×10^{-7} (cancer risk) or

at HI values of about 0.2, but the identification of risk contributors was a best-professional-judgment decision. These risk contribution departure evaluation points are approximate and may vary based on the chemical type detected and the individual chemical risk or hazard estimated.

- **Site Action Evaluation Step 3.** Characterization findings from across the entire Group Reporting Area are reviewed to spatially identify areas where higher concentrations of risk drivers and contributors are detected. The identified areas are termed in this report 'CMS Areas' and represent locations recommended for further evaluation of chemicals during the CMS. Areas recommended for further evaluation during the CMS are comprehensive of all receptors and land use scenarios evaluated following currently approved RFI work plans. During the CMS, estimated risks and chemical drivers and contributors will be evaluated further, and cleanup levels will be established with agency approval. Therefore, 'CMS Areas' recommended during the RFI may change during the CMS.
- **Site Action Evaluation Step 4.** Uncertainties identified in RFI characterization and risk assessments (see Section 6.2) that affect findings are addressed. In some cases, chemical areas are recommended for evaluation in the CMS as a result of these uncertainties. For example, some chemicals are assumed to be present in soil based on TPH extrapolation factors (e.g., benzene and PAHs) and contribute to total risk for the RFI site above acceptable levels. In these cases, 'CMS Areas' have been identified for evaluation because of the uncertainties associated with the extrapolation used in the risk assessment. Since this assumption is often highly conservative, its use as a basis for CMS recommendations may be further evaluated in the CMS, or addressed prior to the CMS during DTSC review of this report.

After this 4-step process is completed, site action recommendations are made for chemicals in surficial media within the Group Reporting area. These are tabulated by RFI site chemical use area, and chemical risk drivers/contributors are identified for each evaluated receptor. CMS Areas are also depicted graphically to illustrate location and approximate aerial extent. Areas shown are intended to be comprehensive of the receptors and land use scenarios evaluated. Based on historical document review findings and the conservative approach used for risk assessment, and to make site action recommendations for the CMS described above, locations outside of the CMS Areas are recommended for NFA for the receptors evaluated.

It is worth noting that extents of the CMS Areas depicted graphically are conservative and likely over-estimated for the receptors evaluated. As described in Step 3 above, CMS Areas are based on identifying chemical concentrations that are above their respective RBSLs. This process results in CMS Areas that are larger than would need to be addressed during chemical cleanup to achieve acceptable risks for residential, recreational, and/or ecological receptors. This is because individual soil sample results rather than area-average

concentrations are compared directly to RBSLs. Area-averaged concentrations will be used in the CMS to refine the cleanup extent at these recommended CMS Areas.

Two additional aspects of RFI reporting will serve to finalize the areas recommended in Group RFI Reports for evaluation in the CMS. The first is an ecological evaluation for large-home range receptors (e.g., mule deer, bobcat, and hawk). Assessment of potential risks to these receptors due to cumulative exposures at multiple RFI sites within the SSFL will be performed once sufficiently large areas of the SSFL have been evaluated and the results have been presented in Group RFI Reports. Potential cumulative exposures and risks will be reported in the Site-Wide Large-Home Range Risk Assessment Report. The second is a groundwater evaluation that will be reported in the Site-Wide Groundwater RFI Report. In this report, future groundwater use and concentrations will be evaluated to estimate the contribution to overall risks. Surficial media site action recommendations made based on these two evaluations will augment those presented in the Group RFI Reports.

Therefore, the chemical areas recommended for further evaluation in the Group RFI Reports can be confidently carried forward into the CMS since these additional evaluations, as well as any additional SB990 requirements, will identify areas to be added to, not removed from, subsequent CMS decision-making.

It is worth noting that criteria other than characterization and risk assessment results can be applied during the CMS to identify areas for further evaluation. Additional criteria may include evaluation of other regulatory criteria (e.g., permit limits or requirements), aesthetics, or public input during the CMS and EIR process.

Source Area Stabilization Site Action Evaluation Process

Chemical data collected during the RFI are evaluated for chemical contaminant migration as described in Section 5 of this report. Resulting site action recommendations focus on stabilization measures related to sediment transport via the surface water pathway. Other migration pathways (e.g., groundwater and vapor) may also be considered in the Group RFI Reports, depending on conditions encountered. Criteria considered for those recommendations would be based on site-specific conditions and described as necessary in the Group RFI Report.

Criteria used to evaluate if source area stabilization measures are needed to control surface water migration include:

- Presence of concentrations above background or RBSLs in surficial (not deeper) soils.
- Proximity of surficial source area to an active surface water drainage pathway or sensitive ecological receptors.
- Moderate to steep topography.
- Absence of containment features (e.g., surface coatings, dams).
- Chemical concentration gradients.

Each criterion is considered important, and a weight-of-evidence evaluation is used to make a recommendation for chemical source area stabilization measures. For example, if high concentrations were identified in surficial soils, but if they are present in a topographically low area (e.g., a retention pond) with no or limited surface flow conditions, then a recommendation for stabilization would not be made. Concentration data are compared to RBSLs to evaluate magnitude of impact, but a strict threshold has not been developed given the importance of the other criteria.

Source area stabilization measures to prevent migration to surface water may use BMPs such as installation of straw bales, fiber rolls, or silt fencing, or covering areas with plastic tarps. Soil or sediment that meets the criteria identified above but is present within or above man-made liners (asphalt- or concrete-lined ditches, swales, sumps, or pits) will be recommended for removal as part of facility maintenance actions.

Erosion control measures have been applied to many surficial soil source areas at the SSFL. These are described in the SSFL Storm Water Pollution and Prevention Plan (SWPPP) (MWH, 2006a). This document is regularly updated and describes the types and locations of BMPs, including installation and maintenance associated with each control measure.

7.3 RECOMMENDATIONS FOR GROUP 7 REPORTING AREA SITES

Based on the evaluations presented in this document, data collected for the Group 7 Reporting Area are considered sufficiently complete to make site action recommendations for the receptors evaluated as described above, and to support evaluations to be performed during the CMS. Although additional data may be necessary to support some CMS evaluations, those data can be collected either in a subsequent phase of the RFI or as part of

the CMS. Information in the historical documents indicating past chemical use practices and areas, coupled with site characterization data indicating environmental impacts or lack thereof, provide a solid basis for the NFA and CMS recommendations made in this report for residential, recreational, and ecological receptors.

Group 7 site action recommendations for chemicals in surficial media are listed in Table 7-1 and presented on Figure 7-1. Table 7-1 lists CMS or NFA recommendations and includes identification of chemical risk drivers and contributors for each exposure scenario. Source area stabilization recommendations were recommended for one CMS area based on the evaluation described above. CMS Areas shown on Figure 7-1 are comprehensive and represent evaluations inclusive of the receptors and land use evaluated. A summary of the Group 7 CMS Area recommendations is presented in Table 7-2. As described above, recommendations reported in this document will be reviewed upon completion of the site-wide groundwater report and large-home range receptor evaluations, as well as when SB990 uncertainties are determined, and updates to this report will be prepared as needed.

Group 7 areas recommended for further evaluation of chemicals in the CMS, including associated chemical drivers/contributors and areas identified for surficial soil source stabilization measures, are summarized below for the receptors evaluated. Portions of Group 7 outside of these CMS Areas are recommended for NFA for the receptors based on chemical characterization and historical record review findings.

CMS Areas

A total of six CMS Areas were identified for the Group 7 RFI Sites (Table 7-2, Figure 7-1), including:

- **B4133-1**: Area North of Building 4133 (Aroclor 1254).
- **B4133-2**: Area Northeast of Building 4133 (benzene; gasoline range organics; 1,2,4-trimethylbenzene).
- **RMHF-1**: South Fence Excavation Area (Aroclor 1260, benzo(a)pyrene).
- **RMHF-2**: Waste Receiving Yard Area (benzene, methylene chloride).
- **RMHF-3**: Northeast Slope Area (cadmium, cobalt, zinc).
- **RMHF**-4: Southern Culvert Area (cobalt, copper, silver, zinc)

Stabilization Areas

One Stabilization Areas was identified for the Group 7 CMS Areas, at RMHF-4 since the impacted soil is immediately adjacent to a storm drain.

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9.0 GLOSSARY AND DEFINITION OF TERMS

Alluvium

A general term used to describe unconsolidated soils deposited by water (e.g., streams, rivers). At the SSFL these deposits occur above bedrock.

AOC – Area of Concern

A portion or site at a RCRA facility identified by the United States Environmental Protection Agency (USEPA) during the RCRA Facility Assessment (RFA) that may have used, stored, or handled chemicals that could potentially cause a threat to human health or the environment.

CF – Chatsworth formation

The geologic name of the bedrock that occurs at the SSFL. The bedrock consists predominantly of sandstone and some finer-grained siltstone and shale units. Forms the large exposed outcrops (bluffs) on the hills near the site and occurs at depth beneath the surficial soils.

CFOU - Chatsworth Formation Operable Unit

Refers to the portion of the SSFL RCRA Corrective Action Program that includes investigation of unsaturated and saturated bedrock and deep groundwater within the unweathered CF bedrock.

Chemical Risk Driver

A chemical identified in the risk assessment to be a major contributor to the estimated cumulative risk.

CMI – Corrective Measure Implementation

The fourth phase of the RCRA Corrective Action Program. This phase occurs when the sites are cleaned up to meet the standards set by the DTSC in the CMS.

CMS – Corrective Measures Study

The third phase of a RCRA Corrective Action Program. In this phase, types of cleanup methods are evaluated and selected. Public comment is requested on the findings of the CMS report before cleanup is conducted in the Corrective Measures Implementation (CMI).

Colluvium

A general term used to describe unconsolidated soils or material located at the bottom of a slope or cliff that were mainly transported by gravity.

COPC – Chemical of Potential Concern

A chemical identified during the risk assessment that may pose a risk or hazard to human receptors.

CPEC – Chemical of Potential Ecological Concern

A chemical identified during the risk assessment that may pose a hazard to ecological receptors.

CTE - Central tendency exposure

Refers to the average chemical exposure for a receptor, based on a simple mathematical average of exposures at a site.

Data Validation

A quality control procedure where a qualified chemist reviews the laboratory data from samples collected during the RFI. The chemist reviews laboratory procedures to make sure the data is acceptable to use as reported. In some cases, the reviewing chemist 'qualifies' the data so that it should be considered to be estimated, or that it should be rejected. Rejected data is not used in the risk assessment, but estimated data can be. Decisions made using estimated data are always carefully considered.

Discrete Depth Monitoring Point

A device placed in a monitoring well or borehole that allows collection of groundwater samples from small sections of the groundwater system. The device has small openings (typically 1 to 10 feet, depending on the type of system used) that are separated by 'blanks' that are closed to the groundwater system, allowing discrete depth intervals of the groundwater to be monitored. At the SSFL, the type of device installed in some of the deep monitoring wells is a flexible liner known as a FLUTe.

DTSC - California Environmental Protection Agency, Department of Toxic Substances Control

The regulatory agency overseeing the RCRA Corrective Action Program investigation and cleanup of the SSFL.

Drainage Basin

The land area where precipitation runs off into streams, rivers, lakes, and reservoirs. Similar to watershed.

EPCs – Exposure Point Concentrations

Concentrations used to calculate risk for a chemical if selected as a Chemical of Potential Concern (COPC) in the human health risk assessment or as a Chemical of Potential Ecological Concern (CPEC).

FAL – Field Action Level

A chemical concentration in soil used to help determine if additional sampling is necessary. FALs were developed for the RFI field program at the SSFL, and were approved by DTSC in the RFI work plan. The FALs are general guidelines for making field decisions; final evaluation of data completeness and risks posed by chemicals is done in the RFI report and risk assessment.

Fill

Rock, soil, or other materials that were deposited by man. Includes soils or material that may have been moved or re-distributed locally.

FLUTe – Flexible Liner Underground Technology®

A depth-discrete groundwater sampling mechanism used in open-borehole wells. As it is lowered into the well, the flexible rubber 'sock' liner is inverted and filled with water to seal it against the wall of the borehole. Samples are collected by displacing groundwater with nitrogen pumped through small-diameter tubes.

HI - Hazard Index

A number that is the sum of hazard quotients (see below), and represents the total estimated level of non-cancer human health risk or ecological risk associated with exposure to chemicals. A HI less than 1 is generally considered acceptable.

HQ - Hazard Quotient

A number that indicates an estimated level of non-cancer human health risk or ecological risk associated with exposure to a single chemical. A HQ less than 1 is generally considered acceptable.

ILCR - Incremental Lifetime Cancer Risk

The upper-bound estimate of cancer risk based upon a lifetime-averaged exposure dose.

JP/RP Fuels - Very pure (high grade) kerosene- or diesel-range petroleum fuels

Called Jet Propulsion (JP) or Rocket Propulsion (RP) fuels. Numbers following the JP- or RP- designation refer to a particular mixture in each fuel.

Kilogram (1,000 g) - One thousand grams

Lean clay

A very fine-grained soil consisting of mostly clay, with varying percentages of silt, and very fine sand particles, showing low to medium plasticity.

Microgram (10^{-6} g) - One-millionth of a gram

Milligram (10^{-3}g) - One thousandth of a gram

MMH - Monomethyl Hydrazine

A hydrazine fuel used for rocket engine or component testing.

Nanogram (10^{-9} g) - One-billionth of a gram

NSGW - Near-Surface Groundwater

Groundwater that occurs within the alluvium or the weathered portion of the Chatsworth formation bedrock. Can be separated from or vertically continuous with a deeper groundwater system. If it occurs above and separated from a deeper groundwater system by unsaturated bedrock, the near-surface groundwater is called 'perched groundwater.'

Ozonator

An aboveground tank where wastewater containing small amounts of MMH was routed. Ozone was bubbled through the water, oxidizing the MMH to carbon dioxide and water.

Picogram- (10^{-12} g) One-trillionth of a gram

Perched Groundwater

Near-surface groundwater that is separated from underlying, deeper groundwater by an unsaturated zone (i.e., dry bedrock).

pH

A number indicating the measured acidity or alkalinity of a material. pH between 0 and 7 is acid, pH between 7 and 13 is alkaline, and a pH of 7 is neutral.

Piezometer

A temporary shallow well installed to monitor near-surface groundwater. In this report, monitoring wells and piezometers are collectively termed 'monitoring wells.'

RCRA – Resource Conservation and Recovery Act

USEPA regulations (1976, revised 1984) requiring safe management and disposal of wastes. Often referred to as "cradle to grave" regulations for hazardous wastes as it governs practices of waste generation, storage, and disposal.

RCRA Corrective Action Program

The investigation and cleanup of chemicals that cause a risk under RCRA guidelines. The program is conducted in four phases: RFA (preliminary assessment), RFI (investigation phase), CMS (evaluation of cleanup phase), and CMI (cleanup phase). For the SSFL, this program is under the oversight of the DTSC.

RFA – RCRA Facility Assessment

This is the first phase of the RCRA Corrective Action Program. It includes evaluation of a RCRA facility operations, records, and reports to identify areas where chemicals were handled, used, or stored (called Solid Waste Management Units, SWMUs) and areas where such practices may have occurred (Areas of Concern, AOCs). The RFA typically includes a site visit inspection. At the SSFL, this was conducted by SAIC, a consultant for the USEPA. A draft RFA report was issued by the USEPA in 1991 and finalized in 1994.

RFI – RCRA Facility Investigation

The second phase of the RCRA Corrective Action Program. This is the investigation phase, during which chemicals that pose a risk to human health or the environment are identified. It typically includes sampling, evaluation of the results, and risk assessment. This is the phase of the work being described in this report for one of the sites identified at the SSFL. The work is being conducted under the oversight of DTSC.

Risk Assessment

The process by which chemicals causing a risk to human health or the environment are identified and risk quantified. Based on these findings, a site is recommended for either (1) No Further Action, or (2) Evaluation of cleanup alternatives in the CMS.

RME - Reasonable maximum exposure

Defined as the maximum chemical exposure to receptors that could realistically be expected. This exposure is biased toward higher chemical concentrations and conservative exposure assumptions at a site.

Shear Zone

A geologic fault zone within the Chatsworth formation bedrock that occurs in the eastern portion of the SSFL.

Sheet flow

Flow that occurs overland in places where there are no defined channels.

Solvents

Organic liquids used for cleaning purposes. Known for their "degreasing" properties. Examples include trichloroethene (TCE), tetrachloroethene (PCE), Freon compounds, methylene chloride, etc.

Surficial OU – Surficial Media Operable Unit

This refers to the portion of the SSFL RCRA Corrective Action Program that includes surficial media (soils, soil vapor, sediment, surface water, air, biota, and near-surface groundwater).

SVOCs – Semivolatile Organic Compounds

Chemicals that are less volatile than VOCs. Typical SVOCs detected in environmental samples include polynuclear aromatic hydrocarbons (PAHs), and phthalate compounds (used in plastics).

SWMU – Solid Waste Management Unit

A site identified during the RCRA Facility Assessment that handled, used, or stored chemicals that may pose a threat to human health or the environment.

VOCs – Volatile Organic Compounds

Compounds that easily become gases (volatilize). The most typical VOCs at the SSFL are those used as solvents (e.g., TCE, PCE, Freon compounds, and acetone).

Watershed

The specific land area that drains water into a river system or other body of water

Water Table

A generally planar surface below the ground surface where unsaturated alluvium becomes fully saturated; the 'top' of groundwater.

Weathered Bedrock

The upper portion of the bedrock that is typically oxidized (brown instead of gray) and less cemented (less competent) than the underlying deeper bedrock. At the SSFL, the weathered bedrock can be directly below the alluvium or exposed at the ground surface.

TABLES

TABLE ES-1
SUMMARY OF GROUP 7 REPORTING AREA SURFICIAL MEDIA CMS RECOMMENDATIONS
(Page 1 of 2)

RFI Site/Use	CMS Area	Description	Chemical Risk Drivers and Significant Contributors
Building 4029 (B4029) (SWMU 7.11) Building 4029 operated as the Radiation Calibration Facility from 1959 to 1974 and was used to store radiologic source materials for the purpose of calibrating radiation detection equipment. Radioactive materials were stored at three below-grade concrete source storage structures. Radioactive source materials were removed in 1974 The storage structures were removed and areas backfilled in 1988. From 1978 to 1997, Building 4029 was used as the storage location for non-radioactive reactive metals waste awaiting treatment (oxidation and conversion to caustic solution) at Building 4133. Reactive metals were stored in drums and container boxes along the north and south walls of the building. Other operational activities included temporary storage along the access road and loading/unloading activities. A fuel pipeline existed along the roadway; removed in 1999.	None	NA	--NA
Building 4133 (B4133) (SWMU 7.2) Building 4133 operated as the Sodium Burn Facility from 1978 to 1997 and was used to treat reactive metals and equipment containing those metals via oxidation and conversion to caustic solutions (primarily sodium and potassium hydroxides). Metals commonly treated at the facility include sodium and sodium-potassium alloy. Prior to 1978, the Building 4133 area was used for parking and equipment/drum storage in support of Sodium Reactor Experiment (SRE) RFI Site operations. Other operational activities included storage of reactive metals and caustic solutions, metal equipment cutting, and the storage of spent/dummy fuel elements and equipment at the Interim Storage Facility (Building 4654). Two removal actions have occurred at the site to address radiological impacts, at Building 4654 in 1984/1985 (about 220 cubic yards), and north of Building 4133 in 2003 (about 10 cubic yards).	B4133-1	Area North of Building 4133	Aroclor 1254
	B4133-2	Area Northeast of Building 4133	Benzene, gasoline range organics, and 1,2,4-trimethylbenzene

TABLE ES-1
SUMMARY OF GROUP 7 REPORTING AREA SURFICIAL MEDIA CMS RECOMMENDATIONS
(Page 2 of 2)

RFI Site/Use	CMS Area	Description	Chemical Risk Drivers and Significant Contributors
Radioactive Materials Handling Facility (RMHF) (SWMU 7.6 and Area IV AOC) RMHF has been in continuous operation as a radioactive materials, hazardous waste, mixed waste storage facility, and small-scale low-level radioactive waste water treatment facility since its construction in 1959. South of RMHF was a nuclear test facility (Building 4028) that was in operation from 1962 through 1981. Since termination of nuclear operations at Area IV facilities in 1988, RMHF has been used in support of ongoing decontamination and decommissioning activities associated with site closure. Currently the RMHF only is only used for waste storage and shipments. Several excavation measures to address radiological impacts were performed in areas at or near RMHF from 1978 and 2006. These include • Removal of the Building 4021 Leach Field in 1978 (approximately 1,037 cubic yards of material, soil, and bedrock); • Excavation of three small areas south of the Mixed Waste Storage Yard in 2003 (130 cubic yards soil); • Excavation of one small area north of the fence line (about 2 cubic yards of soil); • Removal of the former Catch Basin (approximately 20 cubic yards of material and soil); and, • Excavation of two small areas near the former Catch Basin in 2007 (approximately 13 cubic yards of soil).	RMHF-1	South Fence Excavation Area	Aroclor 1260, Benzo(a)pyrene
	RMHF-2	Waste Receiving Yard Area	Benzene, Methylene Chloride
	RMHF-3	Northeast Slope Area	Cadmium, Cobalt, Zinc
	RMHF-4	Southern Culvert Area	Cobalt, Copper, Silver, Zinc

Notes:

(a) The lateral extent of areas recommended for further evaluation in the CMS (i.e., "CMS Areas") shown on Figure ES-1 are approximate and based on evaluation of residential, recreational, and ecological receptors using methodologies in currently approved work plans. CMS Areas may be refined during the CMS based on additional sampling results, land use scenarios, and/or additional risk assessment.

(b) Areas outside of the CMS Areas are recommended for No Further Action (NFA) based on findings of the historical document review, characterization data, and risk assessment results.

TABLE ES-2
GROUP 7 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS
(Page 1 of 3)

RFI Site / Chemical Use	Risk Estimate (Values provided are maximum risks calculated for entire RFI site)			Grouped Chemical Use Areas (b) (Chemical Use Area Number)	Chemical Groups Detected / Matrix (soil matrix unless noted)	Areas Recommended for CMS Evaluation (c)* (Chemical Use Area Number)
	Human Risks (Surficial Media Plus Indirect Groundwater)		Ecological Risks (HI)			
	Residential Risks (a)	Recreator Risks				
Building 4029 (B4029) (SWMU 7.11) Building 4029 was operated as the Radiation Calibration Facility from 1959 to 1974 and used to store radiologic source materials for the purpose of calibrating radiation detection equipment. Radioactive materials were stored at three below-grade concrete source storage structures. Radioactive source materials were removed in 1974. Storage structures were removed and areas backfilled in 1988. Building 4029 was operated as the Reactive Metals Storage Yard from 1978 to 1997 and used as the storage location for non-radioactive reactive metals waste awaiting treatment (oxidation and conversion to caustic solution) at Building 4133. Metals (primarily sodium and sodium-potassium alloy) were stored in drums and container boxes along the north and south walls of the building. Other site operations included: • Temporary storage and loading/unloading activities along access road • A petroleum fuel oil pipeline existed along roadway; removed in 1999.	Human risk: 2×10^{-7} Human HI: 0.07	Human risk: 5×10^{-8} Human HI: 0.004	Deer Mouse: 8 Thrush: 6 Hawk:: 3 Bobcat: 2 Mule Deer: None	**<u>Building 4029 and Access Road</u>** - Building 4029 (1) - Building 4029 Access Road (2)	VOCs (soil matrix), SVOCs, TPH, metals	-
				<u>Pipeline</u> - Former OCY Fuel Tank Pipeline (3)	--	--
Building 4133 (B4133) (SWMU 7.2) Building 4133 was operated as the Sodium Burn Facility from 1978 to 1997 and used to treat reactive metals and equipment contaminated by those metals via oxidation and conversion to caustic solutions (primarily sodium and potassium hydroxides). Metals commonly treated at the facility included sodium and a sodium-potassium alloy. Prior to 1978, the Building 4133 area was used for parking and equipment/drum storage in support of SRE RFI Site operations. Two removal actions have occurred at the site to address radiological impacts, including demolition/excavation of Building 4654 (approximately 220 cubic yards) in 1984/1985, and a small area northeast of Building 4133 (about 10 cubic yards) in 2003. Other site operations included: • Storage of caustic solutions • Metal equipment cutting using kerosene and mineral oils • Spent and dummy fuel storage at Building 4654); area also used for equipment storage.	Human risk: 7×10^{-7} Human HI: 0.4	Human risk: 2×10^{-7} Human HI: 0.07	Deer Mouse: 10 Thrush: 10 Hawk: None Bobcat: None Mule Deer: 2	**<u>Building 4133 and associated tanks</u>** - Building 4133 Treatment Building, Southern Concrete Pad, and Size Reduction Area (1) - Caustic Solutions Storage Tanks (2a, 2c, 2e) - Reactive Metals Storage and Reaction Tanks (2b, 2d, 2f)	VOCs (soil vapor and soil matrix), SVOCs, TPH, metals	• **B4133-2 (2c, 3)** - Benzene, gasoline range organics, 1,2,4-trimethylbenze
				<u>Storage and Staging Areas</u> - Building 4133 Storage and Staging Area (3) - Former Building 4564 Interim Storage Facility (6)	VOCs (soil vapor and soil matrix), SVOCs, TPH, PCBs, metals	• **B4133-1 (3)** - Aroclor 1254 • **B4133-2 (2c, 3)** - Benzene, gasoline range organics, 1,2,4-trimethylbenzene
				<u>Debris Area</u> - Western Drainage Debris Area (4)	VOCs (soil matrix), SVOCs, TPH, PCBs, metals	--
				<u>Excavation Area</u> - Northwest Excavation Area (5)	VOCs, PCBs	--

TABLE ES-2
GROUP 7 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS
(Page 2 of 3)

RFI Site / Chemical Use	Risk Estimate (Values provided are maximum risks calculated for entire RFI site)			Grouped Chemical Use Areas (b) (Chemical Use Area Number)	Chemical Groups Detected / Matrix (soil matrix unless noted)	Areas Recommended for CMS Evaluation (c)* (Chemical Use Area Number)
	Human Risks (Surficial Media Plus Indirect Groundwater)		Ecological Risks (HI)			
	Residential Risks (a)	Recreator Risks				
Radioactive Materials Handling Facility (RMHF) (SWMU 7.6 and Area IV AOC) RMHF has been in continuous operation as a radioactive materials, hazardous waste, mixed waste storage facility, and small-scale low-level radioactive waste water treatment facility since its construction in 1959. Other areas of the site included a nuclear test facility (Building 4028) that was in operation from 1962 through 1981. Since termination of nuclear operations at ETEC Area IV facilities in 1988, RMHF has been used in support of ongoing decontamination and decommissioning activities associated with site closure. Currently the RMHF is used for waste storage and shipments. Several removal actions have been performed to address radiological impacts in areas at or near RMHF from 1978 to 2007: • Removal of the Building 4021 Leach Field in 1978 (approximately 1,037 cubic yards of excavated material, soil, and bedrock). • Excavation of three small areas south of the Mixed Waste Storage Yard in 2003 (approximately 130 cubic yards of soil). The excavation areas measured approximately 125 x 13 feet, 5 x 7 feet, and 7 x 12 feet, respectively. Depth of excavations was approximately 0.5 feet. • Excavation of a small area along the RMHF north slope in 2006 (approximately 2 cubic yards). The area excavated measured approximately 100 square feet, with a depth of approximately 0.5 feet. • Removal of the former Catch Basin in 2006 (approximately 20 cubic yards of material and soil). • Excavation of two small areas near the former Catch Basin in 2007 (approximately 13 cubic yards of soil). One area was located approximately 10 feet north of the former Catch Basin and one within in the footprint of the former drainage channel leading to the former Catch Basin.	Human risk: 5×10^{-6} Human HI: 0.3	Human risk: 2×10^{-6} Human HI: 0.08	Deer Mouse: 10 Thrush: 8 Hawk: 2 Bobcat: none Mule Deer: 2	**<u>Storage</u>** - Building 4022 Radioactive Waste Vault Storage (1b) - Building 4621 Radioactive Accountable Waste Storage (5a) - Mixed Waste Storage Yard (5b) - Building 4663 Equipment Storage Area (5c) - Building 4075 Contaminated Storage (6a) - Building 4563 Covered Storage Area (6b) - Waste Receiving Yard (7) - Building 4688 Equipment and Hazardous Waste Storage Area (9c)	VOCs (soil vapor and soil matrix), SVOCs, TPH, PCBs, metals	• **RMHF-2** (6b, 7 [(d)]) - Benzene, methylene chloride
				<u>Waste Treatment or Processing Areas</u> - Building 4021 Radioactive Waste Decontamination and Packaging (1a) - Radioactive Water Treatment System (1c) - Building 4664 Low Level Waste Processing Facility (8a) - Building 4665 Radioactive Scrap Oxidation Facility (8b)	VOCs (soil vapor and soil matrix), SVOCs, TPH, PCBs, metals, pesticides	--
				<u>Nuclear Test Facility</u> - Building 4028 STIR / LMFBR Test Facility (11a) - Building 4811 STIR / LMFBR Mechanical Support Pad (11b)	VOCs (soil vapor and soil matrix), SVOCs, TPH, metals	--
				<u>Leach Field</u> - Building 4021 Septic Tank and Piping (4a) - Building 4021 Leach Field (4b)	VOCs (soil matrix), SVOCs, TPH, PCBs, metals	--
				<u>Oils/PCBs Areas</u> - Substation 721 (2a) - Transformer X-27A (2b) - Substation 728 (2c)	None	--
				<u>Other Support Facilities and Features</u> - Filter/Blower Area (1d) - Diesel AST (3) - Office, counting laboratory, and break room (9a, 9b) - Oil sump (12) -	TPH, metals	• **RMHF-3** (1d, 10a [(d)]) - Cadmium, cobalt, zinc
				<u>Surface Water Storage and Conveyance</u> - Asphalt drainage swale (10a) - Drainage channel (10b) - RMHF Catch Basin (10c) - Discharge pipeline (10d)	VOCs (soil matrix), SVOCs, TPH, metals, PCBs	• **RMHF-3** (1d, 10a [(d)]) - Cadmium, cobalt, zinc

TABLE ES-2
GROUP 7 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS
(Page 3 of 3)

RFI Site / Chemical Use	Risk Estimate (Values provided are maximum risks calculated for entire RFI site)			Grouped Chemical Use Areas (b) (Chemical Use Area Number)	Chemical Groups Detected / Matrix (soil matrix unless noted)	Areas Recommended for CMS Evaluation (c)* (Chemical Use Area Number)
	Human Risks (Surficial Media Plus Indirect Groundwater)		Ecological Risks (HI)			
	Residential Risks (a)	Recreator Risks				
RMHF (continued) Operational facilities include: • Radioactive vault storage • Decontamination and packaging • Low-level radioactive waste processing • Equipment and hazardous waste storage buildings • Waste storage and receiving yards Supporting facilities include: • Office, break room, and counting lab • HEPA filtration equipment area • One sanitary leach field • Surface water storage and conveyance system				**<u>Debris Areas</u>** - Building 4664 Debris Area (13a) - Building 4075 Debris Area (G07-2044 and G07-2045) (13b) - Debris Areas G07-1011 and G07-2046 (13c) - Debris Area G07-1012 (13d) - Debris Areas G07-1013 and G07-1014 (13e) - Debris Area G07-2043 (13f) - Debris Area G07-1015 (13g) - Debris Area G07-1016 (13g) - Debris Area G07-1017 (13i) - Building 4059 Debris Area (G07-1018 and G07-1019) (13j) - Debris Area G07-3022 (13k)	VOCs (soil matrix), SVOC, TPH, PCBs, metals	--
				<u>Excavation and Soil Disturbance Areas</u> - RMHF Northern Slope Excavation Area (14a) - RMHF Catch Basin Drainage Channel Excavation Area (14b) - RMHF Catch Basin Excavation Area (14c) - RMHF South Fence Excavation Area (14d) - RMHF Soil Disturbance Area (15) -	VOCs (soil vapor and soil matrix), SVOCs, TPH, metals, PCBs	• **RMHF-1** - Aroclor 1260, benzo(a)pyrene • **RMHF-4*** - Cobalt, copper, silver, zinc

Notes:
'--' Indicates area is recommended for No Further Action (NFA).
'* ' Indicates CMS Area is also recommended for source stabilization to address potential surficial migration of contaminants. One source stabilization areas were identified in Group 7.
Metals and dioxins are listed if detected above background.
CMS - Corrective Measure Study is recommended based on compounds considered to be risk drivers for receptors evaluated (excess cancer risk > 1 x 10-6 or hazard index > 1) and/or significant risk contributors.
Ecological risks for the hawk, bobcat, and mule deer are conservatively based on RFI site exposures only. Ecological risks for these large-home range receptors will be presented in the Large-Home Range Risk Assessment Report.

(a) Residential risk estimates presented above do not include direct groundwater exposures.
(b) Chemical use areas have been grouped by location and related chemical use.
(c) CMS Areas are numbered in sequence (e.g., B4133-1, B4133-2). The extent of CMS Areas shown on Figure ES-1 are approximate and reflect site action recommendations based on characterization and risk assessment results for receptors evaluated (see Section 7). Risk drivers and significant risk contributors are indicated. An asterisk indicates that stabilization is also recommended. Areas outside of CMS Areas are recommended for NFA based on findings of the historical document review, characterization data, and risk assessment results.
(d) The CMS area extends into a portion of the CUA.

Acronyms:
AOC = Area of Concern
AST = aboveground storage tank
CMS = Corrective Measures Study
ETEC = Energy Technology Engineering Center
HEPA = high-efficiency particulate air
HI = Hazard Index
LFMBR – Liquid Metal Fast Breeder Reactor
NFA = No Further Action
OCY = Old Conservation Yard
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
RMHF = Radioactive Materials Handling Facility
RFI = RCRA Facility Investigation
SRE = Sodium Reactor Experiment
STIR = Shield Test Irradiation Reactor
SVOC = semivolatile organic compound
SWMU = Solid Waste Management Unit
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Table 3-1
General Descriptions of Chemical Use
And Typical Target Analytical Suites for RFI Soil Characterization
(Page 1 of 2)

Chemical Use Area Type	Descriptions of Chemical Use Area Type	Typical Analytical Methods Used for RFI Characterization										
		VOCs	SVOCs	TPH	PCBs	Metals	Dioxins/Furans	NDMA	MMH (Formaldehyde)	Perchlorate	Inorganics (Asbestos and Fluoride)	pH
Solvents	Engine/component testing areas, laboratories, storage areas, clarifiers, sumps/pits, degreasers, surface impoundments/ponds, and storage tanks and associate pipelines.	X	X [a]									
Petroleum	Gasoline, jet/rocket fuel, diesel storage tanks and associated pipelines, engine/component testing areas, and surface impoundments/ponds. In Group 7, kerosene use as lubricant.	X [b]	X [b]	X								
Oils/PCBs	Hydraulic and lubricant oil storage tanks, sumps/pits, waste oils, and transformers. Includes terphenyl use in Area IV.		X	X	X	X						
Metals/Inorganic Compounds (excluding debris areas)	Corrosive activities/areas, sumps/pits, and storage tanks, and fluoride use areas. In Group 7 includes reactive metals treatment.					X					X	X
Perchlorate	Flare production, igniter preparation areas, small rocket engine or system testing areas.									X [d]		
Hydrazine (NDMA, MMH)	Small rocket engine or system testing areas, and surface impoundments/ponds.							X	X			
Debris	Debris and burn areas.	X	X [e]	X	X	X	X [e]					
Landfill	Construction wastes including soil, bedrock, concrete, asphalt, and scrap metal.	X	X [a, e]	X [c]	X [c]	X	X [e]			X	X [f]	X
Leach Field	Sanitary leach fields	X	X	X	X [g]	X					X [g]	X
Potential (Screening for Potential Chemical Use/Impacts)	Areas identified with possible or suspected chemical use. Proposed analytical methods vary for areas based on available site information. Typical suite shown.	X	X	X		X						X

Table 3-1
General Descriptions of Chemical Use
And Typical Target Analytical Suites for RFI Soil Characterization
(Page 2 of 2)

General Notes:

- Typical RFI sampling suites are used for investigation of areas. Specific analytical suites vary depending on site activities and/or other sampling results. Target analytes do not include chemicals used for routine maintenance or construction activities.
- See Figures 3-2 through 3-9 for color-coded identification of chemical use areas in Group 7 RFI sites. Table 3-2 contains a list of individual known or potential chemical use areas in Group 7 and identifies their Chemical Use Area Type as defined here.
- In the case of down-slope or down-stream areas, analytical suites were based on up-slope or up-gradient potential chemical use.

Notes:

a) Includes screening for glycols if used, stored, or potentially disposed of at site.
b) VOCs were analyzed in areas of gasoline use, and SVOCs (specifically, PAHs) were analyzed in areas of diesel use or use of other heavy hydrocarbons.
c) Perchlorate was not targeted if *de minimis* quantities were used (a few grams to a few pounds) and consumed during use (i.e., perchlorate igniters used at rocket engine test stands).
d) Dioxins/SVOCs were analyzed if visible burned materials were present.
e) Asbestos was included if potentially asbestos-containing materials were observed.
f) Analysis of PCBs, and/or fluoride was added if related to associated site or building use.

Acronyms:

AOC = Area of Concern
CMS = Corrective Measures Study
LF = leach field
MMH = monomethyl hydrazine
NDMA = N-nitrosodimethylamine
PAH = polynuclear aromatic hydrocarbon
PCBs = polychlorinated biphenyls
RFI = RCRA Facility Investigation
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbons
UDMH = unsymmetrical dimethyl hydrazine

TABLE 3-2
Group 7 Reporting Area Chemical Use Investigation Areas
(Page 1 of 4)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)						
			Solvents	Petroleum Fuels	Oils / PCBs	Metals / Inorganics (excluding debris areas)	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
Building 4029 RFI Site (SWMU 7.11) – Appendix A									
1	Building 4029 and Concrete Pads	Metals/Inorganics				X			(3)
2	Building 4029 Access Road	None Documented (Potential fuels, oils, metals)							X
3	Former Old Conservation Yard Tank Pipeline	Petroleum Fuels		X					
Building 4133 RFI Site (SWMU 7.2) – Appendix B									
1	Building 4133 Treatment Building, Southern Concrete Pad, and Size Reduction Area	Metals/Inorganics, kerosene, mineral oil	(7)	X		X			(4)
2a	Caustic Solution Tank T-1	Metals/Inorganic Compounds, Acid (potential petroleum fuels/oil associated with use of mechanical pumps)				X			(4)
2b	Sodium-Potassium Alloy Tank T-2	Metals/Inorganics				X			(4)
2c	Caustic Solution Tank T-3	Metals/Inorganics				X			(4)
2d	Rinse Tanks T-4A and T-4B	Metals/Inorganic Compounds, Acid (Potential fuels/oil associated with use of mechanical pumps)				X			(4)
2e	Temporary Holding Tank	Metals/Inorganics				X			(4)
2f	Lithium Hydride Reaction Vessel	Metals/Inorganics				X			(4)
3	Building 4133 Storage and Staging Area	None Documented (Potential storage of construction materials, drums, debris, solvents, kerosene, oils)							X
4	Western Drainage Debris Area	Debris					X		
5	Northwest Excavation Area	None Documented							X
6	Former Building 4654 Interim Storage Facility	None Documented							X

TABLE 3-2
Group 7 Reporting Area Chemical Use Investigation Areas
(Page 2 of 4)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)						
			Solvents	Petroleum Fuels	Oils / PCBs	Metals / Inorganics (excluding debris areas)	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
Radioactive Materials Handling Facility (RMHF) RFI Site (SWMU 7.6 and Area IV AOC) – Appendix C									
1a	Building 4021 Radioactive Waste Decontamination and Packaging	Solvents, Petroleum Fuels and Oils, Metals, Low-Level Radioactive Waste (LLRW) Water	X	X	(5)	X			
1b	Building 4022 Radioactive Waste Vault Storage	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X	(5)	X			
1c	Radioactive Water Treatment System	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X		X			
1d	Filter/Blower Area	Solvents, hydraulic oils, LLRW water	X	X		X			
2a	Substation 721	Oils / PCBs			X				
2b	Transformer Pole X-27A	Oils / PCBs			X				
2c	Substation 728	Oils / PCBs			X				
3	Diesel AST	Petroleum		X					
4a	Building 4021 Septic Tank and Pipeline	Leach Field						X	
4b	Building 4021 Leach Field	Leach Field						X	
5a	Building 4621 Radioactive Accountable Waste Storage	Solvents, Petroleum Fuels and Oils, Metals	X	X	(5)	X			
5b	Mixed Waste Storage Yard	Solvents, Petroleum Fuels and Oils, Metals	X	X	(5)	X			
5c	Building 4663 Equipment Storage Area	Solvents, Petroleum Fuels and Oils, Metals	X	X	(5)	X			
6a	Building 4075 Contaminated Storage	Metals / Inorganics	(3)	(3)	(5)	X			
6b	Building 4563 Storage Area	Metals / Inorganics	(3)	(3)	(5)	X			
7	Waste Receiving Yard	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X	(5)	X			
8a	Building 4664 Low Level Waste Processing Building	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	(3)	X		X			
8b	Building 4665 Radioactive Scrap Oxidation Facility	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	(3)	X		X			

TABLE 3-2
Group 7 Reporting Area Chemical Use Investigation Areas
(Page 3 of 4)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)						
			Solvents	Petroleum Fuels	Oils / PCBs	Metals / Inorganics (excluding debris areas)	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
9a	Building 4034 (Office) and Building 4622 (Counting Building)	None Documented							X
9b	Building 4044 Break Room and Counting Lab	None Documented							X
9c	Building 4688 Equipment and Hazardous Waste Storage Area	None Documented							X
10a	Asphalt Drainage Swale	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X		X			
10b	Catch Basin Drainage Channel	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X		X			
10c	Building 4614 Former Catch Basin	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water	X	X	(5)	X			
10d	Catch Basin Discharge Pipeline	Solvents, Petroleum Fuels and Oils, Metals, LLRW Water		X		X			
11a	Building 4028 STIR/LFMBR Test Facility	Solvents, Petroleum Fuels and Oils, Metals (primarily uranium (II) oxide)	(3)	(3)		X			
11b	Building 4811 STIR/LFMBR Mechanical Support Pad	Solvents, Petroleum Fuels, Metals	(3)	(3)		X			
12	Former Oil Sump	Petroleum		X					
13a	Building 4664 Debris Area	Debris	(6)				X		
13b	Building 4075 Debris Area (G07-2044 and G07-2045)	Debris	(6)				X		
13c	Debris Areas G07-1011 and G07-2046	Debris					X		
13d	Debris Area G07-1012	Debris					X		
13e	Debris Areas G07-1013 and G07-1014	Debris	(6)				X		
13f	Debris Area G07-2043	Debris					X		
13g	Debris Area G07-1015	Debris	(6)				X		
13h	Debris Area G07-1016	Debris	(6)				X		

TABLE 3-2
Group 7 Reporting Area Chemical Use Investigation Areas
(Page 4 of 4)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)						
			Solvents	Petroleum Fuels	Oils / PCBs	Metals / Inorganics (excluding debris areas)	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
13i	Debris Area G07-1017	Debris	(6)				X		
13j	Building 4059 Debris Area (G07-1018 and G07-1019)	Debris	(6)				X		
14a	RMHF Northern Slope Excavation Area	None Documented							X
14b	RMHF Catch Basin Drainage Channel Excavation Area	None Documented							X
14c	RMHF Catch Basin Excavation Area	None Documented							X
15	RMHF Soil Disturbance Area	None Documented							X

General Notes:

Potential chemical use areas are shown on Figure 3-9 and defined by number on Figure 3-3 and on figures in Appendices A, B, C, and D.

Notes:

(1) Descriptions of chemical use area types and typical analytical suites used for RFI characterization are described in Table 3-1.
(2) Analytical suites for these types of chemical use areas were modified as appropriate based on site history documentation or visual inspection of the area (e.g., if burned material was noted, dioxins were included.). In the case of down-slope or downstream areas, analytical suites were based on upgradient potential chemical use.
(3) VOCs, SVOCs, and TPH analyzed at this chemical use area as part of overall site characterization.
(4) VOCs, SVOCs, TPH, and/or PCBs analyzed at this chemical use area as part of the characterization of the Building 4133 Storage and Staging Area (CUA 3).
(5) PCBs documented as stored at RMHF RFI Site and were screened in waste storage and reduction areas as part of site characterization.
(6) Debris areas characterized for VOCs if drums, piping, or storage containers observed or if debris area was in proximity of area with documented solvent use/storage.

Acronyms:

AOC – Area of Concern
AST – aboveground storage tank
BTEX – benzene, toluene, ethylbenzene, and xylenes
CUA – Chemical Use Area
LMFBR – Liquid Metal Fast Breeder Reactor
PCB – polychlorinated biphenyls
RMHF – Radioactive Materials Handling Facility
STIR – Shield Test Irradiation Reactor
SVOC – semivolatile organic compound
SWMU – Solid Waste Management Unit
TPH – total petroleum hydrocarbons
UST – underground storage tank
VOC – volatile organic compound

Table 6-1 (1 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 7 Reporting Area

Chemical	Soil	Groundwater	Soil Vapor
Inorganic Compounds			
Barium	X		
Beryllium		X	
Cadmium	X		
Chromium	X		
Cobalt	X		
Copper	X		
Cyanide	X		
Hexavalent chromium	X		
Lithium	X		
Mercury	X		
Selenium	X		
Thallium	X		
Zinc	X		
VOCs			
1,1,2-Trichloro-1,2,2-trifluoroethane		X	X
1,1-Dichloroethane		X	
1,1-Dichloroethene		X	
1,2,4-Trimethylbenzene	X		X
1,3,5-Trimethylbenzene	X		X
2-Butanone	X		X
Acetone	X	X	
Benzene	X		X
Chloroform		X	
cis-1,2-Dichloroethene		X	
Isopropylbenzene	X		
m,p-Xylene	X		X
Methylene chloride	X		X
n-Butylbenzene	X		X
n-Propylbenzene	X		X
o-Xylene	X		X
p-Isopropyltoluene	X		X
sec-Butylbenzene	X		X
Styrene	X		X
Tetrachloroethene	X	X	X
Toluene	X	X	X
Trichloroethene		X	
SVOCs			
1-Methylnaphthalene	X		
2-Methylnaphthalene	X		
Acenaphthene	X		

Table 6-1 (2 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 7 Reporting Area

Chemical	Soil	Groundwater	Soil Vapor
Acenaphthylene	X		
Anthracene	X		
Benzo(a)anthracene	X		
Benzo(a)pyrene	X		
Benzo(b)fluoranthene	X		
Benzo(e)pyrene	X		
Benzo(g,h,i)perylene	X		
Benzo(k)fluoranthene	X		
bis(2-Ethylhexyl)phthalate	X		
Butyl benzyl phthalate	X		
Chrysene	X		
Dibenz(a,h)anthracene	X		
Di-n-butylphthalate	X		
Fluoranthene	X		
Fluorene	X		
Indeno(1,2,3-cd)pyrene	X		
Naphthalene	X		
Perylene	X		
Phenanthrene	X		
Pyrene	X		
Pesticides			
4,4'-DDE	X		
4,4'-DDT	X		
Total Petroleum Hydrocarbons			
C08-C11(Gasoline Range)	X		
C11-C14(Kerosene Range)	X		
C14-C20(Diesel Range)	X		
C20-C30(Lubricant Oil Range)	X		
PCDD/PCDFs			
2,3,7,8-TCDD	X		
1,2,3,7,8-PeCDD	X		
1,2,3,4,7,8-HxCDD	X		
1,2,3,6,7,8-HxCDD	X		
1,2,3,7,8,9-HxCDD	X		
1,2,3,4,6,7,8-HpCDD	X		
OCDD	X		
2,3,7,8-TCDF	X		
1,2,3,7,8-PeCDF	X		
2,3,4,7,8-PeCDF	X		
1,2,3,4,7,8-HxCDF	X		
1,2,3,6,7,8-HxCDF	X		
2,3,4,6,7,8-HxCDF	X		
1,2,3,7,8,9-HxCDF	X		

Table 6-1 (3 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 7 Reporting Area

Chemical	Soil	Groundwater	Soil Vapor
1,2,3,4,6,7,8-HpCDF	X		
1,2,3,4,7,8,9-HpCDF	X		
OCDF	X		
PCDD/PCDF	X		
PCBs			
Aroclor 1242	X		
Aroclor 1248	X		
Aroclor 1254	X		
Aroclor 1260	X		
PCB-105	X		
PCB-114	X		
PCB-118	X		
PCB-123	X		
PCB-126	X		
PCB-156	X		
PCB-157	X		
PCB-167	X		
PCB-169	X		
PCB-189	X		
PCB-77	X		
PCB-81	X		

Notes:
X - selected as a chemical of potential concern
VOC - volatile organic compound
SVOC - semivolatile organic compound
PCDD/PCDF - polychlorinated dibenzo-p-dioxin and dibenzofurans
PCBs - polychlorinated biphenyls

Table 6-2 (1 of 1)

Human Health Risk Estimates[1]
Group 7 Reporting Area

Receptor	B4029 RFI Site				B4133 RFI Site				RMHF RFI Site			
	HI Range	CD[2]	Risk Range	CD[2]	HI Range	CD[2]	Risk Range	CD[2]	HI Range	CD[2]	Risk Range	CD[2]
Future Adult Recreator	<0.001 - <0.001	-	2E-10 - 6E-08	-	<0.001 - 0.009	-	2E-09 - 2E-07	-	<0.001 - 0.007		5E-09 - 2E-06	a
Future Child Recreator	<0.001 - 0.004	-	2E-09 - 5E-08	-	0.01 - 0.07	-	2E-08 - 2E-07	-	0.02 - 0.08		7E-08 - 1E-06	
Future Adult Resident	0.003 - 0.008	-	4E-09 - 9E-08	-	0.02 - 0.09	-	3E-08 - 4E-07	-	0.01 - 0.03		1E-07 - 2E-06	a
Future Child Resident	0.03 - 0.07	-	3E-08 - 2E-07	-	0.1 - 0.4	-	2E-07 - 7E-07	-	0.1 - 0.3		7E-07 - 5E-06	a

Notes:
1. Risk estimates shown are a sum of all exposure pathways for site media, assuming no domestic use of groundwater; the range reported is for central tendency and reasonable maximum exposures, respectively.
2. Chemical risk drivers are those COPCs detected onsite with an HI > 1, cancer risk > $1x10^{-6}$, or blood lead concentration > 10 µg/dl. cumulative HI >> 1 or

a - Aroclor 1260

CD = Chemical risk driver
COPC = Chemical of potential concern
HI = Hazard index
µg/dl - micrograms per deciliter

Table 6-3 (1 of 3)

Human Health Risk Assessment Uncertainty Analysis
Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
COPC Selection		
A number of inorganics (e.g. cadmium, copper, cobalt, mercury, selenium and zinc) that were demonstrated to be consistent with background concentrations through Wilcoxon Rank Sum test were included as COPCs because the maximum detected concentrations were substantially above the maximum detected background concentration, and were located in areas of suspected metals impacts.	Medium	Conservative
Cadmium concentrations were shown to be above background concentrations at the B4133 RFI Site based on the Wilcoxon Rank Sum test. However, the maximum detected site concentration was only slightly higher than the maximum background concentration and the mean, median and standard deviation of the background data were higher than that of the B4133 RFI Site data. Cadmium was conservatively retained as a COPC.	Low	Conservative
Chromium concentrations were shown to be above background concentrations at the B4029 Area RFI Site based on the Wilcoxon Rank Sum test. However, the maximum detected site concentration was less than the maximum background concentration. Chromium was conservatively retained as a COPC.	Low	Conservative
Hexavalent chromium concentrations are considered to be above background concentrations at the B4133 Area RFI Site because soil background data are not available. However, at the location of the maximum hexavalent chromium concentration, the total chromium concentration is below background concentrations of total chromium; and chromium concentrations are shown to be below background based on the results of the Wilcoxon Rank Sum test. However, hexavalent chromium was conservatively retained as a COPC.	Low	Conservative
Dioxin congener groups that were demonstrated to be consistent with background concentrations at the RMHF RFI Site through Wilcoxon Rank Sum test were included as COPCs because the summation of the maximum detected Total Octa site concentrations were substantially greater than maximum detected background concentrations.	Medium	Conservative
Several VOCs detected in soil (1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2-butanone, n-butylbenzene, n-propylbenzene, p-isopropyltoluene, sec-butylbenzene and styrene) were not analyzed for in soil vapor and were retained as soil vapor COPCs because they could migrate to soil vapor from soil.	Low	Uncertain
The selection of toluene as a COPC for indirect exposure to groundwater (i.e., vapor modeling to ambient and indoor air) at the B4029 Area RFI Site is a conservative measure since it was only detected in one of three samples, the detection was just after well installation, and toluene is considered a common laboratory contaminant.	Low	Conservative
Potential impacts of the Topanga fire on the selection of COPCs and risks have been evaluated. Although soil concentrations of metals and dioxins may have been impacted by the fire and therefore risks may have been increased, there were no identified risk assessment decisions based solely on post-Topanga fire data	Low	Uncertain
EPC Calculations		
Where available, site-specific (actual) chemical data were used in the risk assessment. Where data were not available, risks associated with benzene, toluene, ethylbenzene, xylenes (BTEX) and polynuclear aromatic hydrocarbons (PAHs) are estimated based, in part, on extrapolation factors using site TPH data as described in the SRAM (MWH, 2005). The estimation of BTEX and PAH concentrations from TPH concentrations is considered conservative since the extrapolation factors used to estimate BTEX and PAH concentrations are based on the maximum ratio of TPH concentration to petroleum constituent concentration in the dataset.	Medium	Conservative
TPH-G was detected in a single surface sample out of 139 samples at the RMHF RFI site; the chemical is not considered site related and not all BTEX-related compounds were detected in any soil or active/passive soil gas samples near the location, therefore extrapolation of TPH-G was not conducted.	Medium	Not Conservative
Where VOCs are detected in one media, and analyzed for in another media to which the VOC could migrate to but were not detected, media-to-media extrapolations were conducted (e.g., soil-to-soil vapor). This procedure is expected to overestimate potential exposures	Medium	Conservative

Table 6-3 (2 of 3)

Human Health Risk Assessment Uncertainty Analysis
Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
When VOC soil vapor samples were available for the RMHF and B1433 RFI Sites, soil matrix to soil vapor extrapolations were only conducted for non-collocated soil matrix samples with detects.	Low	Conservative
Soil and soil vapor CTE EPCs were calculated using 1/2 the SQL when there were too few samples to calculate a mean in ProUCL.	Low	Conservative
At the RMHF RFI site one sample was included in soil vapor from 10.25 ft which is below the range 3-10 ft bgs. It was technically outside the assumed exposure range, but was very close and represented a station without other data at higher depths.	Low	Conservative
Vapor migration into indoor air has been estimated using a model which is being validated for the site. Preliminary findings show that the model conservatively over-predicts air concentrations when compared to flux chamber measurements.	Medium	Conservative
Indoor and ambient air m,p-xylene concentrations were determined based on the physical and chemical properties of p-xylene.	Low	Uncertain
The 95% UCL concentration of some chemicals is greater than the maximum concentration, therefore the maximum concentration was used as the RME EPC. This is considered to be a likely overestimation of the representative exposure point concentration because samples were collected in areas with the highest likelihood to detect the highest concentrations at the site, and a receptor using the site is not always exposed to the location of highest concentrations.	High	Conservative
The maximum detected concentration of each COPC detected in groundwater was used as the EPC.	Medium	Conservative
The mean concentration for some chemicals exceeded the selected RME concentration, therefore the RME concentration was also used as the CTE concentration under some circumstances.	Medium	Conservative
EPCs for the RMHF RFI site were calculated including data collected outside the RMHF site boundary and downgradient.	High	Conservative
Data from drainage areas at Brendeis Bardine, near the RMHF RFI site, included a detected concentration of DDD. Later data were not analyzed for pesticides and were not included in the RMHF RFI site calculations. This uncertainty is low because site data did not include high pesticide contributions to risk and therefore drainage from RMHF would also not likely contribute to site-related risks.	Low	Uncertain
As described in Section 1.0, some additional soil samples were collected at the RMHF RFI Site after the site risk assessment was completed. Data for these additional samples could not be assessed quantitatively, which results in some uncertainty. The additional samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH, and metals. VOC, TPH, and pesticide compounds were detected at concentrations similar or lower than the concentrations detected previously, so including the additional data for these compounds would not affect the overall conclusions of the risk assessment. Several PAHs and metals were detected in the additional samples at concentrations greater than those detected previously. As a result, risk estimates for these compounds were likely underestimated for this site. However, the additional samples with higher concentrations of PAHs and metals are located in areas proposed for CMS and/or further evaluation.	Medium	Not Conservative
As described in Section 1.0, some additional soil samples were collected at the B4029 RFI Site after the site risk assessment was completed. Data for these additional samples could not be assessed quantitatively, which results in some uncertainty. The additional samples were analyzed for SVOCs, PCBs, and TPH. No SVOCs or PCBs were detected in these samples, and the concentrations of detected TPH compounds were within the range of concentrations previously detected and evaluated in the risk assessment. Consequently, including the additional data in the quantitative evaluation would not change the overall conclusions of the risk assessment for this site.	Low	Not Conservative
Exposure		
Future land use of the site is currently undecided but may be recreational, which has lower risks than residential.	High	Conservative

Table 6-3 (3 of 3)

Human Health Risk Assessment Uncertainty Analysis
Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
The RMHF RFI site has been used for handling and storage of radioactive materials. However, radioactive risks are evaluated separately for this site.	High	Uncertain
Risks associated with potable use of groundwater are not expected because the groundwater beneath the SSFL is not currently used as a drinking water source and the presence of the contamination will likely require a restriction on its future use as well.	High	Conservative
In some cases, although risks were estimated for metals (e.g. cadmium, chromium, cobalt, copper, mercury, selenium, thallium and zinc) at various RFI sites, both the CTE and RME EPC concentrations were less than the maximum background concentrations.	Medium	Conservative
Toxicity Criteria		
There is a high degree of uncertainty in extrapolation of dose-response data from laboratory animals to humans.	High	Conservative
Assessment assumes that all carcinogens do not have a threshold below which a carcinogenic response does not occur, and therefore, any dose, no matter how small, results in some potential risk.	Medium	Conservative
Cancer slope factors derived from animal studies are the upper-bound maximum likelihood estimates based on a linear dose-response curve, and therefore, overstate carcinogenic potency.	Medium	Conservative
Although benzo(g,h,i)perylene was selected as a COPC in soil, toxicity values were not available for this constituent and risk could not be calculated.	Low	Uncertain

Notes:

Low - This uncertainty is considered to have minimal impact on the total risk estimate.
Medium - This uncertainty is considered to have moderate impact on the total risk estimate.
High - This uncertainty is considered to have significant impact on the total risk estimate.

COPC - Chemical of potential concern
TPH - total petroleum hydrocarbons
BTEX - benzene, toluene, ethylbenzene, and xylenes
PAH - polynuclear aromatic hydrocarbon
EPC - Exposure Point Concentration
DL - Detection Limit
SQL - Sample Quantitation Limit

Table 6-4 (1 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 7 Reporting Area

Chemical	Soil	Soil Vapor
Inorganic Compounds		
Barium	X	
Cadmium	X	
Chromium	X	
Cobalt	X	
Copper	X	
Cyanide	X	
Hexavalent chromium	X	
Lithium	X	
Mercury	X	
Selenium	X	
Zinc	X	
VOCs		
1,1,2-Trichloro-1,2,2-trifluoroethane		X
1,2,4-Trimethylbenzene	X	X
1,3,5-Trimethylbenzene	X	X
Acetone	X	X
Benzene	X	X
Chloroform		X
cis-1,2-Dichloroethene		X
Ethylbenzene	X	X
Isopropylbenzene	X	X
m,p-Xylene	X	X
Methylene chloride	X	X
n-Butylbenzene	X	X
n-Propylbenzene	X	X
o-Xylene	X	X
p-Isopropyltoluene	X	X
sec-Butylbenzene	X	X
Styrene	X	X
Tetrachloroethene	X	X
Toluene	X	X
Trichloroethene		X
SVOCs		
1-Methylnaphthalene	X	
2-Methylnaphthalene	X	
Acenaphthene	X	
Acenaphthylene	X	
Anthracene	X	
Benzo(a)anthracene	X	

Table 6-4 (2 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 7 Reporting Area

Chemical	Soil	Soil Vapor
Benzo(a)pyrene	X	
Benzo(b)fluoranthene	X	
Benzo(e)pyrene	X	
Benzo(g,h,i)perylene	X	
Benzo(k)fluoranthene	X	
bis(2-Ethylhexyl)phthalate	X	
Butyl benzyl phthalate	X	
Chrysene	X	
Dibenz(a,h)anthracene	X	
Di-n-butylphthalate	X	
Fluoranthene	X	
Fluorene	X	
Indeno(1,2,3-cd)pyrene	X	
Naphthalene	X	
Perylene	X	
Phenanthrene	X	
Pyrene	X	
Pesticides		
4,4'-DDE	X	
4,4'-DDT	X	
Total Petroleum Hydrocarbons		
C08-C11(Gasoline Range)	X	
C11-C14(Kerosene Range)	X	
C14-C20(Diesel Range)	X	
C20-C30(Lubricant Oil Range)	X	
PCDD/PCDFs		
2,3,7,8-TCDD	X	
1,2,3,7,8-PeCDD	X	
1,2,3,4,7,8-HxCDD	X	
1,2,3,6,7,8-HxCDD	X	
1,2,3,7,8,9-HxCDD	X	
1,2,3,4,6,7,8-HpCDD	X	
OCDD	X	
2,3,7,8-TCDF	X	
1,2,3,7,8-PeCDF	X	
2,3,4,7,8-PeCDF	X	
1,2,3,4,7,8-HxCDF	X	
1,2,3,6,7,8-HxCDF	X	

Table 6-4 (3 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 7 Reporting Area

Chemical	Soil	Soil Vapor
2,3,4,6,7,8-HxCDF	X	
1,2,3,7,8,9-HxCDF	X	
1,2,3,4,6,7,8-HpCDF	X	
1,2,3,4,7,8,9-HpCDF	X	
OCDF	X	
PCDD/PCDF	X	
PCBs		
Aroclor 1242	X	
Aroclor 1248	X	
Aroclor 1254	X	
Aroclor 1260	X	
PCB-105	X	
PCB-114	X	
PCB-118	X	
PCB-123	X	
PCB-126	X	
PCB-156	X	
PCB-157	X	
PCB-167	X	
PCB-169	X	
PCB-189	X	
PCB-77	X	
PCB-81	X	

Notes:
X - selected as a chemical of potential ecological concer
VOC - volatile organic compoun
SVOC - semivolatile organic compoun
PCB - polychlorinated bipheny
CPEC - chemical of potential ecological concer
bgs - below ground surface

Table 6-5 (1 of 1)

Risk Estimates for Ecological Receptors
Group 7 Reporting Area

Receptor	Chemical Risk Drivers[1]		
	B4029 RFI Site	**B4133 RFI Site**	**RMHF RFI Site**
Deer Mouse	Barium (8), Zinc (7)	Cadium (10), Total Aroclors (2)	Total Aroclors (7), Cadmium(10), Copper (4), Selenium (2), Zinc (6)
without inhalation pathway	Barium (8), Zinc (7)	Cadium (10), Total Aroclors (2)	Total Aroclors (7), Cadmium(10), Copper (4), Selenium (2), Zinc (6)
Thrush	Barium (3), Zinc (6)	Cadium (10)	Total Aroclors (7), Copper (8), Zinc (5)
Hawk	Zinc (3)	None	Total Aroclors (2), Zinc (2)
Using Large Home Range Factor[2]	None	None	None
Bobcat	Zinc (2)	None	None
Using Large Home Range Factor[2]	None	None	None
Mule Deer	None	Cadium (2)	Cadmium (2)
Using Large Home Range Factor[2]	None	None	None

Notes:

1. Chemical risk drivers are those CPECs detected onsite with an HQ or HI > 1, the RME HQ is provided after the chemical name. "None" indicates that no chemical's HQs were > 1.
2. The HQs for hawk, mule deer, and bobcat assume that their home ranges are equal to the RFI site acreage. This is an extremely conservative assumption; RFI site acreage is typically only a small fraction of a large animal's home range. The estimated HQs decrease to the values indicated above if an adjustment is made to reflect a more realistic home range for these receptors.

CPEC = Chemical of potential ecological concern
HQ = Hazard quotient
HI = Hazard index

Table 6-6 (1 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
CPEC Selection		
A number of inorganics (e.g. cadmium, copper, cobalt, mercury, selenium and zinc) that were demonstrated to be consistent with background concentrations through Wilcoxon Rank Sum test were included as CPECs because the maximum detected concentrations were substantially above the maximum detected background concentration, and were located in areas of suspected metals impacts.	Medium	Conservative
Cadmium concentrations were shown to be above background concentrations at the B4133 RFI Site based on the Wilcoxon Rank Sum test. However, the maximum detected site concentration was only slightly higher than the maximum background concentration and the mean, median and standard deviation of the background data were higher than that of the B4133 RFI Site data. Cadmium was conservatively retained as a CPEC.	Low	Conservative
Chromium concentrations were shown to be above background concentrations at the B4029 Area RFI Site based on the Wilcoxon Rank Sum test. However, the maximum detected site concentration was less than the maximum background concentration. Chromium was conservatively retained as a CPEC.	Low	Conservative
Hexavalent chromium concentrations are considered to be above background concentrations at the B4133 Area RFI Site because soil background data are not available. However, at the location of the maximum hexavalent chromium concentration, the total chromium concentration is below background concentrations of total chromium; and chromium concentrations are shown to be below background based on the results of the Wilcoxon Rank Sum test. However, hexavalent chromium was conservatively retained as a CPEC.	Low	Conservative
Dioxin congener groups that were demonstrated to be consistent with background concentrations at the RMHF RFI Site through Wilcoxon Rank Sum test were included as CPECs because the summation of the maximum detected Total Octa site concentrations were substantially greater than maximum detected background concentrations.	Medium	Conservative
Several VOCs detected in soil (1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2-butanone, n-butylbenzene, n-propylbenzene, p-isopropyltoluene, sec-butylbenzene and styrene) were not analyzed for in soil vapor and were retained as soil vapor CPECs because they could migrate to soil vapor from soil.	Low	Uncertain
The selection of toluene as a CPEC for indirect exposure to groundwater (i.e., vapor modeling to ambient and indoor air) at the B4029 Area RFI Site is a conservative measure since it was only detected in one of three samples, the detection was just after well installation, and toluene is considered a common laboratory contaminant.	Low	Conservative
Potential impacts of the Topanga fire on the selection of CPECs and risks have been evaluated. Although soil concentrations of metals and dioxins may have been impacted by the fire and therefore risks may have been increased, there were no identified risk assessment decisions based solely on post-Topanga fire data	Low	Uncertain
EPC Calculations		
Where available, site-specific (actual) chemical data were used in the risk assessment. Where data were not available, risks associated with benzene, toluene, ethylbenzene, xylenes (BTEX) and polynuclear aromatic hydrocarbons (PAHs) are estimated based, in part, on extrapolation factors using site TPH data as described in the SRAM (MWH, 2005). The estimation of BTEX and PAH concentrations from TPH concentrations is considered conservative since the extrapolation factors used to estimate BTEX and PAH concentrations are based on the maximum ratio of TPH concentration to petroleum constituent concentration in the dataset.	Medium	Conservative
TPH-G was detected in a single surface sample out of 139 samples at the RMHF RFI site; the chemical is not considered site related and not all BTEX-related compounds were detected in any soil or active/passive soil gas samples near the location, therefore extrapolation of TPH-G was not conducted.	Medium	Not Conservative

Table 6-6 (2 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
Where VOCs are detected in one media, and analyzed for in another media to which the VOC could migrate to but were not detected, media-to-media extrapolations were conducted (e.g., soil-to-soil vapor). This procedure is expected to overestimate potential exposures	Medium	Conservative
When VOC soil vapor samples were available for the RMHF and B1433 RFI sites, soil matrix to soil vapor extrapolations were only conducted for non-collocated soil matrix samples with detects.	Low	Conservative
Soil and soil vapor CTE EPCs were calculated using 1/2 the SQL when there were too few samples to calculate a mean in ProUCL.	Low	Conservative
Burrow-air inhalation risks for Chatsworth Groundwater matrix COPC trichloroethene at the B4133 RFI site are estimated using groundwater-to-soil vapor partitioning, though the chemical was not detected in soil or soil vapor.	Low	Conservative
Estimation of soil vapor concentrations overstates actual burrow concentrations: 1. Model is conservative 2. Model does not account for attenuation between 12 to 73 feet bgs depth to groundwater and 0 to 6 feet bgs depth interval for burrows 3. Air flow in burrows is not accounted for	Medium	Conservative
The 95% UCL concentration of some chemicals is greater than the maximum concentration, therefore the maximum was used as the RME EPC. This is considered to be a likely overestimation of the representative exposure point concentration because samples were collected in areas with the highest likelihood to detect the highest concentrations at the site, and a receptor using the site is not always exposed to the location of highest concentrations.	Medium	Conservative
The mean concentration for some chemicals exceeded the selected RME concentration, therefore the RME concentration was also used as the CTE concentration under some circumstances.	Medium	Conservative
At the RMHF RFI site one sample was included in soil vapor from 10.25 ft which is below the range 3-10 ft bgs. It was technically outside the assumed exposure range, but was very close and represented a station without other data at higher depths.	Low	Conservative
EPCs for the RMHF RFI site were calculated including data collected outside the RMHF site boundary and downgradient.	High	Conservative
Data from drainage areas at Brendeis Bardine, near the RMHF RFI site, included a detected concentration of DDD. Later data were not analyzed for pesticides and were not included in the RMHF RFI site calculations. This uncertainty is low because site data did not include high pesticide contributions to risk and therefore drainage from RMHF would also not likely contribute to site-related risks.	Low	Uncertain
As described in Section 1.0, some additional soil samples were collected at the RMHF RFI Site after the site risk assessment was completed. Data for these additional samples could not be assessed quantitatively, which results in some uncertainty. The additional samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH, and metals. VOC, TPH, and pesticide compounds were detected at concentrations similar or lower than the concentrations detected previously, so including the additional data for these compounds would not affect the overall conclusions of the risk assessment. Several PAHs and metals were detected in the additional samples at concentrations greater than those detected previously. As a result, risk estimates for these compounds were likely underestimated for this site. However, the additional samples with higher concentrations of PAHs and metals are located in areas proposed for CMS and/or further evaluation.	Medium	Not Conservative

Table 6-6 (3 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 7 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
As described in Section 1.0, some additional soil samples were collected at the B4029 RFI Site after the site risk assessment was completed. Data for these additional samples could not be assessed quantitatively, which results in some uncertainty. The additional samples were analyzed for SVOCs, PCBs, and TPH. No SVOCs or PCBs were detected in these samples, and the concentrations of detected TPH compounds were within the range of concentrations previously detected and evaluated in the risk assessment. Consequently, including the additional data in the quantitative evaluation would not change the overall conclusions of the risk assessment for this site.	Low	Not Conservative
Exposure		
Representative wildlife species were selected based on attributes that tended to provide conservative estimates of exposure for other members of the guild.	Medium	Conservative
The assumption that the hawk, bobcat and mule deer spend all of their time at an individual Group 7 RFI site is unlikely to be true and results in an overestimation of potential risks. The minimum reported foraging ranges for the red-tailed hawk, bobcat and mule deer are 195, 1,152 and 192 acres, respectively, as compared to between 0.3 and 4.1 acres for the Group 7 RFI sites. If the foraging ranges of these species are accounted for, the RME HQs would all be below 1.	Medium	Conservative
The RMHF RFI site has been used for handling and storage of radioactive materials. However, radioactive risks are evaluated separately for this site.	High	Uncertain
Dermal and inhalation exposure pathways were not quantified for surface-dwelling	Low	Not Conservative
Toxicity Criteria		
High degree of uncertainty in extrapolation of dose-response data from laboratory animals to representative receptors.	High	Uncertain
Chronic no observable adverse effect levels (NOAEL)-equivalent TRVs are used to characterize toxic doses.	High	Conservative
Avian toxicity values are only available for a limited number of chemicals.	Medium	Not conservative
Use of acute/subchronic-to-chronic and endpoint-to-NOAEL uncertainty factors to estimate chronic NOAEL-equivalent TRVs.	Medium	Conservative
Extrapolation of toxicity data from test species to representative receptors.	High	Uncertain
Lack of TRVs for amphibians and reptiles -- note that no threatened or endangered amphibians or reptiles are known to reside at SSFL.	Medium	Not conservative
Extrapolation of toxicity data from animals under laboratory conditions to receptors under field conditions.	Medium	Uncertain
Constituent-to-constituent toxicity extrapolations for related chemicals (e.g., benzo[a]pyrene toxicity was used as a surrogate for similarly structured PAHs). Use of constituent-to-constituent extrapolations is supported by the abundance of research work on quantitative structure-activity relationships. When known, toxicity data from the more toxic constituent was used as the surrogate toxicity.	Medium	Conservative

Notes:

Low - This uncertainty is considered to have minimal impact on the total risk estimate.
Medium - This uncertainty is considered to have moderate impact on the total risk estimate.
High - This uncertainty is considered to have significant impact on the total risk estimate.

CPEC - chemical of potential ecological concern
TPH - total petroleum hydrocarbons
NOAEL - No Observed Adverse Effect Level
TRV - Toxicity Reference Value
EPC - Exposure Point Concentration
BTEX - benzene, toluene, ethylbenzene, and xylenes
SVOC - semivolatile organic compound
PAH - polynuclear aromatic hydrocarbon
DL - Detection Limit
SQL - Sample Quantitation Limit

TABLE 7-1
Group 7 Reporting Area Surficial Media Site Action Recommendations
(Page 1 of 3)

Area	Chemical Use Area Number	CMS Areas [1]	Recommended for Further Consideration in CMS Based On:			Comments
			Residential Receptor [2]	Recreational Receptor [2]	Ecological Receptor [2]	
B4029 RFI Site (SWMU 7.11) – Appendix A						
Building 4029 and Concrete Pads (3)	1	--	--	--	--	
Building 4029 Access Road	2	--	--	--	--	
Former OCY Tank Pipeline	3	--	--	--	--	
B4133 RFI Site (SWMU 7.2) – Appendix B						
Building 4133 Treatment Building, Southern Concrete Pad, and Size Reduction Area	1	--	--	--	--	
Caustic Solution Tank T-1	2a	--	--	--	--	
Sodium-Potassium Alloy Tank T-2	2b	--	--	--	--	
Caustic Solution Tank T-3	2c	B4133 - 2	Benzene; gasoline range organics; 1,2,4-trimethylbenzene	--	--	Elevated detections in soil vapor and soil matrix in area northeast of Tank T-3
Rinse Tanks T-4A and T-4B	2d	--	--	--	--	
Temporary Holding Tank	2e	--	--	--	--	
Lithium Hydride Reaction Vessel	2f	--	--	--	--	
Unpaved area north of Building 4133	3[3]	B4133-1	Aroclor 1254	--	--	Elevated Aroclor detection north of site collocated with elevated sodium; near drainage and former access road to RMHF
Western Drainage Debris Area	4	--	--	--	--	
Northwest Excavation Area	5	--		--	--	
Former Building 4654 Interim Storage Facility	6	--	--	--	--	
RMHF RFI Site (SWMU 7.6 and Area IV AOC) – Appendix C						
Building 4021 Radioactive Waste Decontamination and Packaging	1a	--	--	--	--	
Building 4022 Radioactive Vault Storage Building	1b	--	--	--	--	
Radioactive Water Treatment System	1c	--	--	--	--	
Filter/Blower Area	1d	RMHF-3	--	--	Cadmium (DM,MD), Cobalt (DM), Zinc (DM, T, H)	Elevated detections at the Filter/Blower Area surface water discharge point located on the RMHF northern slope.
Substation 721	2a	--	--	--	--	
Transformer Pole X-27A	2b	--	--	--	--	
Substation 728	2c	--	--	--	--	
Diesel AST	3	--	--	--	--	
Building 4021 Septic Tank and Pipeline	4a	--	--	--	--	
Building 4021 Leach Field	4b	--	--	--	--	
Building 4621 Radioactive Accountable Waste Storage	5a	--	--	--	--	
Mixed Waste Storage Yard	5b	--	--	--	--	
Building 4663 Equipment Storage Building	5c	--	--	--	--	

TABLE 7-1
Group 7 Reporting Area Surficial Media Site Action Recommendations
(Page 2 of 3)

Area	Chemical Use Area Number	CMS Areas [1]	Recommended for Further Consideration in CMS Based On:			Comments
			Residential Receptor [2]	Recreational Receptor [2]	Ecological Receptor [2]	
Building 4075 Contaminated Storage	6a	--	--	--	--	
Building 4563 Storage Area	6b [3]	RMHF-2	Benzene, methylene chloride	--	--	Elevated detections in stained soils; SVOC detection limits also elevated in area
Waste Receiving Yard	7 [3]	RMHF-2	Benzene, methylene chloride	--	--	Elevated detections in stained soils; SVOC detection limits also elevated in area
Building 4664 Low Level Waste Processing Building	8a	--	--	--	--	
Building 4665 Radioactive Scrap Oxidation Facility	8b	--	--	--	--	
Building 4034 (Office) and Building 4622 (Counting Building)	9a	--	--	--	--	
Building 4044 Break Room and Counting Lab	9b	--	--	--	--	
Building 4688 Equipment and Hazardous Waste Storage Area	9c	--	--	--	--	
Asphalt-Lined Drainage	10a [3]	RMHF-3	--	--	Cadmium (DM, MD), Cobalt (DM), Zinc (DM, T, H)	Elevated zinc and cobalt detected at the eastern portion of the asphalt-paved drainage swale. Elevated zinc concentrations down slope to west.
Catch Basin Drainage Channel	10b	--	--	--	--	
RMHF Catch Basin	10c	--	--	--	--	
RMHF Drainage Pipeline	10d	--	--	--	--	
Building 4029 STIR/LMFBR Test facility	11a	--	--	--	--	
Building 4811 STIR/LMFBR Mechanical Support Pad	11b	--	--	--	--	
Former Oil Sump	12	--	--	--	--	
Building 4664 Debris Area	13a	--	--	--	--	
Building 4075 Debris Area (G07-2044 and G07-2045)	13b	--	--	--	--	
Debris Area G07-1011 and G07-2046	13c	--	--	--	--	
Debris Area G07-1012	13d	--	--	--	--	
Debris Areas G07-1013 and G07-1014	13e	--	--	--	--	
Debris Areas G07-2043	13f	--	--	--	--	
Debris Area G07-1015	13g	--	--	--	--	
Debris Area G07-1016	13h	--	--	--	--	
Debris Area G07-1017	13i	--	--	--	--	
Building 4059 Debris Area (G07-1018 and G07-1019)	13j	--	--	--	--	
RMHF Northern Slope Excavation Area	14a	--	--	--	--	
RMHF Catch Basin Drainage Channel Excavation Area	14b	--	--	--	--	
RMHF Catch Basin Excavation Area	14c	--	--	--	--	
RMHF South Slope Excavation Area	14d	RMHF-1	Aroclor 1260, benzo(a)pyrene	Aroclor 1260	Aroclor 1260 (DM, T, BC, MD)	Located south of fence line in eastern area of former excavation area
		RMHF-4*	Cobalt		Cobalt (DM), Copper (DM, T), Silver (DM), Zinc (DM, T)	Located at storm water culvert that receives runoff from southern portion of RMHF and Building 4024 (Group 5)
RMHF Soil Disturbance Area	15	--	--	--	--	

TABLE 7-1
Group 7 Reporting Area Surficial Media Site Action Recommendations
(Page 3 of 3)

General Notes:
'--' Indicates area is recommended for No Further Action (NFA) for respective receptor, or parameter not applicable; not recommended for CMS evaluation.
PAHs are included in SVOC analytical methods and are referenced specifically in this table where prominent as risk drivers/contributors apart from other SVOCs (e.g., phthalates, 2,4-dinitrophenol).
' * ' Indicates area is also recommended for source stabilization to address potential surficial migration of contaminants.

Notes:

(1) CMS Areas are numbered in sequence (e.g., RMHF-1, RMHF-2, RMHF-3). The extent of CMS Areas shown on Figure 7-1 are approximate and reflect site action recommendations based on characterization and risk assessment results inclusive for receptors evaluated (see Section 7). Risk drivers and significant risk contributors are indicated. An asterisk indicates that stabilization is also recommended. Areas outside of CMS Areas are recommended for NFA based on findings of the historical document review, characterization data, and risk assessment results.

(2) CMS recommendations are based on compounds considered risk drivers (excess cancer risk > 1 x 10^{-6} or hazard index > 1) and/or significant risk contributors.

(3) The CMS Area covers only a portion of this chemical use area.

Acronyms:

AOC = Area of Concern
AST = aboveground storage tank
B4029 = Building 4029
B4133 = Building 4133
BC = bobcat
CMS = Corrective Measures Study
DM = deer mouse
H = hawk
LMFBR = Liquid Metal Fast Breeder Reactor
MD = mule deer
NFA = no further action
OCY = Old Conservation Yard
PCE = tetrachloroethene
RFI = RCRA Facility Investigation
RMHF = Radioactive Materials Handling Facility
STIR = Shield Test Irradiation Reactor
SVOC = Semivolatile organic compound
SWMU = Solid Waste Management Unit
T = thrush
VOCs = Volatile Organic Compound

TABLE 7-2
SUMMARY OF GROUP 7 REPORTING AREA SURFICIAL MEDIA CMS RECOMMENDATIONS
(Page 1 of 2)

CMS Area	Description	Chemical Risk Drivers and Contributors	Rationale
B4133 – 1	Area North of Building 4133	Aroclor 1254	Elevated Aroclor 1254 detected in the unpaved area north of site, collated with elevated sodium results. Extent delineated by sampling results and drainage pathways.
B4133 – 2	Area Northeast of Building 4133	Benzene, gasoline range organics, 1,2,4-trimethylbenzene	Elevated benzene, gasoline range organics, and 1,2,4-trimethylbenzene detected in northeast portion of site adjacent to tank T-3. Extent delineated by sampling results.
RMHF-1	South Fence Excavation Area	Aroclor 1260, Benzo(a)pyrene	Elevated Aroclor 1260 and benzo(a)pyrene detected south of the RMHF fence line. Extent delineated based on sampling results, thin soils, and bedrock outcrop.
RMHF-2	Waste Receiving Yard Area	Benzene, Methylene Chloride	Elevated methylene chloride and benzene detected in stained soil in the area between the Waste Receiving Yard and Building 4563 Storage Area. SVOCs also with elevated detection limits in area. Extent delineated based on sampling results and thin soils to north.
RMHF-3	Northeast Slope Area	Cadmium, Cobalt, Zinc	Elevated cadmium and zinc detected at the discharge point for the Filter/Blower Area drainage pipeline, and elevated cobalt and zinc detected at the eastern border of the asphalt drainage swale. Extent delineated based on sampling results and bedrock outcrops.
RMHF-4	Southern Culvert Area	Cobalt, Copper, Silver, Zinc	Elevated metals in soil near storm drain culvert; extent based on surface water drainage patterns. Additional delineation sampling recommended.

TABLE 7-2
SUMMARY OF GROUP 7 REPORTING AREA SURFICIAL MEDIA CMS RECOMMENDATIONS
(Page 2 of 2)

Notes:

(a) The lateral extent of areas recommended for further evaluation in the CMS (i.e., "CMS Areas") shown on Figure 7-1 are approximate; CMS Areas may be refined during the CMS based on additional sampling results, land use scenarios, and/or additional risk assessment.

(b) Areas outside of the CMS Areas are recommended for No Further Action (NFA) based on findings of the historical document review, characterization data, and risk assessment results for currently evaluated receptors.

Acronyms:

B4029 = Building 4029

B4133 = Building 4133

bgs = below ground surface

CMS = Corrective Measures Study

NA = not applicable

PCB = polychlorinated biphenyl

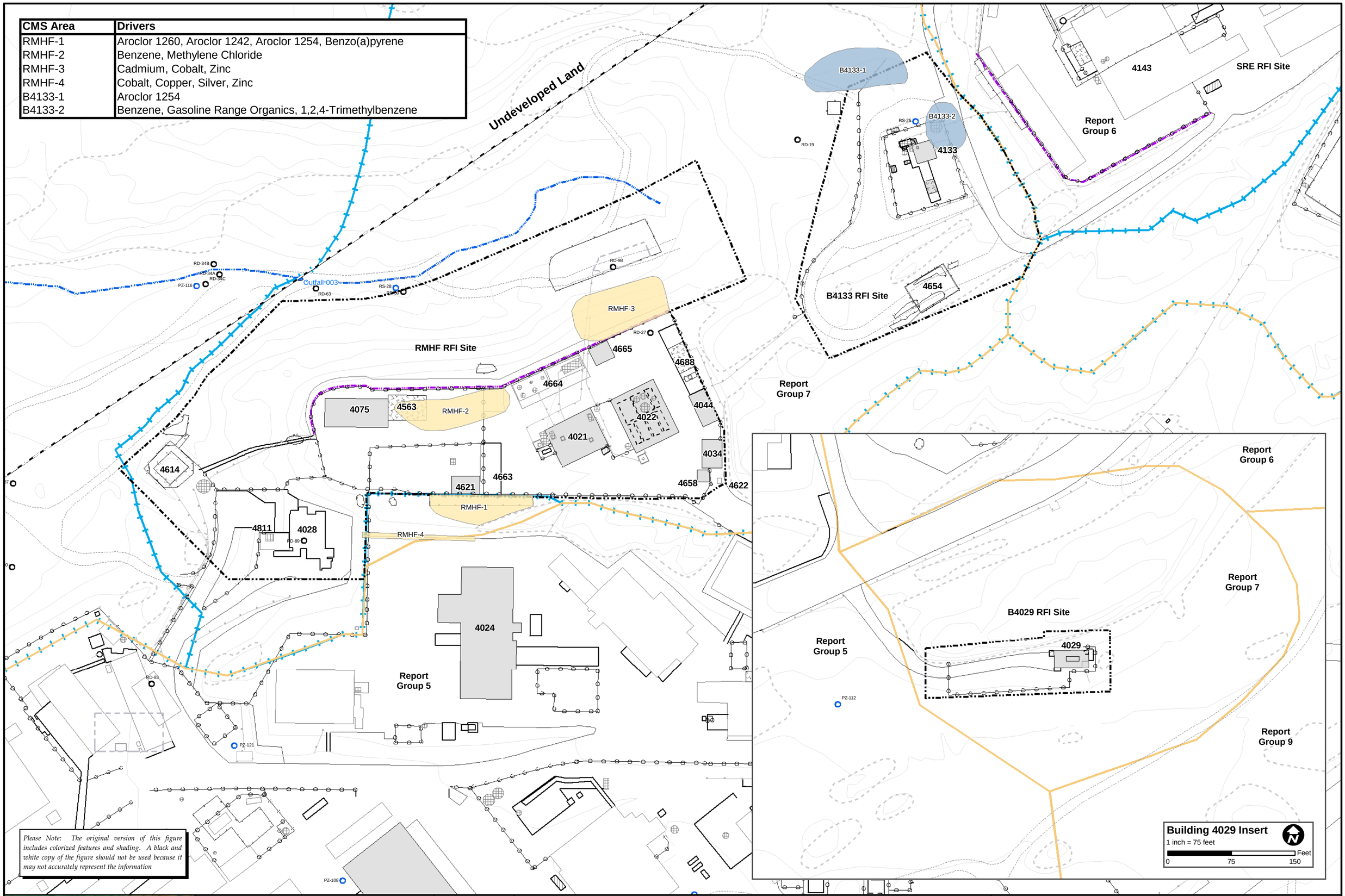
RFI = RCRA Facility Investigation

RMHF = Radioactive Materials Handling Facility

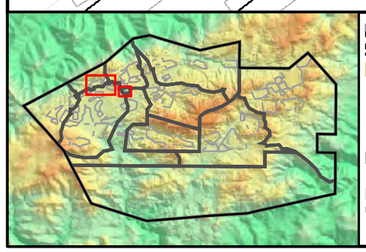
SVOC = semivolatile organic compound

FIGURES

CMS Area	Drivers
RMHF-1	Aroclor 1260, Aroclor 1242, Aroclor 1254, Benzo(a)pyrene
RMHF-2	Benzene, Methylene Chloride
RMHF-3	Cadmium, Cobalt, Zinc
RMHF-4	Cobalt, Copper, Silver, Zinc
B4133-1	Aroclor 1254
B4133-2	Benzene, Gasoline Range Organics, 1,2,4-Trimethylbenzene



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide/Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

SANTA SUSANA FIELD LABORATORY

Areas Recommended for Corrective Measures Study (CMS) Group 7 Reporting Area

Document: RFI-Report-Group7-Bundle-CMS_Group7.mxd

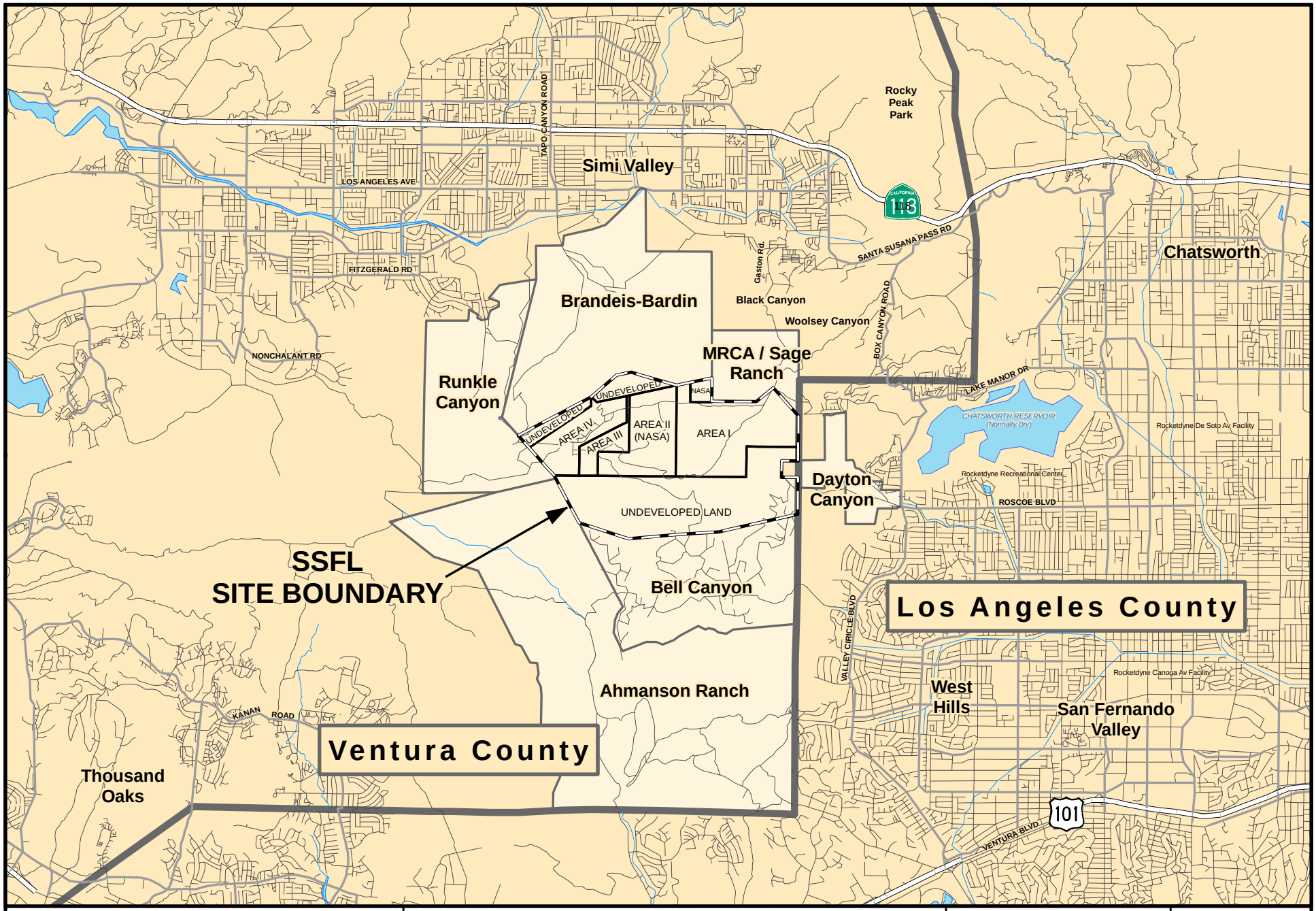
Date: Jun 11, 2009

1 inch = 75 feet

0 75 150 Feet

MWH

FIGURE ES-1



1 inch = 1.5 miles

Miles 0 1.5 3

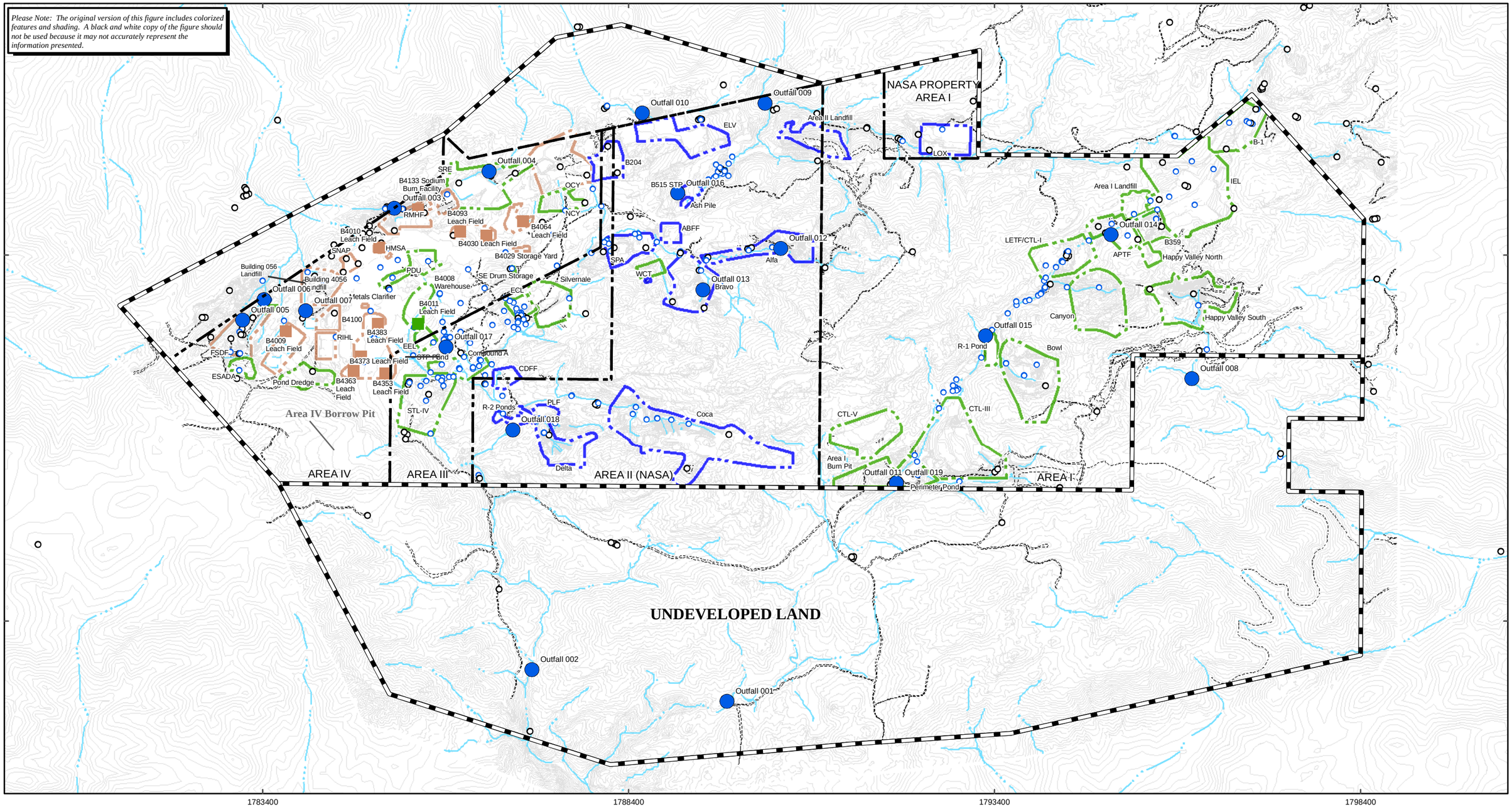
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Regional_Map.mxd

Date: Jun 10, 2009

Regional Map

FIGURE 1-1



MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

RFI Sites
- DOE
- NASA
- BOEING

Leach Fields
- DOE
- Boeing

- NPDES Outfall
- Near-surface Groundwater Wells
- Deep (Chatsworth Formation) Groundwater Wells

Notes:
1. Property ownership labeled for administrative areas.
2. DOE has leased and used several buildings in Area IV as shown.
3. All leach fields in Areas I, II, III are located at RFI sites. Therefore, these leach fields are not identified on this figure.
4. Site ownership/responsibility shown as developed for RFI.

Base Map Legend
- SSFL Property Boundary
- Administrative Boundary
- Pond
- Drainage
- Dirt Road
- Road

SSFL Site Plan

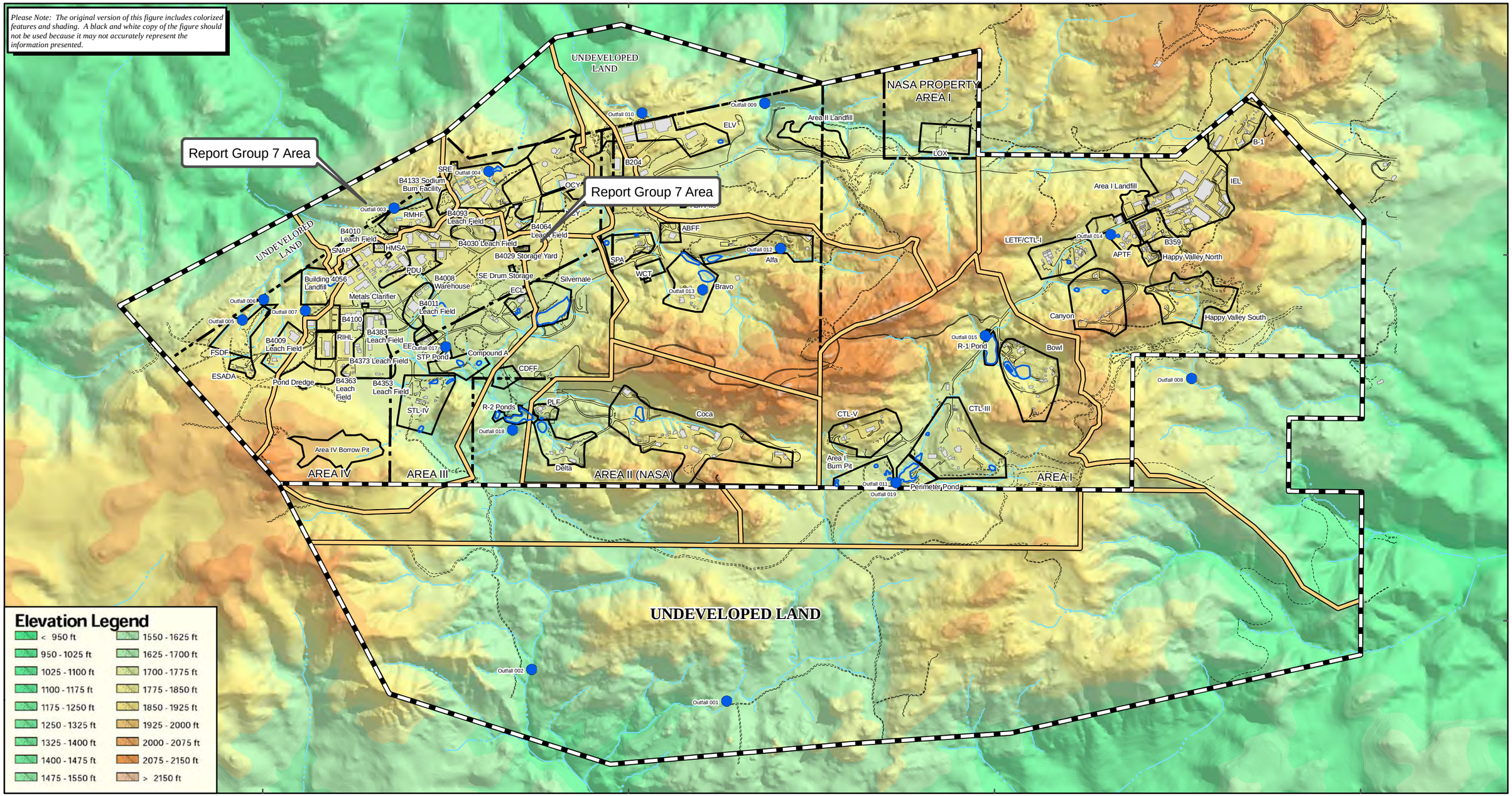
SANTA SUSANA FIELD LABORATORY

Date: Jun 10, 2009

MWH

FIGURE 1-2

Document: RFI-Report-Group7-Bundle-SitePlan_SSFL.mxd



0 1,300
FEET

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

AREA I
SWMU 4.1 - B1 Area
SWMU 4.2 - Area I Landfill
SWMUs 4.3, 4.4 and AOC - Instrument and Equipment Laboratories (IEL)
SWMU 4.5, 4.6 - LOX Plant Former Sump/Clarifier and Drum Disposal Area
SWMU 4.7 - Component Test Laboratory III (CTL-III) Area
SWMU 4.8 - Area I Burn Pit
SWMU 4.9, 4.10, 4.11, AOC - Advanced Propulstion Test Facility (APTF) Area
SWMU 4.12 - Laser Engineering Test Facility (LETF) Component Test Lab (CTL-1) Area
SWMU 4.14 Canyon Area
SWMU 4.15 and AOC - Bowl Area and Building 901 Leachfield
SWMU 4.16 - Area I Reservoir (R-1 Pond)
SWMU 4.17 - Perimeter Pond
AOC - Building 1359 Sump
AOC - Happy Valley Area
AOC - CTL-V

AREA II
SWMU 5.1 - Area II Landfill
SWMU 5.2 - ELV Final Assembly Building 2206
SWMU 5.5 and AOC - Building 2204 Area
SWMU 5.6 - Former Incinerator Ash Pile
SWMU 5.7 - Hazardous Waste Storage Area Waste Coolant Tank (WCT)
SWMU 5.9, 5.10, 5.11 - Alfa Area
SWMU 5.12, 5.13, 5.14, 5.15 - Alfa/Bravo Skim Pond and Bravo Area
SWMU 5.18, 5.19 - Coca Area
SWMU 5.20, 5.21, 5.22 - Propellant Load Facility (PLF)
SWMU 5.23, 5.24 - Delta Area
SWMU 5.26 - R-2A and R2B Ponds
AOC - Building 2515 Sewage Treatment Plant
AOC - Storable Propellant Area (SPA)
AOC - Alfa/Bravo Fuel Farm
AOC - Coca/Delta Fuel Farm

AREA II (cont)
AOC - Building 2224 Leach Field

AREA III
SWMUs 6.1, 6.3, AOC - Engineering Chemistry Laboratory (ECL) Area
SWMU 6.4 - Compound A Facility
SWMU 6.5 - Systems Test Laboratory IV (STL-IV) Area
SWMU 6.8 - Silvernale Reservoir
SWMU 6.9 - Environmental Effects Laboratory (EEL)
AOC - SewageTreatment Plant (STL) Pond Area

AREA IV
SWMU 7.1 - Building 4056 Landfill
SWMU 7.2 - Building 4133, Sodium Burn Facility
SWMU 7.3 -Former Sodium Disposal Facility (FSDF)
SWMU 7.4 - Old Conservation Yard (OCY)
SWMU 7.5 - Building 4100 Trench
SWMU 7.6 - Radioactive Materials Handling Facility (RMHF)

AREA IV (cont)
SWMU 7.7 - Rockwell International Hot Laboratory (RIHL)
SWMU 7.8 - New Conservation Yard (NCY)
SWMU 7.9 - ESADA Chemical Storage Area
SWMU 7.10 - Former Coal Gasification PDU
SWMU 7.11 - Building 4029, Reactive Metal Storage Yard
AOC - Former Hazardous Materials Storage Area (HMSA)
AOC - Chemistry Laboratory Metals Clarifier
AOC - Pond Dredge Area
AOC - Sodium Reactor Experiment (SRE) Area
AOC - SE Drum Storage Yard
AOC - SNAP Facillity
AOC - Boeing Area IV Leach Fields
AOC - DOE Area IV Leach Fields
AOC - Building 4008 Warehouse

Legend
- SSFL Property Boundary
- Administrative Boundary
- Report Group Boundary
- RFI Site Boundary
- Building
- Pond
- Drainage
- Dirt Road
- Road
- NPDES Outfall

Group 7 RFI Site Location Map

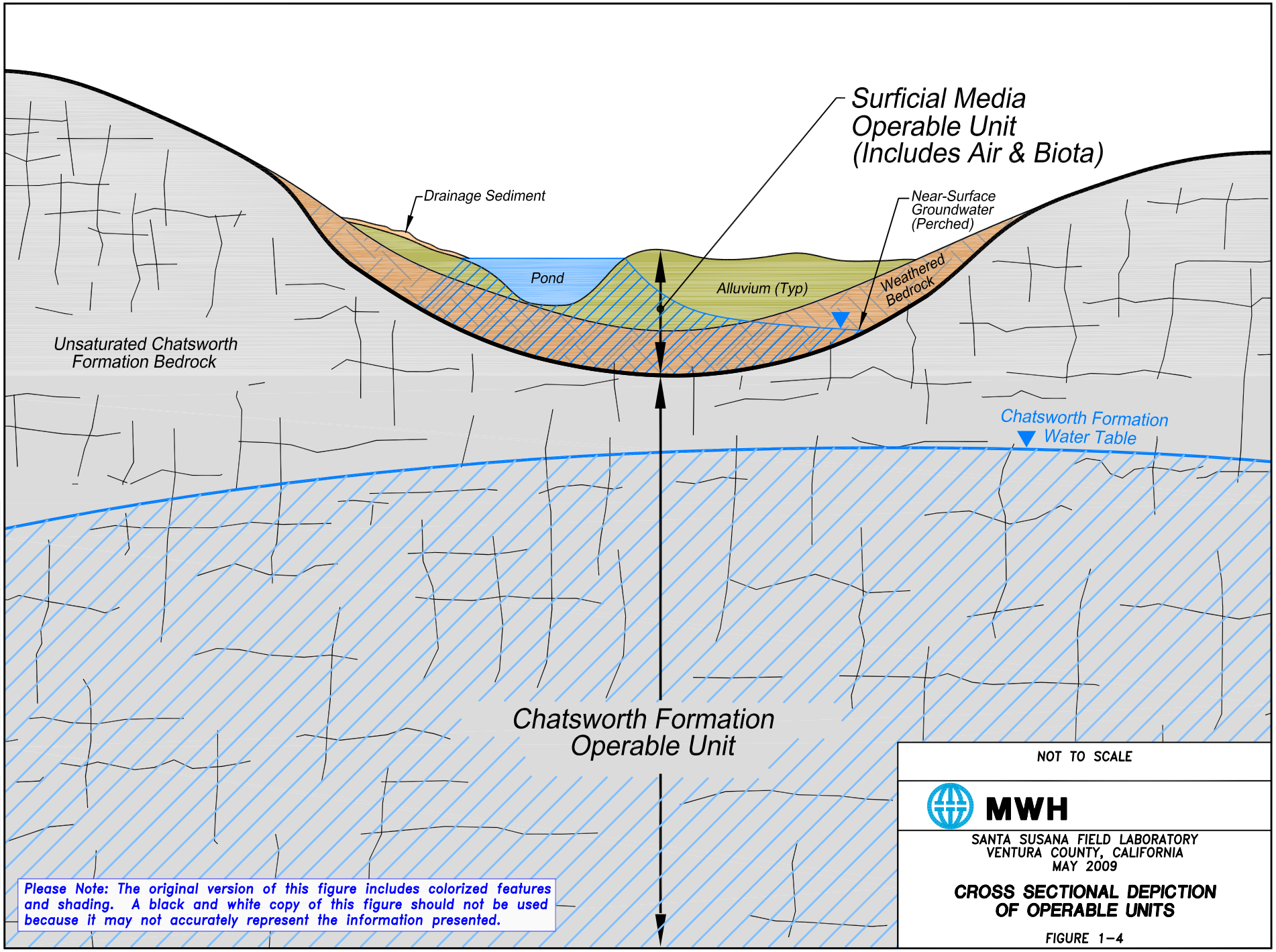
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-RFI_Site_Location.mxd

MWH

Date: Jun 10, 2009

FIGURE 1-3



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of this figure should not be used because it may not accurately represent the information presented.

NOT TO SCALE

MWH

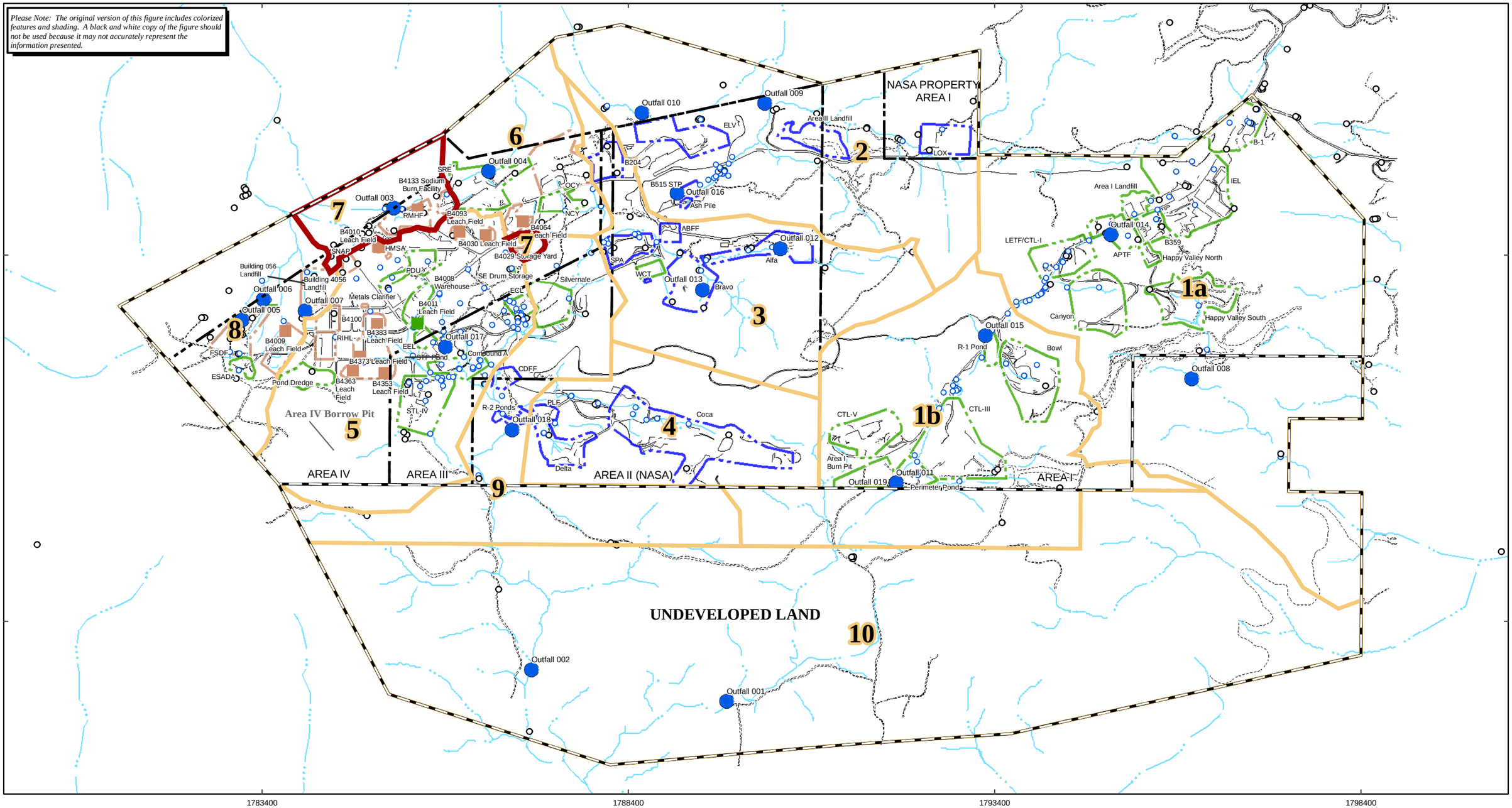
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

CROSS SECTIONAL DEPICTION OF OPERABLE UNITS

FIGURE 1-4

FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGS\CONCEPTUAL XSEC 4 29 09

JOB No.



MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

0 1,300 FEET

RFI Sites

- DOE
- NASA
- BOEING

Leach Fields

- DOE
- Boeing

- NPDES Outfall
- Near-surface Groundwater Wells
- Deep (Chatsworth Formation) Groundwater Wells

Report Group 7

Report Group Boundary

Notes:

1. Property ownership labeled for administrative areas.
2. DOE has leased and used several buildings in Area IV as shown.
3. All leach fields in Areas I, II, III are located at RFI sites. Therefore, these leach fields are not identified on this figure.
4. Site ownership/responsibility shown as developed for RFI.

Base Map Legend

- SSFL Property Boundary
- Administrative Boundary
- Pond
- Drainage
- Dirt Road
- Road

SSFL RFI Report Groupings

SANTA SUSANA FIELD LABORATORY

Date: Jun 11, 2009

Document: Group7-Bundle-SSFL_Report_Group.mxd

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FIGURE 1-5

Undeveloped Land

Outfall 003

Former Building 4021 Leach Field (Area IV AOC)

RMHF RFI Site

B4133 RFI Site

SRE RFI Site

Report Group 5

Report Group 6

Report Group 7

Report Group 9

B4029 RFI Site

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

RFI Sites
DOE Study Area

Group 7 Reporting Areas

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Reporting_Groups.mxd

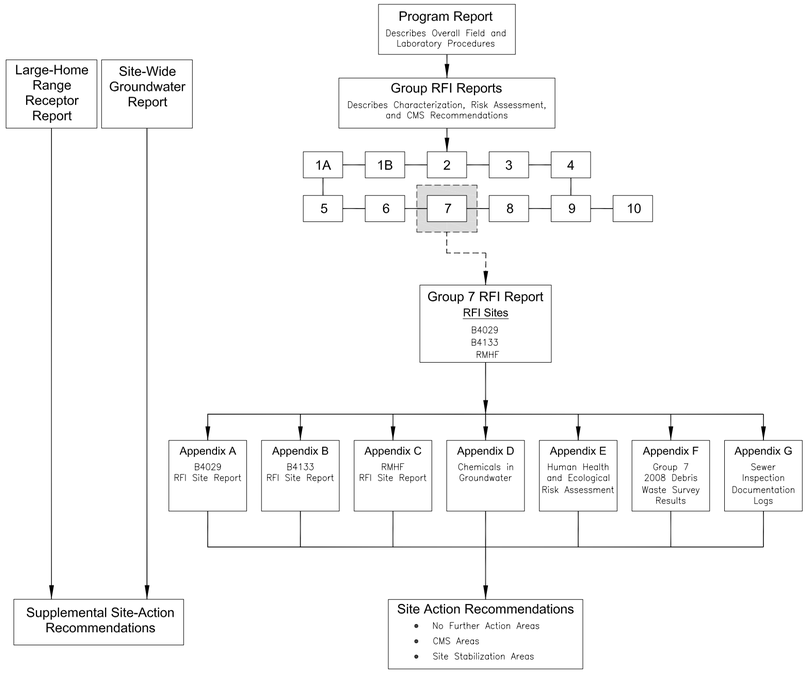
Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

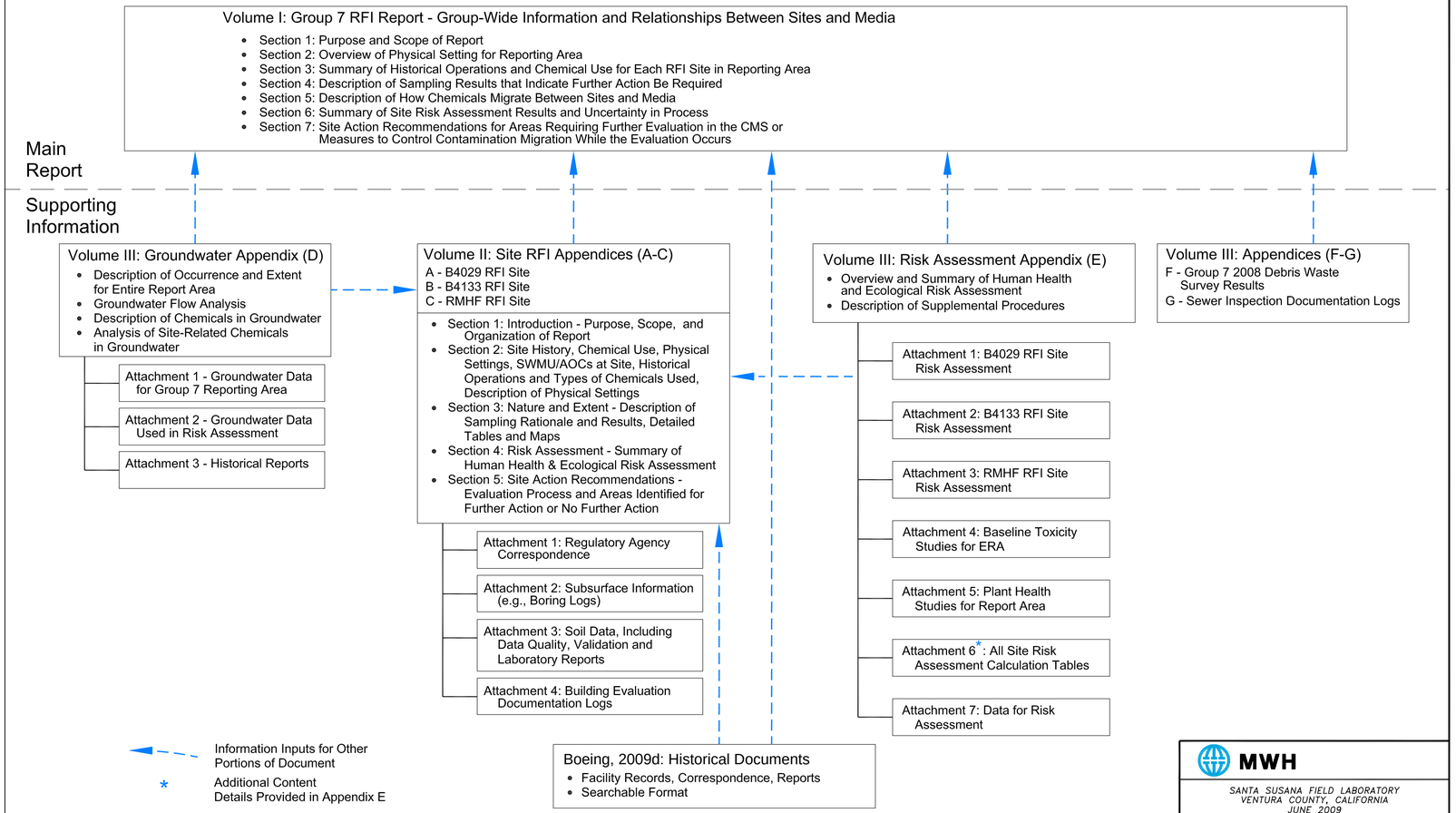
MWH

FIGURE 1-6

RFI Reporting Process



Group 7 Map of RFI Report Contents



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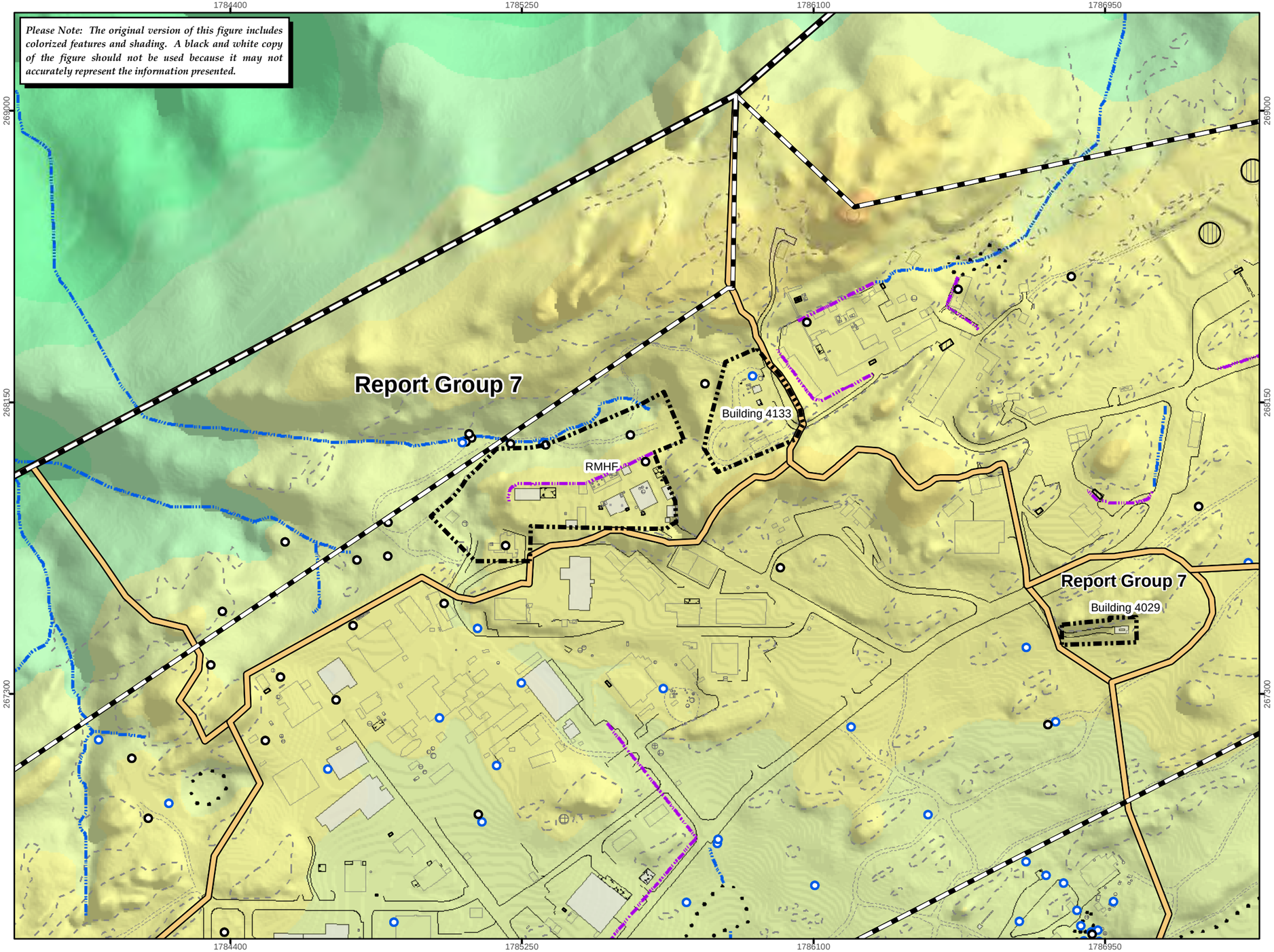
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
JUNE 2009

GROUP 7 MAP OF RFI REPORT CONTENTS

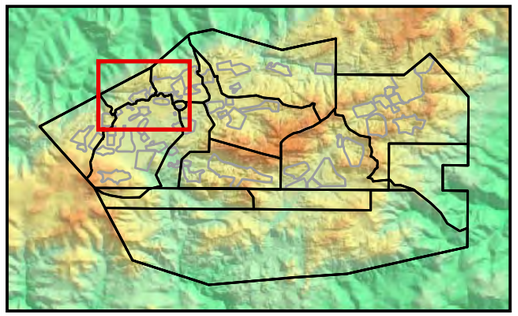
FIGURE 1–7

FILE No. INDSVR\INDUSTRIAL\CAD_MLUEBKE\BOEING_SANTA_SUSANA\GROUP_7_FIGS\FLOWCHART_5_09
JOB No. ---



Elevation Legend

- < 950 ft
- 950 - 1025 ft
- 1025 - 1100 ft
- 1100 - 1175 ft
- 1175 - 1250 ft
- 1250 - 1325 ft
- 1325 - 1400 ft
- 1400 - 1475 ft
- 1475 - 1550 ft
- 1550 - 1625 ft
- 1625 - 1700 ft
- 1700 - 1775 ft
- 1775 - 1850 ft
- 1850 - 1925 ft
- 1925 - 2000 ft
- 2000 - 2075 ft
- 2075 - 2150 ft
- > 2150 ft



Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Awning
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Dirt Road
- A/C Curbing
- Rock Outcrop
- Drainage
- Lined Drainage
- Ponds

Groundwater Wells

- Shallow
- Deep
- Abandoned Well

Topographic Relief Map
Group 7 Reporting Area

Date: Jun 10, 2009

Document: RFI-Report-Group7-Bundle-TopoRelief.mxd

1 inch = 300 feet

0 300 600 Feet

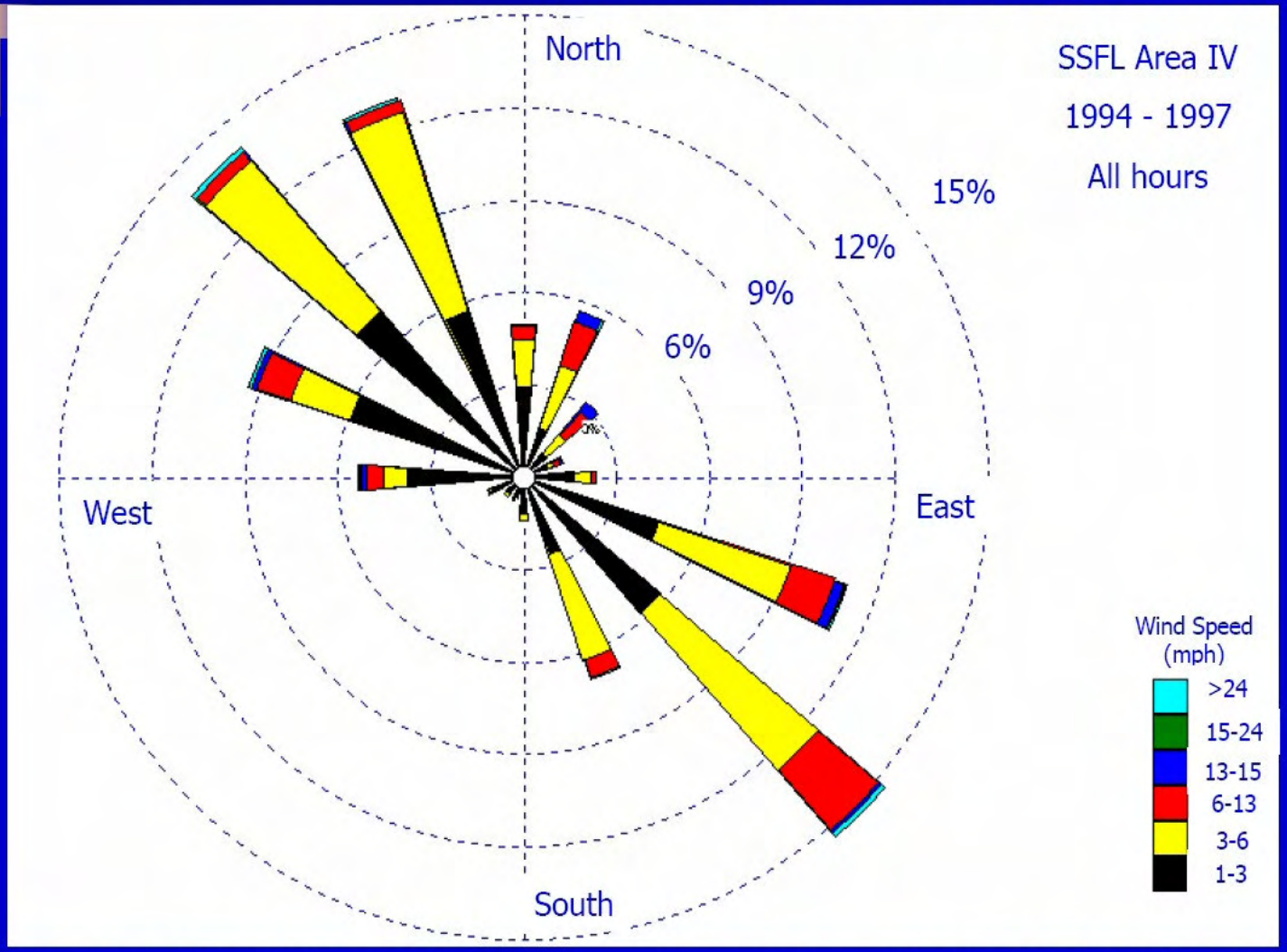
SANTA SUSANA FIELD LABORATORY

MWH

FIGURE 2-1

Wind Roses

Winds equally out of the Northwest and Southeast



The Santa Susana Field Laboratory (SSFL) : Exposure Pathways and Community Exposures Study - UCLA. Preliminary Analysis. August 19, 2003.

Source: STI (2003)

Figure 2-2

FIGURE 2-3A
ANNUAL PRECIPITATION AT SSFL, 1960-2007

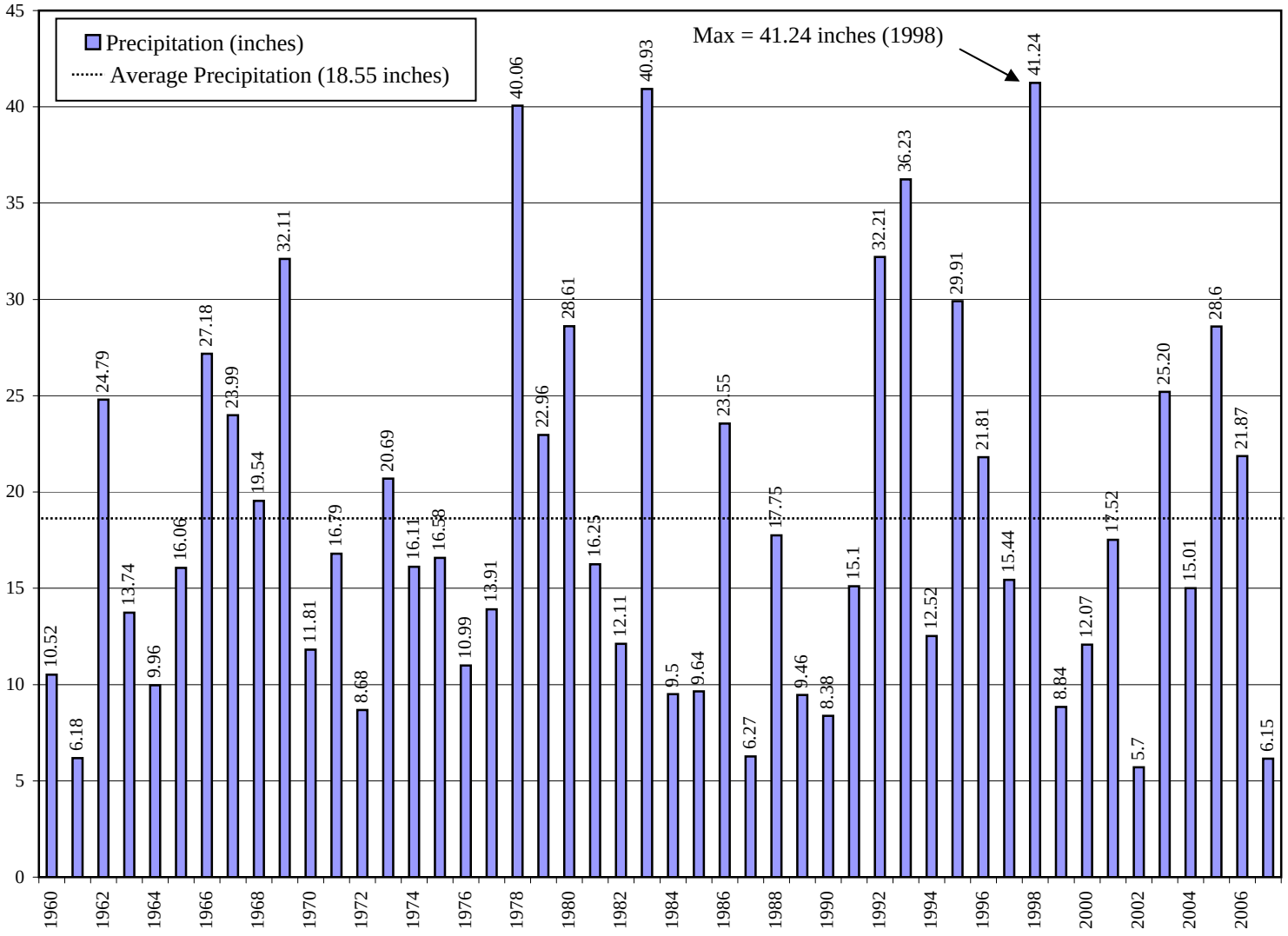
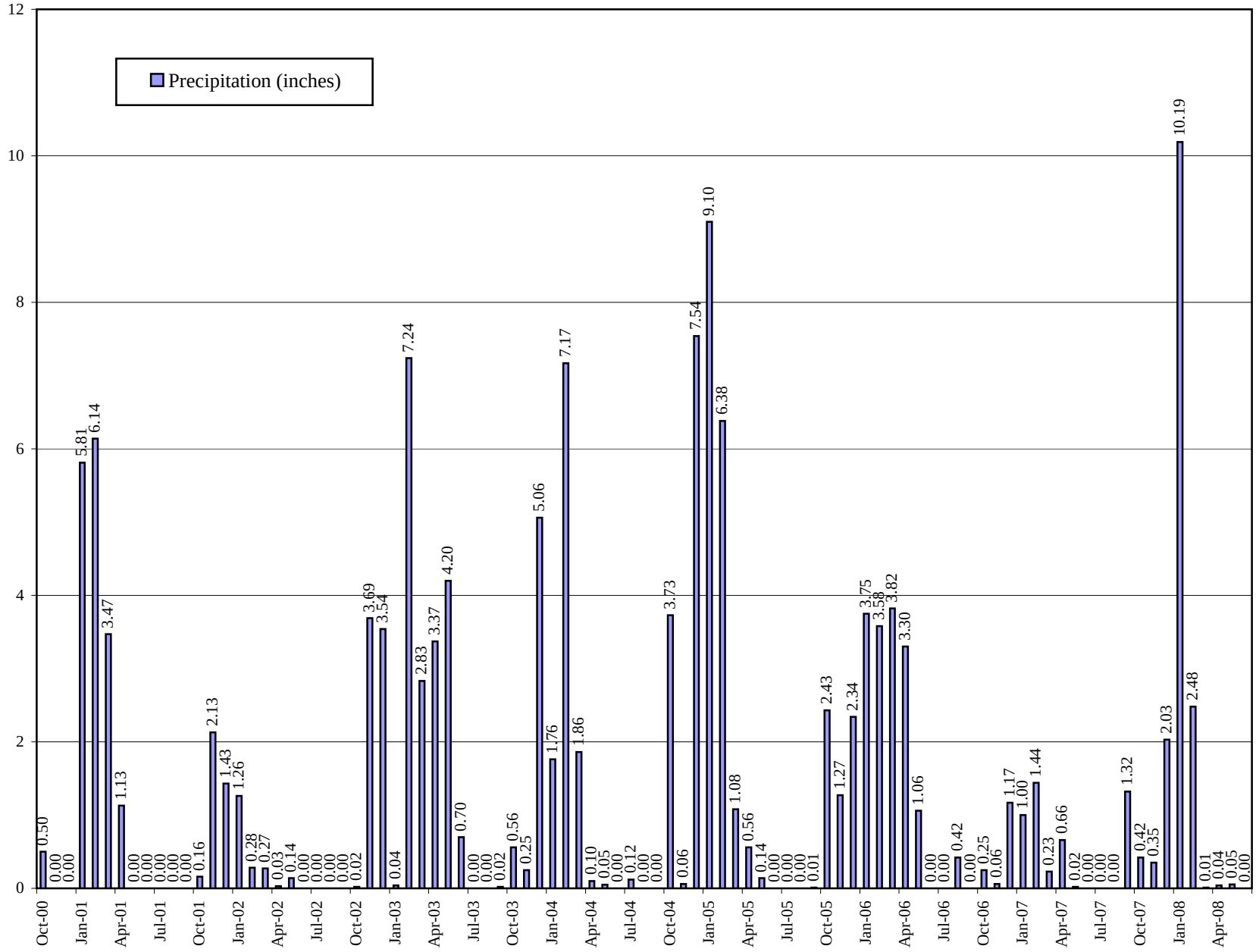
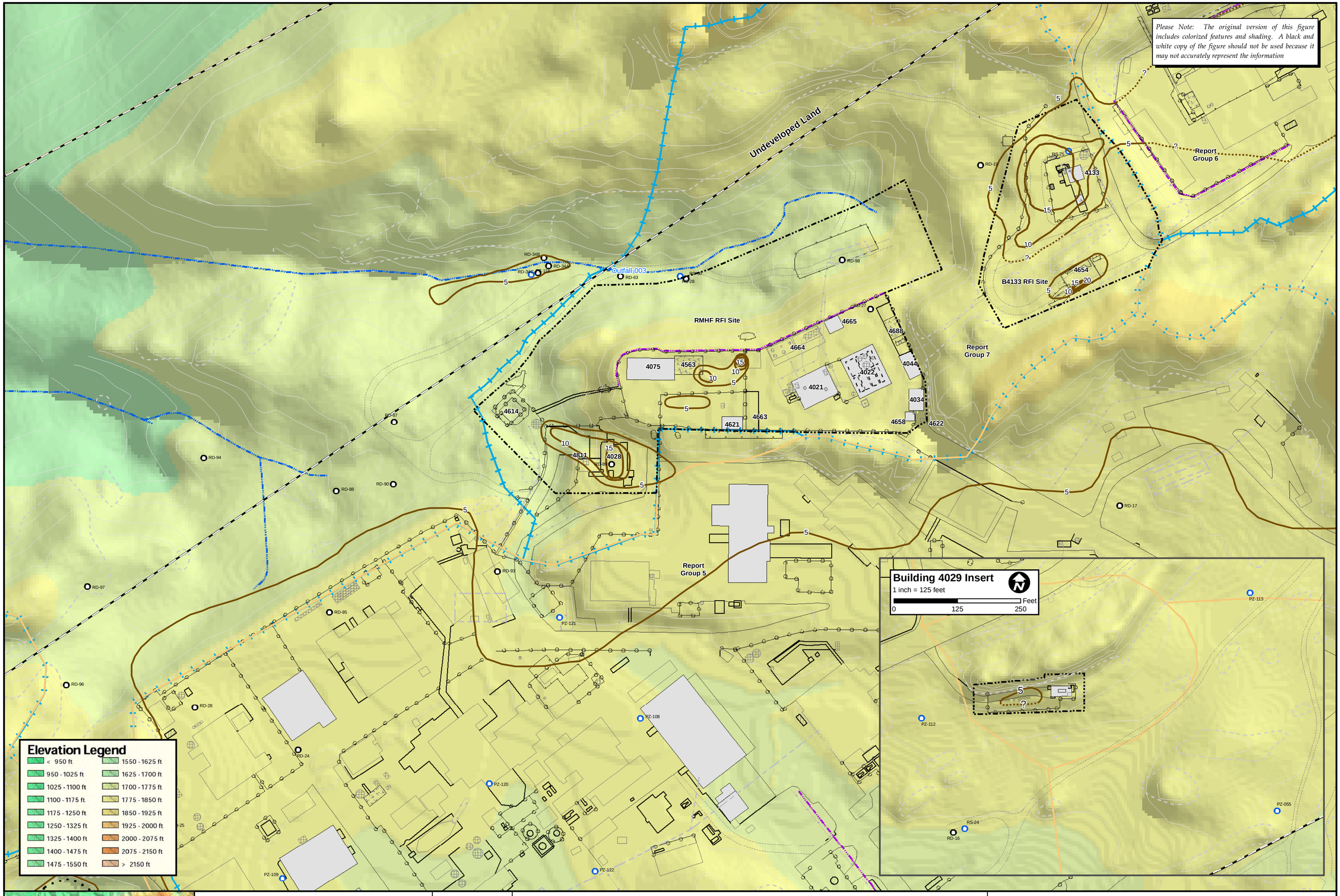
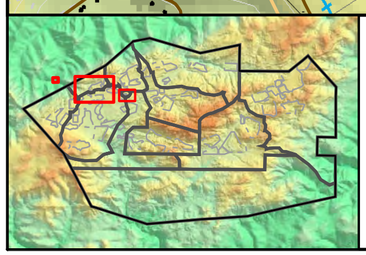


FIGURE 2-3B
MONTHLY PRECIPITATION AT SSFL, OCTOBER 2000 - JUNE 2008







Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Approximate Extent of Alluvium and Fill Soils Thickness

-#-

- Depth in feet of isopatch contour (5, 10, 15, 20)
? - Indicates isopatch contour depth is inferred, due to lack of date

Note: Alluvium and fill soils thickness between isopatch contours is variable, with thinner deposits near bedrock outcrops.

Generalized Extent of Alluvium and Fill Soils Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Alluvium.mxd

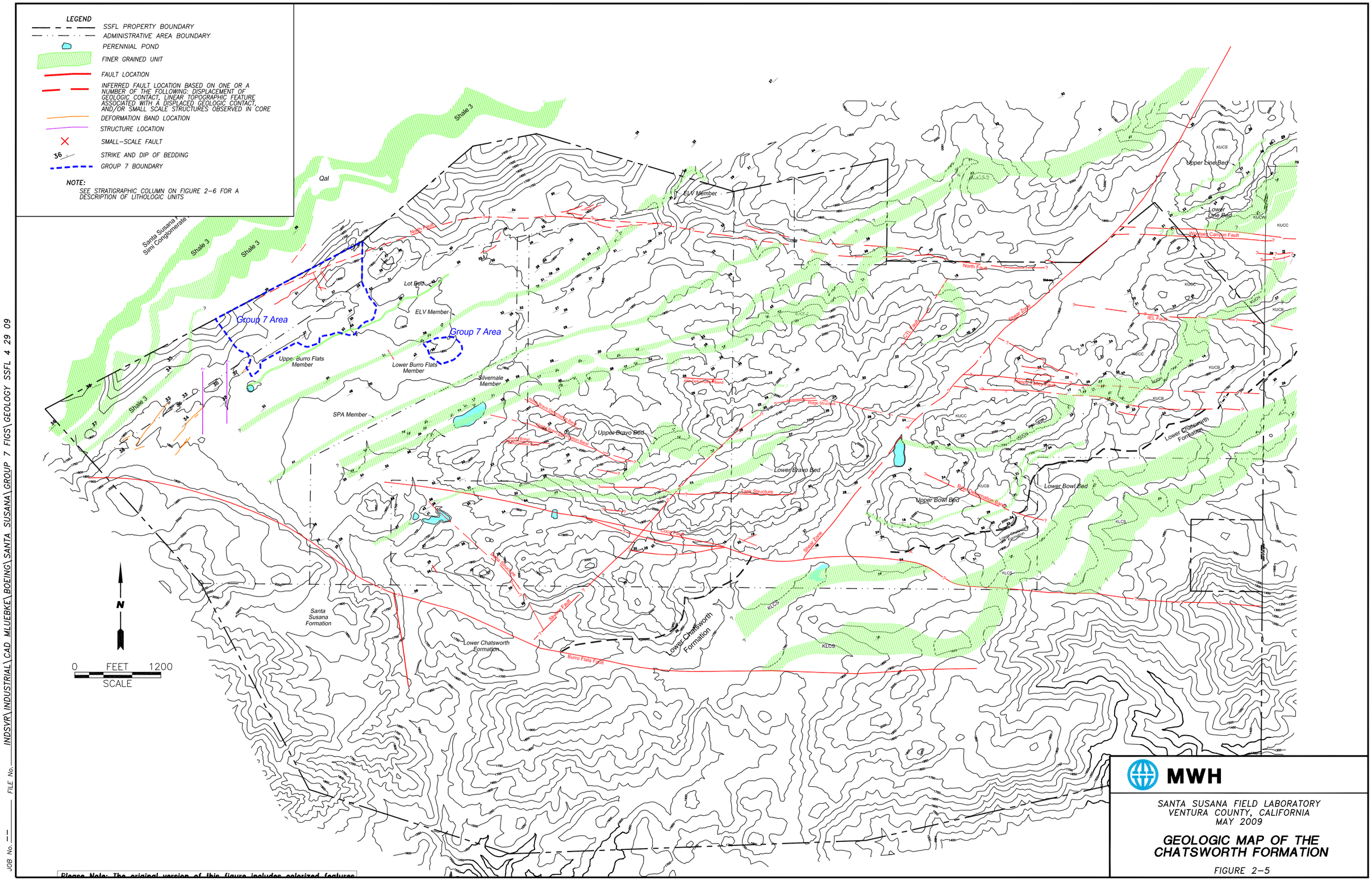
Date: Jun 12, 2009

1 inch = 100 feet

0 100 200 Feet

MWH

FIGURE 2-4



JOB No. --- FILE No. INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGS\GEOLOGY SSFL 4 29 09

Please Note: The original version of this figure includes colorized features

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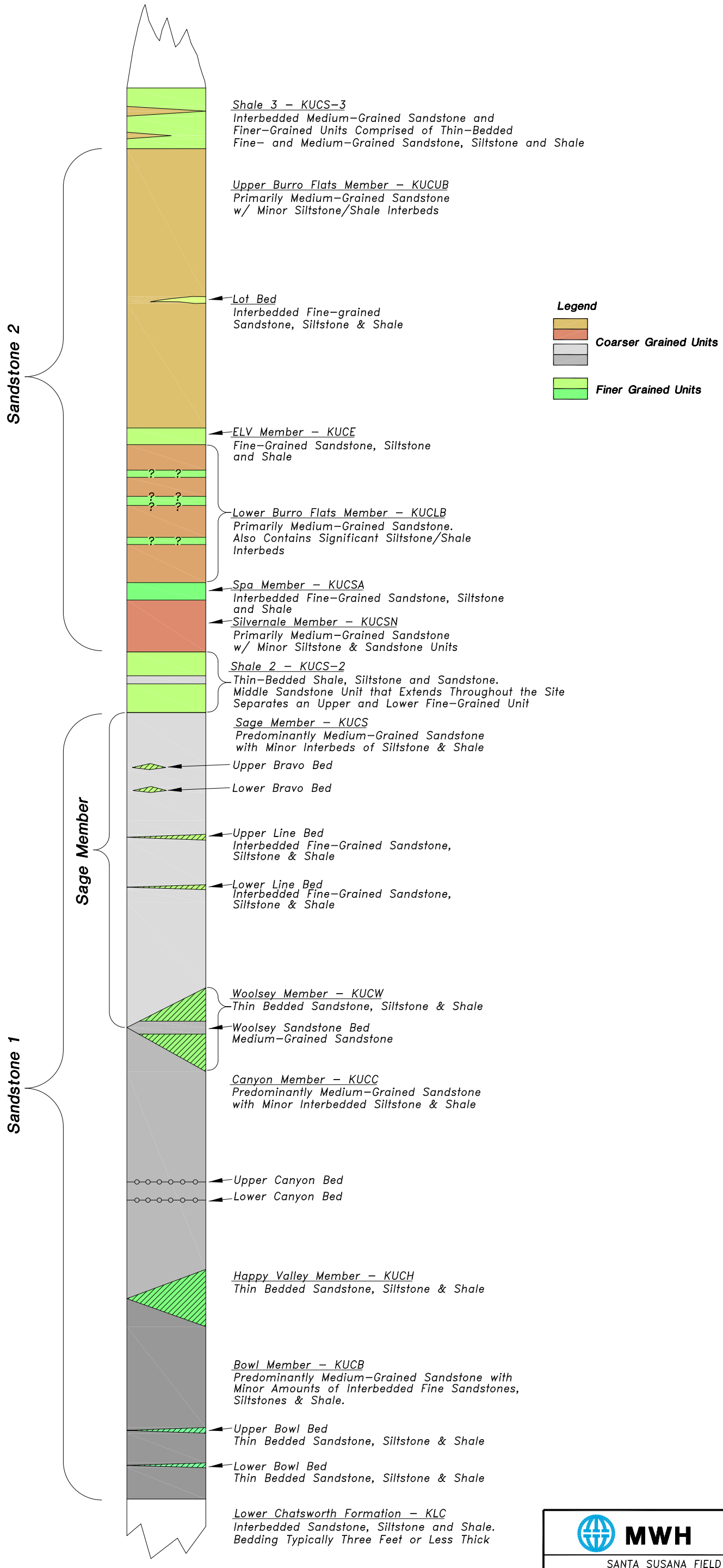
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

GEOLOGIC MAP OF THE CHATSWORTH FORMATION

FIGURE 2-5



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of this figure should not be used because it may not accurately represent the information presented.

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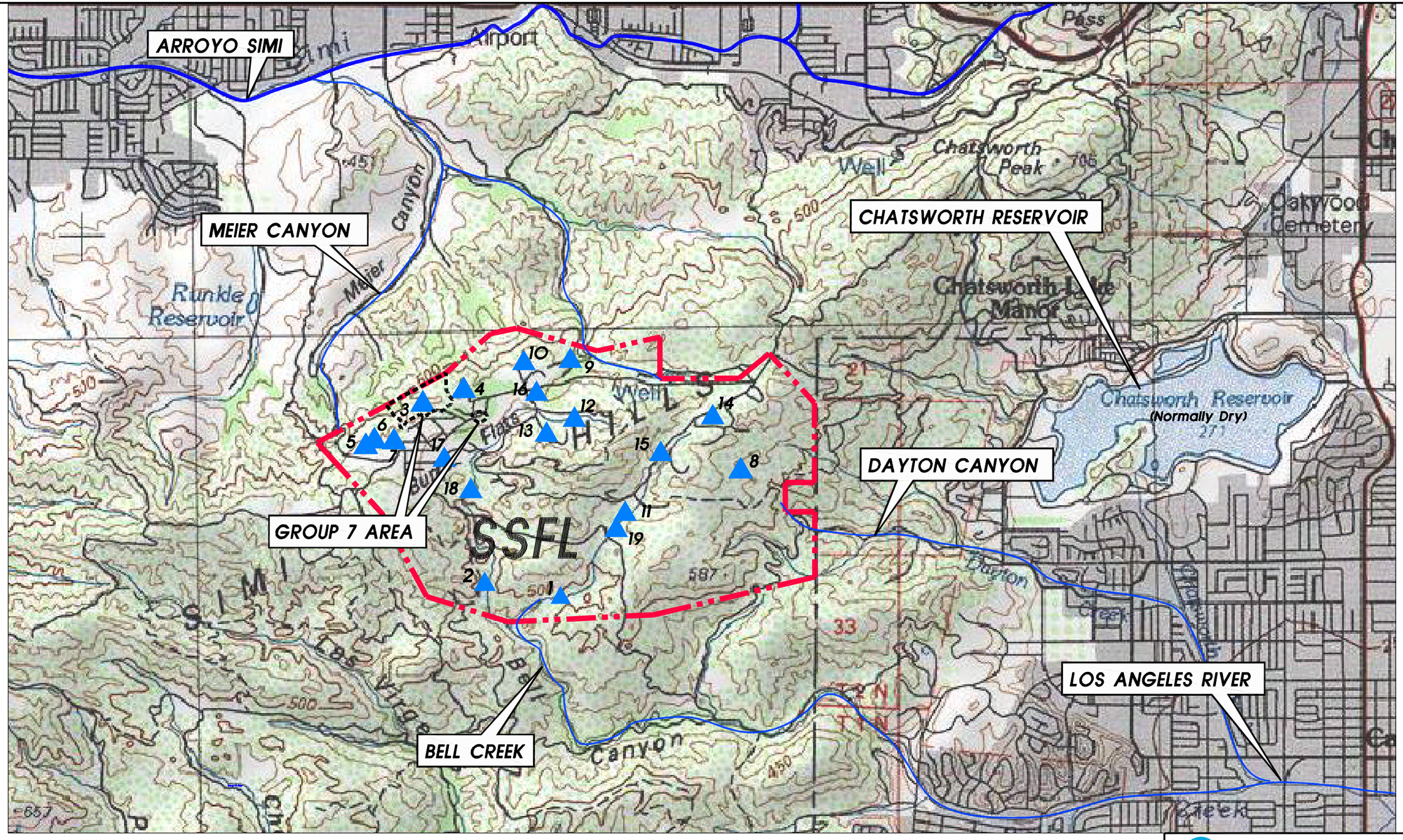
VENTURA COUNTY, CALIFORNIA
MAY 2009

STRATIGRAPHIC COLUMN OF THE CHATSWORTH FORMATION

FIGURE 2–6

JOB No. -- FILE No. INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGS\STRAT COLUMN 4 29 09



Legend

▲ NPDES Outfalls

0 FEET 5280
SCALE

MWH

SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

DRAINAGES LEADING FROM SSFL

FIGURE 2–7A

JOB No. -- FILE No. CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGS\OUTFALLS 4 29 09

Undeveloped Land

Outfall-003

RMHF RFI Site

Asphalt Drainage Swale

Drainage Pipeline

Discharge Pipeline

Storm Drain

H Street

17th Street

Report Group 5

Report Group 6

Report Group 7

B4133 RFI Site

SRE RFI Site

Collection Sumps

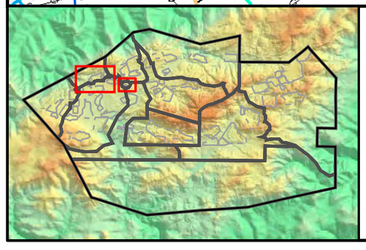
Neutralizing Pit Drain Pipe

4075 4563 4665 4664 4688 4044 4022 4021 4034 4658 4622 4621 4663 4614 4811 4028 4024 4133 4654 4143

RD-34B RD-34A RD-34C RD-116 RD-83 RD-82 RD-30 RD-98 RD-27 RD-19 RD-85 RD-87 RD-94 RD-88 RD-90 RD-89 RD-17 RD-93 RD-97 RD-95 RD-96 RD-28 RD-24

PZ-121 PZ-108 PZ-041 PZ-120 PZ-110

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Watershed Boundary
- Surface Water Divide
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Figure Legend

- Surface Flow

Surface Water Drainages
Northern Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-SurfaceFlow_N.mxd

Date: Jun 12, 2009

1 inch = 100 feet

0 100 200 Feet

MWH

FIGURE 2-7B

Report Group 6

Report Group 7

Report Group 5

Report Group 9

G Street

Pipeline Beneath Road

B4029 RFI Site

4029

Silvernale RFI Site

Silvernale Reservoir

RD-17

PZ-113

PZ-112

PZ-058

PZ-055

RD-16

RS-24

PZ-110

PZ-111

PZ-052

SH-6

SH-7

SH-1

PZ-027

PZ-072

PZ-006

PZ-025

SH-4

SH-2

SH-3

RD-08

SH-9

SH-8

RD-11

SH-5

HMR-26

RD-12

SH-10

WS-6

ECL-SUMP

ECL-FD

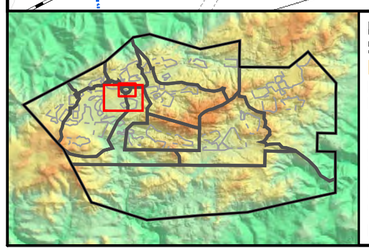
PZ-024

PZ-026

PZ-028

PZ-023

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Figure Legend

- Surface Flow

Surface Water Drainages
Southern Group 7 Reporting Area
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-SurfaceFlow_S.mxd

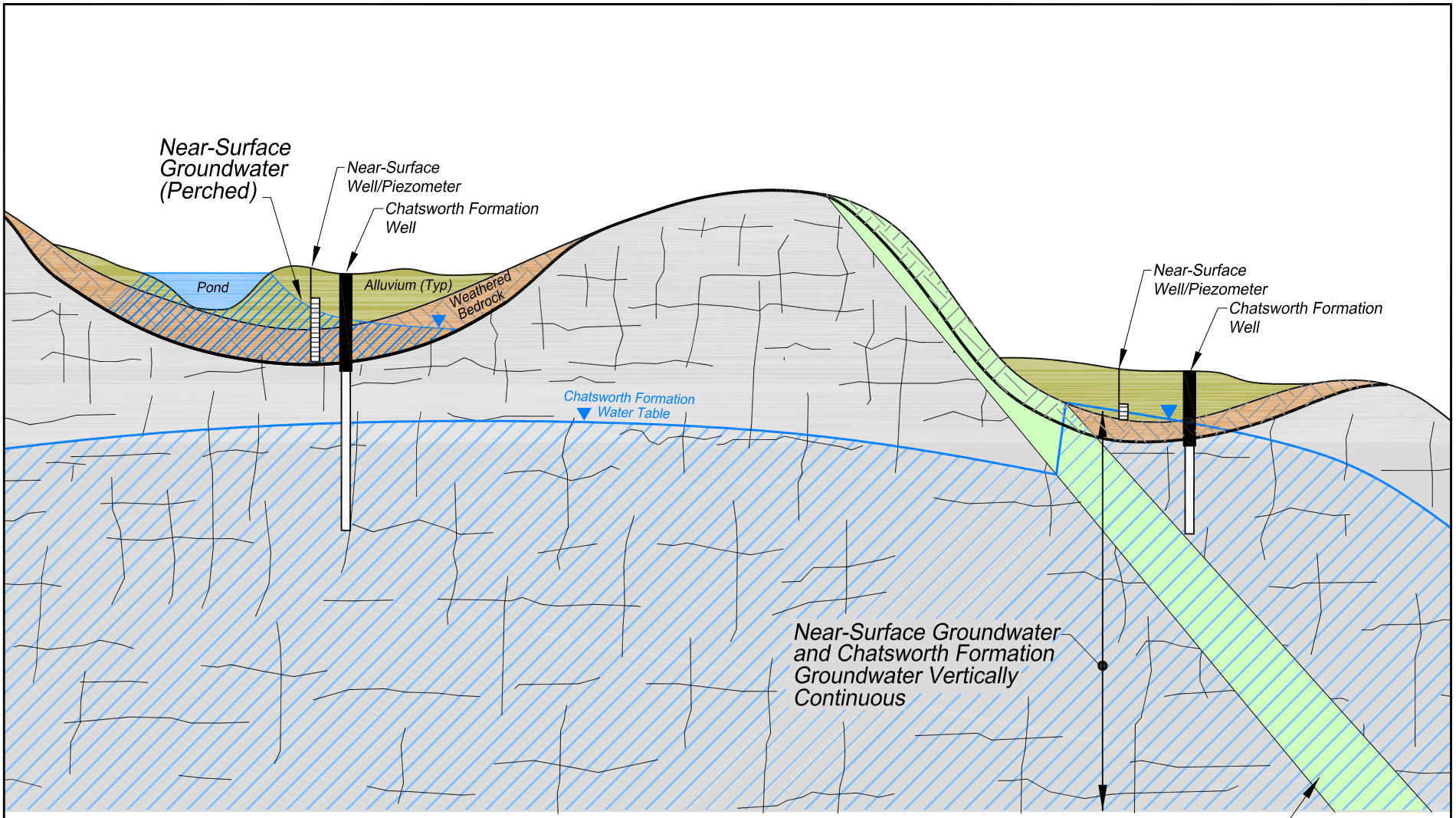
Date: Jun 12, 2009

1 inch = 100 feet

0 100 200 Feet

MWH

FIGURE 2-7C



Note:

From about 2003 to mid–2007 the groundwater was characterized as either "near–surface" or "Chatsworth formation". The set of definitions has been modified to also include the term "perched groundwater" which refers to groundwater that exists above an unsaturated zone in either weathered or unweathered bedrock. This modification is pursuant to DTSC's comments in their draft memorandum dated April 4, 2007 on the Group 6 RFI Report, and a meeting held on June 7, 2007 between DTSC and the SSFL.

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NOT TO SCALE

MWH

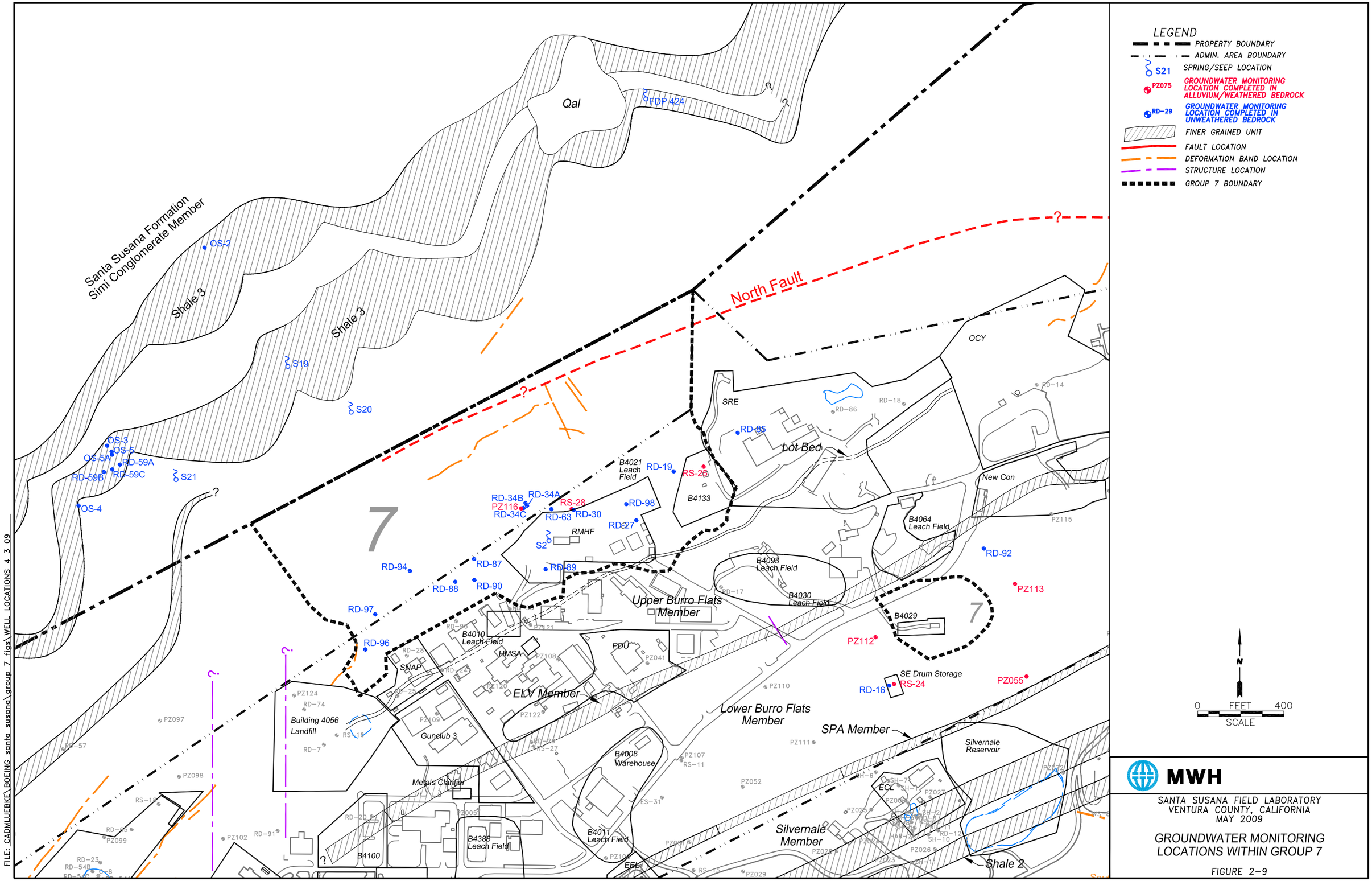
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

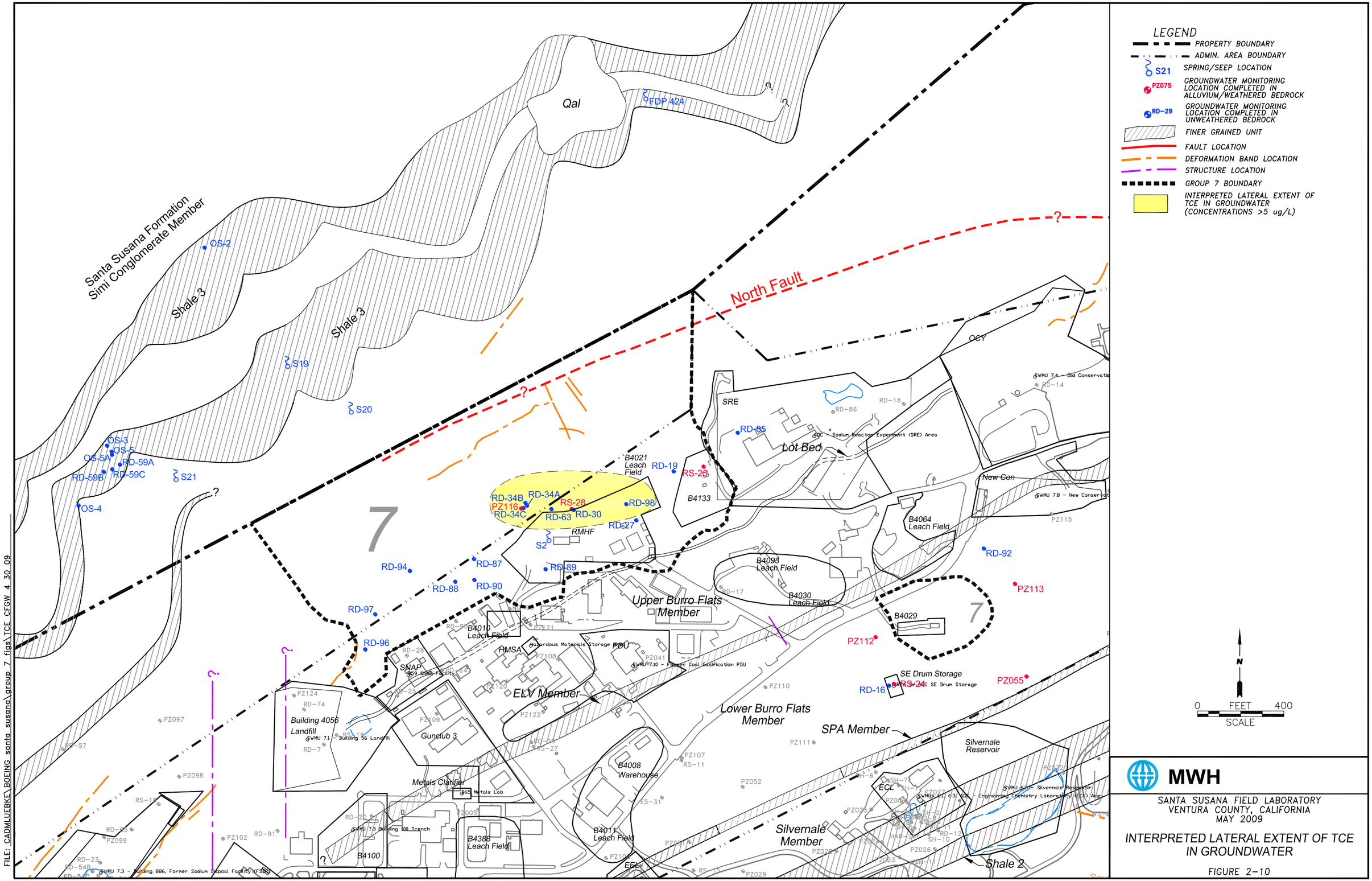
CONCEPTUAL CROSS SECTION OF NEAR-SURFACE & CHATSWORTH FORMATION GROUNDWATER OCCURENCE

FIGURE 2–8

FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGS\CONCEPTUAL XSEC 4 29 09

JOB No.


LEGEND
PROPERTY BOUNDARY
ADMIN. AREA BOUNDARY
S21 SPRING/SEEP LOCATION
PZ075 GROUNDWATER MONITORING LOCATION COMPLETED IN ALLUVIUM/WEATHERED BEDROCK
RD-29 GROUNDWATER MONITORING LOCATION COMPLETED IN UNWEATHERED BEDROCK
FINER GRAINED UNIT
FAULT LOCATION
DEFORMATION BAND LOCATION
STRUCTURE LOCATION
GROUP 7 BOUNDARY
N
0 FEET 400
SCALE
MWH
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009
GROUNDWATER MONITORING LOCATIONS WITHIN GROUP 7
FIGURE 2-9
FILE: CADMLUEBKE\BOEING santa susana\group 7 figs\WELL LOCATIONS 4 3 09
Qal
FDP 424
Santa Susana Formation
Simi Conglomerate Member
Shale 3
Shale 3
North Fault
OS-2
S19
S20
S21
OS-3
OS-5
OS-5A
RD-59A
RD-59B
RD-59C
OS-4
7
RD-94
RD-87
RD-88
RD-90
RD-97
RD-96
RD-34B
RD-34A
PZ116
RD-34C
RS-28
RD-63
RD-30
RD-98
RD-27
RD-89
S2
RMHF
B4021 Leach Field
RD-19
RS-25
B4133
RD-85
Lot Bed
SRE
RD-86
RD-18
OCY
RD-14
New Con
PZ115
B4064 Leach Field
RD-92
PZ113
B4093 Leach Field
B4030 Leach Field
B4029
PZ112
SE Drum Storage
RD-16
RS-24
PZ055
Upper Burro Flats Member
B4010 Leach Field
HMSA
PDU
SNAP
ELV Member
Lower Burro Flats Member
SPA Member
Silvernale Reservoir
Building 4056 Landfill
Gunclub 3
Metals Clarifier
B4008 Warehouse
B4011 Leach Field
B4388 Leach Field
B4100
EFL
ECL
Silvernale Member
Shale 2
PZ124
RD-74
RD-7
RS-16
PZ097
RD-57
PZ098
RS-18
RD-65
PZ099
RD-23
RD-54B
PZ102
RD-91
PZ108
PZ120
PZ122
PZ109
PZ041
PZ110
PZ111
PZ107
RS-11
PZ052
ES-31
PZ005
PZ029
PZ026
PZ023
PZ027
PZ025
PZ028
PZ072
RD-17
RD-95
RD-28
RD-24
RS-25
RS-27
RD-26
RS-15
SH-6
SH-7
SH-11
SH-2
SH-3
SH-4
SH-5
SH-8
SH-9
SH-10
RD-12
HAR-12
SH-1



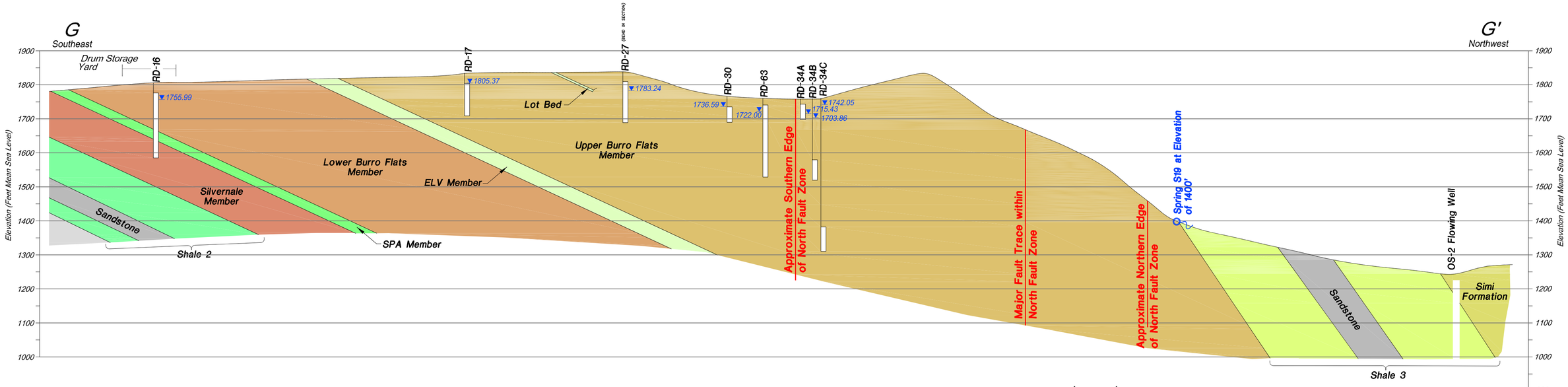
MWH

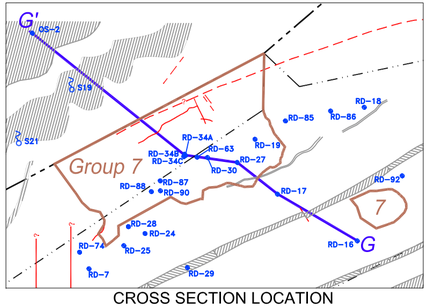
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

INTERPRETED LATERAL EXTENT OF TCE IN GROUNDWATER

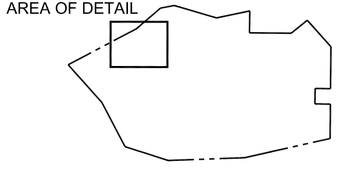
FIGURE 2-10

FILE: CADMLUEBKE\BOEING santa susana\group 7 figs\TCE CFGW 4 30 09





CROSS SECTION LOCATION



SANTA SUSANA FIELD LABORATORY

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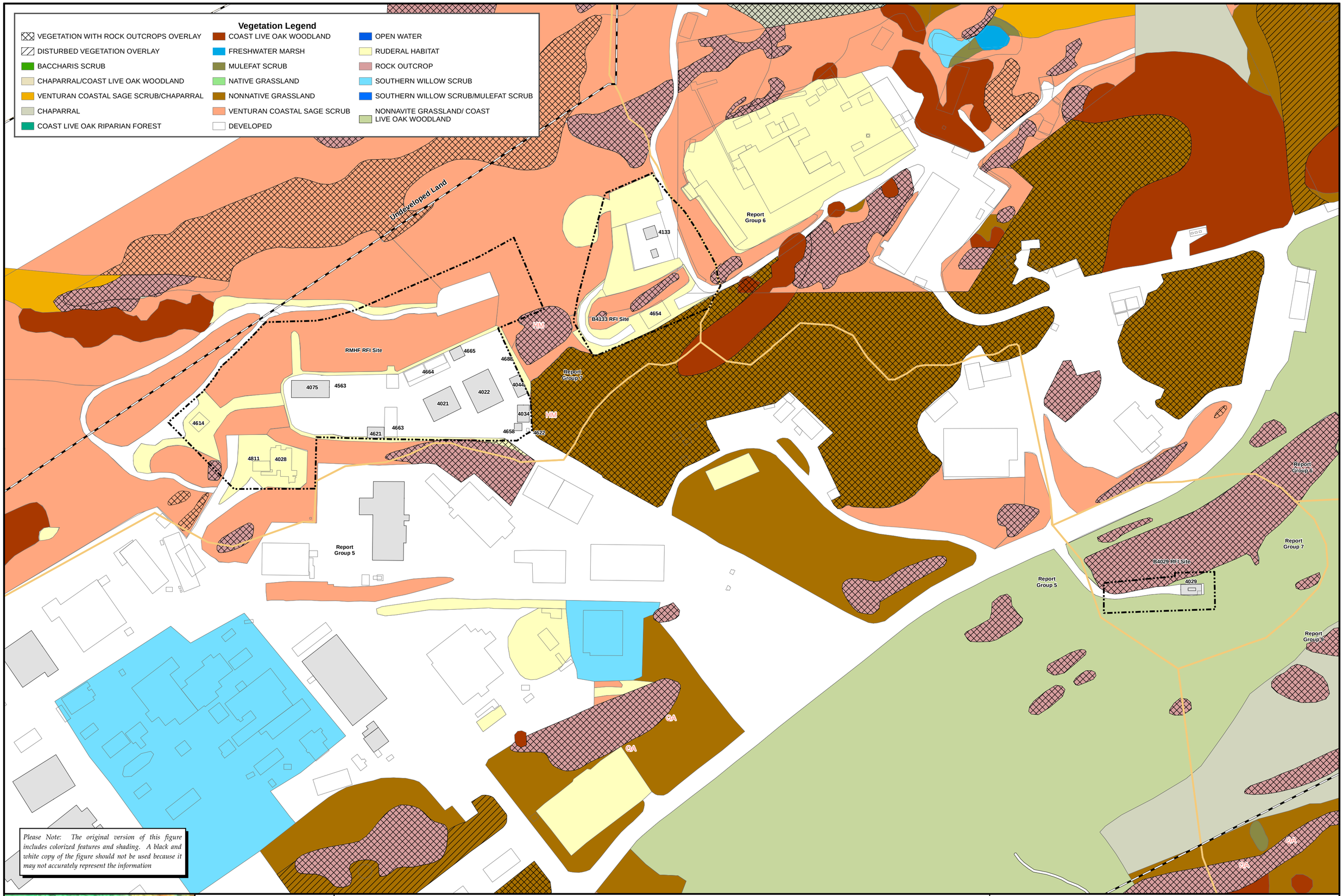
MWH

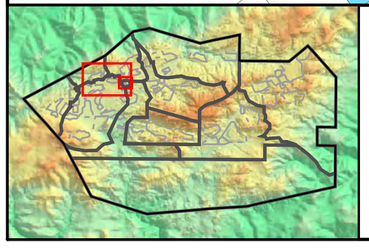
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
MAY 2009

HYDROGEOLOGIC CROSS SECTION AND DEPTH TO CHATSWORTH FORMATION GROUNDWATER

FIGURE 2-11

FILE No. CADMLUEBKE\BOEING\SANTA SUSANA\GROUP 7 FIGURES\CROSS SECTION G-G





Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure

Sensitive Wildlife

BC	BOBCAT
BTJ	S.D. BLACK-TAILED JACKRABBIT
COHA	COOPER'S HAWK
CWW	COASTAL WESTERN WHIPTAIL
DCCO	DOUBLE-CRESTED CORMORANT
GBH	GREAT BLUE HERON
GHOW	GREAT HORNED OWL
LOSH	LOGGERHEAD SHRIKE
MD	MULE DEER
RCSP	RUFOUS-CROWNED SPARROW
RSHA	RED-SHOULDERED HAWK
RTHA	RED-TAILED HAWK
SSHA	SHARP-SHINNED HAWK
TSGS	TWO-STRIPED GARTER SNAKE
TUVU	TURKEY VULTURE

Sensitive Plants

BMV	BRAUNTON'S MILKVETCH
BW	SOUTHERN CAL. BLACK WALNUT
HM	SANTA SUSANA MOUNTAIN TARPLANT
QA	VALLEY OAK
QL	COAST LIVE OAK

Biological Conditions
Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Vegetation.mxd

Date: Jun 10, 2009

1 inch = 125 feet

0 125 250 Feet

MWH

FIGURE 2-12

SSFL Property Boundary

Undeveloped Land

Area IV Boundary

Outfall-003

RMHF Site

Building 4021 Leach Field (Area IV AOC)

Low-Level Radioactive Waste Processing Building

Waste Receiving Yard

Mixed Waste Storage Yard

Former RMHF Catch Basin

STIR / LMFBR Reactor Text Building

Radioactive Decontamination and Packaging

Radioactive Vault Storage

RMHF (SWMU 7.6) Includes the operational features within the fenced area and the RMHF Catch Basin

Report Group 5

Report Group 6

Report Group 7

Report Group 9

B4133 Site

Sodium Burn Facility (SWMU 7.2)

Size Reduction Area

Interim Storage Facility

SRE RFI Site

B4029 Site

Reactive Metals Storage Yard (SWMU 7.11)

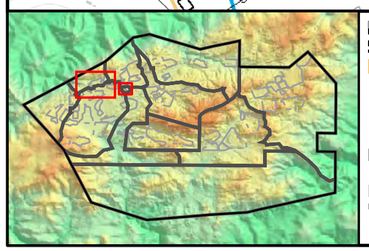
Former Old Conservation Yard Tank Pipeline

Building 4029 Insert

1 inch = 100 feet

0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide/Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

RFI Sites

- DOE Study Area

Site Plan
Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-SitePlan_Group7.mxd

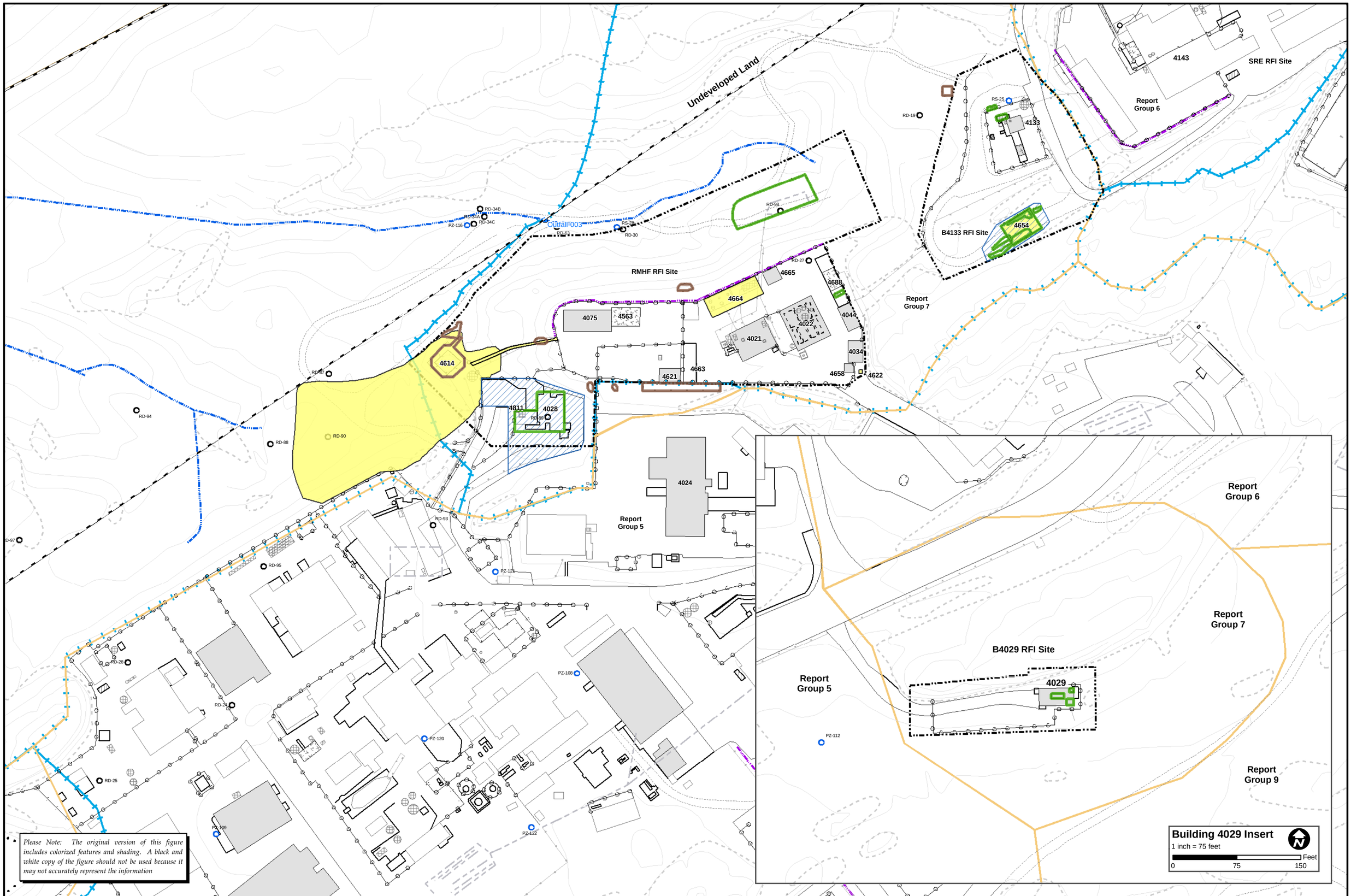
Date: Jun 10, 2009

1 inch = 100 feet

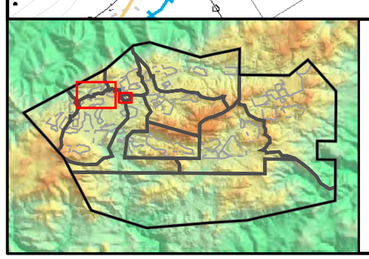
0 100 200 Feet

MWH

FIGURE 3-1



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide/Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Soil Disturbance Areas

- Excavation
- Excavation-Backfill
- Grading
- Building Foundation & Asphalt / Concrete Demolition (minimal grading)

Buildings, Improvements, and Soil Disturbances Within Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-SoilDisturbances.mxd

Date: Jun 10, 2009

1 inch = 100 feet

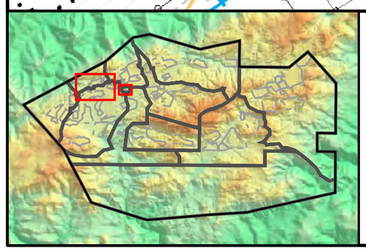
0 100 200 Feet

MWH

FIGURE 3-2

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet



Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Chemical Use Areas
Multiple Use
Solvent
Petroleum
Oil / PCBs
Metal
Debris Areas
Leach Field
Potential

Potential Chemical Use Areas
Group 7 Reporting Area
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Potential-CUA.mxd
Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-3

Undeveloped Land

Outfall 003

RMHF RFI Site

B4133 RFI Site

SRE RFI Site

Report Group 5

Report Group 6

Report Group 7

Report Group 9

B4029 RFI Site

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Concrete Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Solvent Use Areas

Potential Solvent Use Areas
Group 7 Reporting Area
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Solvent-CUA.mxd
Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-4

Undeveloped Land

SRE RFI Site

Report Group 6

Report Group 7

B4133 RFI Site

RMHF RFI Site

Report Group 5

Outfall-003

Report Group 6

Report Group 7

B4029 RFI Site

Report Group 5

Report Group 9

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Petroleum Use Areas

Potential Petroleum Use Areas
Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Petroleum-CUA.mxd

Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-5

Undeveloped Land

Outfall-003

RMHF RFI Site

B4133 RFI Site

SRE RFI Site

Report Group 6

Report Group 7

Report Group 5

Report Group 9

B4029 RFI Site

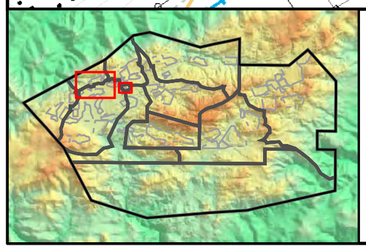
4143 4133 4654 4665 4688 4664 4022 4021 4044 4034 4658 4622 4075 4563 4614 4621 4663 4811 4028 4024 4029

13k 2a 2b 2c

RS-25 RD-19 RD-98 RD-27 RD-34B RD-34A RD-34C PZ-116 RD-63 RS-26 RD-30 RD-87 RD-94 RD-88 RD-90 RD-93 RD-95 RD-97 RD-96 RD-28 RD-29 RD-25 PZ-124 PZ-108 PZ-120 PZ-109 PZ-122 PZ-112

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide/Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells
- Near Surface
- Chatsworth

Potential Oil/PCBs Use Areas

Potential Oil/PCBs Use Areas
Group 7 Reporting Area
SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-OilPCBs_CUA.mxd

Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-6

Undeveloped Land

Outfall-003

RMHF RFI Site

B4133 RFI Site

SRE RFI Site

Report Group 6

Report Group 7

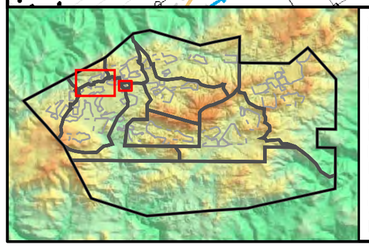
Report Group 5

Report Group 9

B4029 RFI Site

Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Metal/Inorganics Use Areas

Potential Metal/Inorganics Use Areas
Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Bundle-Metals-Inorganics_CUA.mxd

Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-7

Undeveloped Land
Outfall-003
RMHF RFI Site
B4133 RFI Site
SRE RFI Site
Report Group 6
Report Group 7
Report Group 5
Report Group 9
B4029 RFI Site
Building 4029 Insert
1 inch = 75 feet
0 75 150 Feet

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Debris Areas

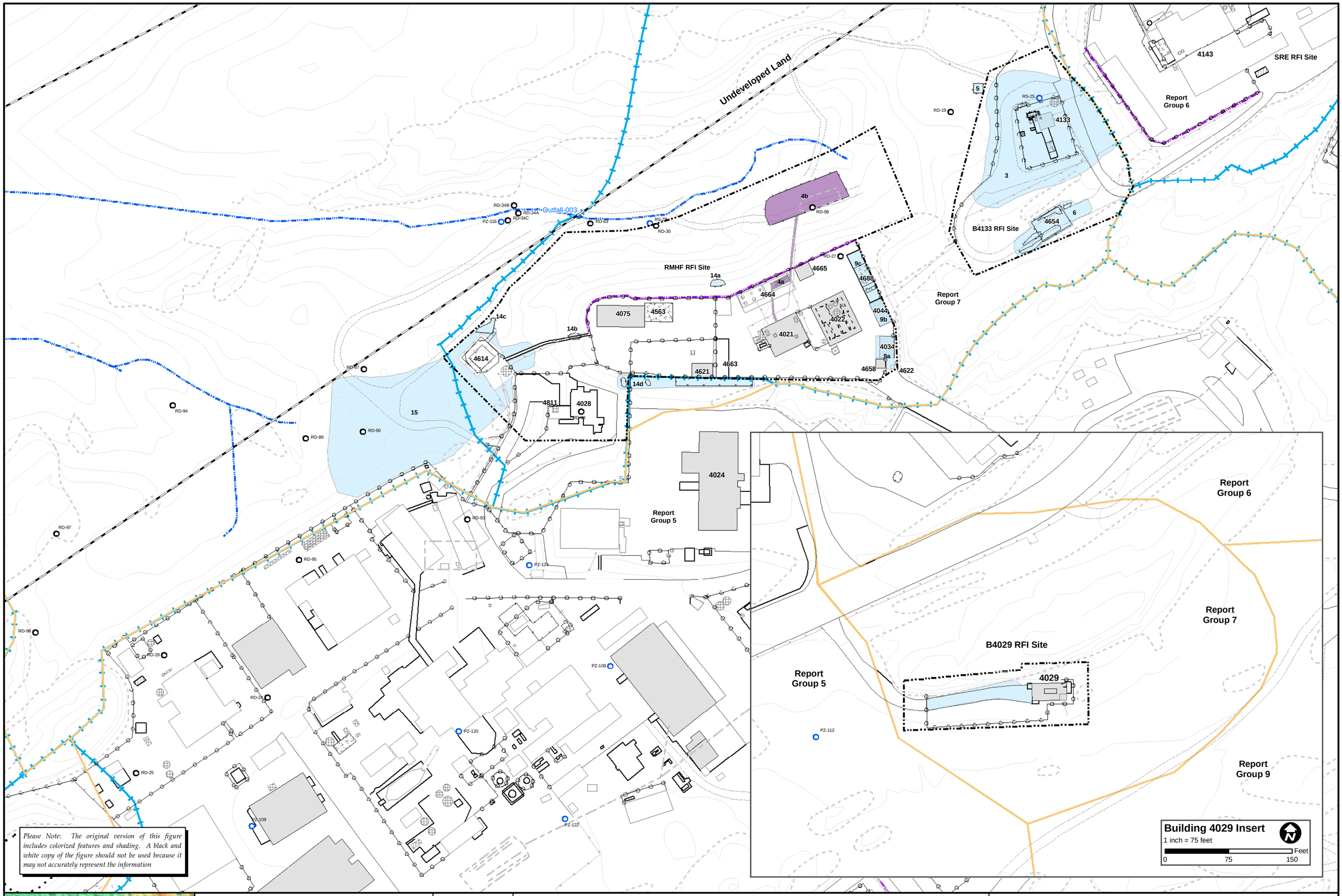
Potential Debris Areas
Group 7 Reporting Area
SANTA SUSANA FIELD LABORATORY

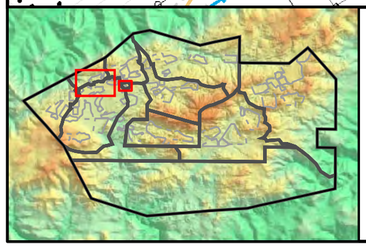
Document: RFI-Report-Group7-Bundle-Debris_CUA.mxd
Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-8





Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Other Tanks
Solvent Tank
Petroleum Fuel/Oil Tank
Hydrazine Tank
Sump
Vaults and Pits
Awning
Ponds
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide/Watershed Boundary
Rock Outcrop
Dirt Road
A/C Paving
Fence
Elevation Contour

Groundwater Wells
Near Surface
Chatsworth

Potential Leach Field and Land Use Areas
Areas Screened for Potential Chemical Use Areas

SANTA SUSANA FIELD LABORATORY

Potential Leach Field and Areas Screened for Potential Chemical Use Group 7 Reporting Area

Document: RFI-Report-Group7-Bundle-Leachfield_Screened_CUA.mxd
Date: Jun 10, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 3-9

Chemical concentrations are from the most recent samples collected from each well. Historical results are also presented for select wells that have historically contained significantly different results from most recent data

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Soil Findings
Methylene chloride at 7 µg/L in drainage north of RMHF RFI Site in historical sample. Methylene chloride not detected in recent samples.

Soil Findings
BTEX constituents in historical (1988) soil matrix samples. Recent samples contained:
- methylene chloride up to 3.67 µg/kg
- m-Xylene and p-xylene up to 0.45 µg/kg
VOCs not detected in soil vapor

Soil Findings
Up to 8.41 µg/kg methylene chloride in B4133 Debris Area

Undeveloped Land

RS-25	2002
VOCs	ND

RD-85	2005
VOCs	ND

RD-19	2008
VOCs	ND

RS-28	2008
TCE	14 µg/L

Groundwater Findings
RD-34A through C (2008): TCE up to 5.3 µg/L at RD-34A.

RD-63	2008
TCE	10 µg/L

RD-30	2008
TCE	11 µg/L

RD-98	2008
TCE	10 µg/L

PZ-116	2005
VOCs	ND

Soil Findings
0.47 µg/kg PCE in debris area. PCE not detected and other VOCs below RBSLs at adjacent sample locations.

Report Group 6

Soil Findings
VOCs in unpaved area northeast of B4133, including:
- 1,2,4-trimethylbenzene up to 19,200 µg/kg
- 1,3,5-trimethylbenzene at 6,170 µg/kg
- Cumene at 684 µg/kg
- Benzene at 0.11 µg/L

B4133 Site

RMHF Site

Soil Findings
At Building 4563:
- Benzene at 0.05 µg/L
- Toluene at 0.14 µg/L

RD-27	2008
VOCs	ND

Report Group 7

RD-87	2004
Acetone	10 µg/L
TCE	0.55 µg/L

Soil Findings
PCE up to 0.57 µg/L adjacent to Building 4021

RD-94	2005
TCE	0.29 µg/L

RD-88	2004
1,1-DCE	17 µg/L
Acetone	10 µg/L
Benzene	10 µg/L
TCE	< 0.26 µg/L

RD-89	2005
VOCs	ND

Soil Findings
Methylene chloride detected up to 8.57 µg/kg west of the Waste Receiving Yard

Report Group 5

RD-97	2006
VOCs	ND

RD-96	2006
VOCs	ND

Building 4029 Insert
1 inch = 100 feet
0 100 200 Feet

Groundwater Findings
RD-92 (2008): VOCs not detected

Report Group 6

Report Group 7

PZ-112	2002
Acetone	2 µg/L
Methylene chloride	1 µg/L

B4029 Site

Report Group 5

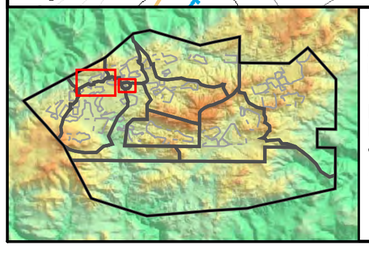
Report Group 9

Groundwater Findings
PZ-55 (2002): VOCs not detected

Soil Findings
4.38 µg/kg methylene chloride at low point south of Building 4029

RD-16	2008
Carbon Disulfide	0.4 µg/L

Soil and soil vapor VOCs are portrayed relative to risk based screening levels (RBSLs). Color code represents maximum ratio of individual VOCs to lowest respective RBSL at each sample location.



Base Map Legend
- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells
- Near Surface
- Chatsworth

Corrective Measure Study Areas
- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

VOC SM Sample Results
- Non-Detect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

VOC SV Sample Results
- Non-Detect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

ug/kg = micrograms / kilogram
ug/L = micrograms / Liter

VOCs Summary for Soil and Groundwater Group 7 Reporting Area

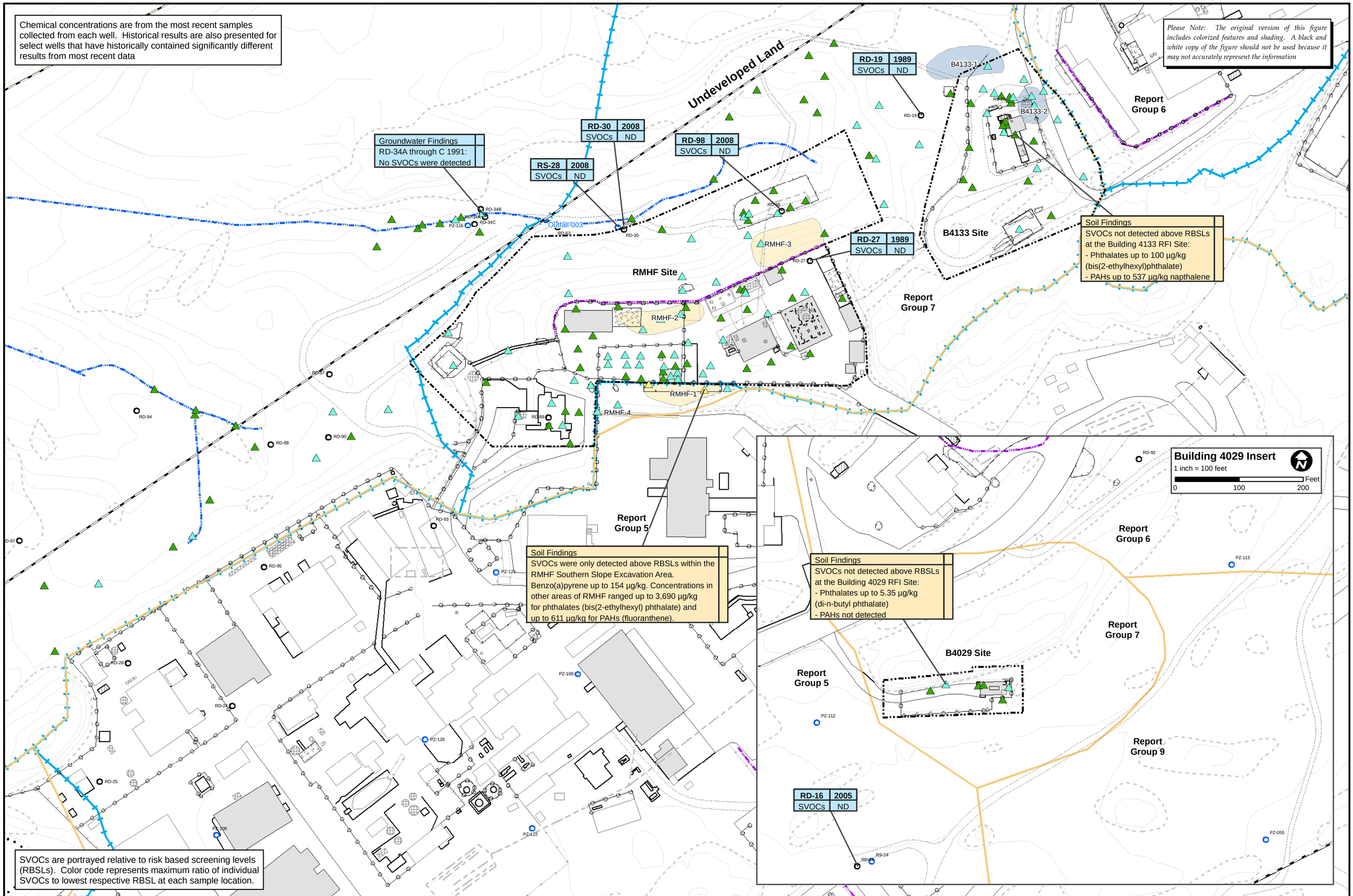
SANTA SUSANA FIELD LABORATORY

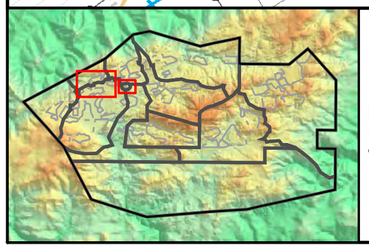
Document: RFI-Report-Group7-Dotmaps-VOC.mxd
Date: Jun 12, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 4-1





Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

SVOC Sample Results

- Non-Detect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

ug/kg = micrograms / kilogram

SVOCs Summary for Soil and Groundwater Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Dotmaps-SVOC.mxd

Date: Jun 12, 2009

1 inch = 100 feet

0 100 200 Feet

MWH

FIGURE 4-2

Chemical concentrations are from the most recent samples collected from each well. Historical results are also presented for select wells that have historically contained significantly different results from most recent data

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Soil Findings
Gasoline range organics (C8-C11)
2.36 mg/kg in west of Building 4133 debris area

RD-19	2008
TPH	ND

RD-98	2008
TPH	ND

RD-30	2008
TPH	ND

RS-28	2008
TPH	ND

Undeveloped Land

Soil Findings
Gasoline range organics (C8-C11)
1.5 mg/kg adjacent to Waste
Receiving Yard, slightly above ResRBSL

Soil Findings
Unpaved area northeast of Building 4133:
- Gasoline range organics (C8-C11) 1,410 mg/kg
- Kerosene range organics (C12-C14) 2,460 mg/kg

Soil Findings
Gasoline range organics (C8-C11)
up to 4.81 mg/kg in Building 4133
Western Debris Area.

Soil Findings
Maximum petroleum hydrocarbon concentrations
at RMHF RFI Site detected at this location:
- Lubricant oil range organics (C21-C30) 1,030 mg/kg
- Diesel range organics (C15-C20) 260 mg/kg

Report Group 5

Report Group 6

Report Group 7

RMHF Site

B4133 Site

Outfall 003

RMHF-1
RMHF-2
RMHF-3
RMHF-4

B4133-1
B4133-2

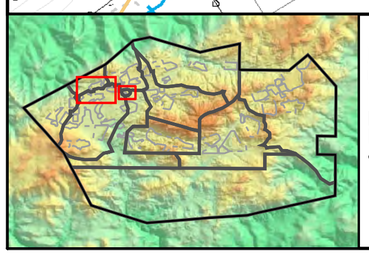
Building 4029 Insert
1 inch = 100 feet
0 100 200 Feet

Soil Findings
Lubricant oil range organics (C21-C30)
detected in the Building 4029 Access
Road up to 493 mg/kg

B4029 Site

Report Group 9

TPH is portrayed relative to risk based screening levels (RBSLs). Color code represents maximum ratio of individual analytes to lowest respective RBSL at each sample location.



Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

TPH Sample Results

- Non-Detect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

mg/kg = milligrams / kilogram

TPH Summary for Soil and Groundwater Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

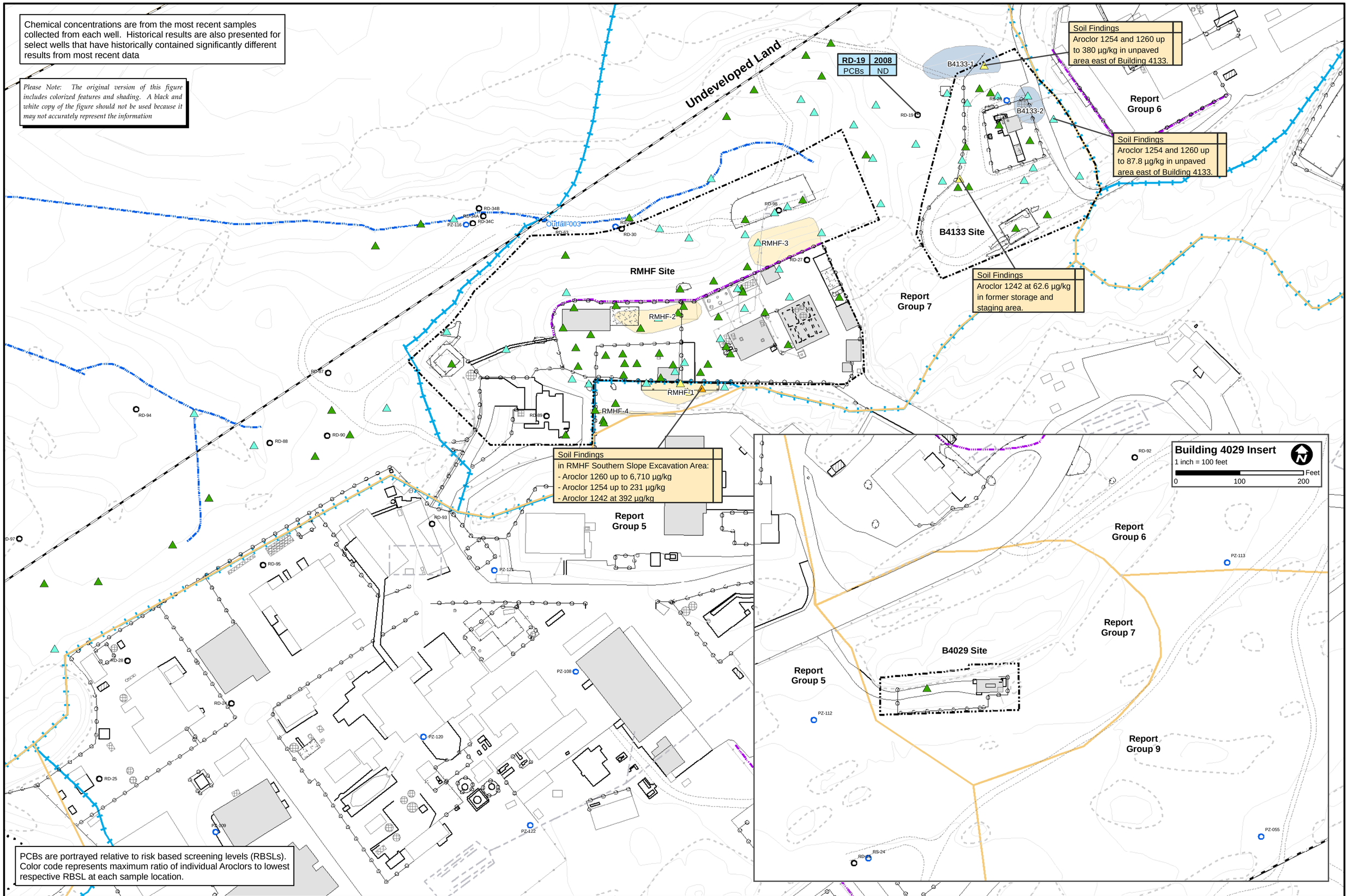
Document: RFI-Report-Group7-Dotmaps-TPH.mxd

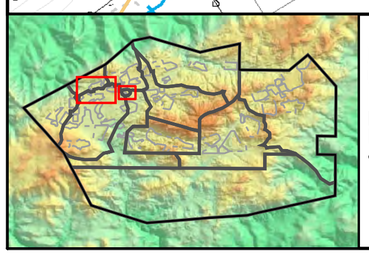
Date: Jun 12, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 4-3





Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

PCB Sample Results

- Non-Detect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

ug/kg = micrograms / kilogram

PCB Summary for Soil and Groundwater Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Dotmaps-PCB.mxd

Date: Jun 12, 2009

1 inch = 100 feet

0 100 200 Feet

MWH

FIGURE 4-4

Chemical concentrations are from the most recent samples collected from each well. Historical results are also presented for select wells that have historically contained significantly different results from most recent data

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Soil Findings
Dioxin 2,3,7,8-TCDD TEQ 1 ng/kg in drainage downslope of RMHF

Undeveloped Land

Outfall 003

RMHF Site

RMHF-1
RMHF-2
RMHF-3
RMHF-4

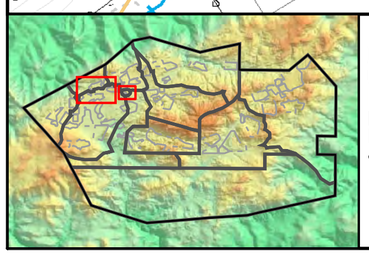
B4133 Site
B4133-1
B4133-2

Report Group 5
Report Group 6
Report Group 7
Report Group 9

B4029 Site

Building 4029 Insert
1 inch = 100 feet
0 100 200 Feet

Dioxin TEQs are portrayed relative to risk based screening levels (RBSLs). Color code represents maximum ratio of TCDD TEQs to lowest respective RBSL at each sample location.



Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

Dioxin TEQ Sample Results

- < Background
- < Eco RBSL
- < Res RBSL
- > RBSLs
- > 10 x RBSLs

ng/kg = nanograms per kilogram

Dioxin Summary for Soil and Groundwater Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Dotmaps-Dioxins.mxd

Date: Jun 12, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 4-5

Metals detected in groundwater are represented if concentrations have exceeded GWCCs in most recent samples collected from each well. Historical results are also presented for select wells that have historically contained significantly different results from most recent data

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information

Soil Findings
Building 4021 Leach Field
- Selenium 1 mg/kg (BG 0.655 mg/kg)
- Hexavalent chromium 0.16 mg/kg (no BG)

Soil Findings
Cadmium 1.1 mg/kg (BG 1 mg/kg)

Soil Findings
-Sodium up to 2,660 mg/kg decreases down drainage

Groundwater Findings
RD-85 (2008): All metals ND or below GWCCs

Soil Findings
Filter/Blower Area surface water pipeline discharge:
- Cadmium 4.8 mg/kg (BG 1 mg/kg)
- Lead 44.1 mg/kg (BG 34 mg/kg)
- Zinc 1,240 mg/kg (BG 110 mg/kg)

Soil Findings
Building 4133 Debris Area
Zinc 143 mg/kg (BG 110 mg/kg)

RD-19	2008
Copper	4.8 µg/L

Soil Findings
Arsenic 17.5 mg/kg (BG 15 mg/kg) in one sample

Groundwater Findings
RD-30 (2008): All metals ND or below GWCCs

RD-98	2008
Copper	6.8 µg/L

RD-63	1994
Lead	11 µg/L
Selenium	5.7 µg/L

RS-28	2008
Selenium	2.5 µg/L

Soil Findings
SRE asphalt culvert:
- Copper 44.8 mg/kg (BG 29 mg/kg)
- Lead 52 mg/kg (BG 34 mg/kg)
- Sodium up to 413 mg/kg (BG 110 mg/kg)
- Zinc up to 493 mg/kg (BG 110 mg/kg)

Groundwater Findings
RD-34A well cluster (2008):
Selenium up to 3.6 µg/L at RD-34A.
All other metals ND or below GWCCS in recent sample.

Soil Findings
Zinc at 120 mg/kg (BG 110 mg/kg).

PZ-116	2008
Molybdenum	8.8 µg/L
Selenium	1.8 µg/L

Soil Findings
Unpaved area north of Building 4133:
-Isolated selenium 0.89 mg/kg (BG 0.655 mg/kg)
-Isolated hexavalent chromium 0.202 mg/kg (no BG)
-Sodium up to 2,660 mg/kg (BG 110 mg/kg)

Groundwater Findings
RD-27 (2008): All metals ND or below GWCCs

Soil Findings
Adjacent to Building 4563:
- Lead 35.4 mg/kg (BG 34 mg/kg)
- Sodium up to 559 mg/kg (BG 110 mg/kg)

Soil Findings
- Boron at 10 mg/kg (BG 9.7 mg/kg)
- Selenium at 0.89 mg/kg (BG 0.655 mg/kg)

Soil Findings
In the Building 4133 area:
- Barium 162 mg/kg (BG 140 mg/kg)
- Selenium at 0.85 mg/kg (BG 0.655 mg/kg)
- Sodium up to 5,900 mg/kg (BG 110 mg/kg)
- Potassium up to 11,000 mg/kg (BG 6,400 mg/kg)

Soil Findings
Zinc up to 173 mg/kg (BG 110 mg/kg).

Soil Findings
Cadmium 1.14 mg/kg (BG 1 mg/kg) (BG 1 mg/kg)

Soil Findings
Catch Basin Discharge Pipeline:
Selenium 2.7 mg/kg (BG 0.655 mg/kg)

Soil Findings
- Zinc 241 mg/kg (BG 110 mg/kg)
- Zirconium 14.2 mg/kg (BG 8.6 mg/kg)

Groundwater Findings
RD-90 (2004): All metals ND or below GWCCs

Soil Findings
Zinc at 113 mg/kg (BG 110 mg/kg).

Soil Findings
RMHF asphalt swale:
- Chromium 37.7 mg/kg (BG 36.8 mg/kg)
- Cobalt 48 mg/kg (BG 21 mg/kg)
- Hexavalent Chromium 0.225 mg/kg (no BG)
- Selenium 0.76 mg/kg (BG 0.655 mg/kg)
- Zinc up to 520 mg/kg (BG 110 mg/kg)

Soil Findings
Mixed Waste Storage Yard, Building 4621, and Equipment Storage Area:
- Boron up to 17.6 mg/kg (BG 9.7 mg/kg)
- Cobalt 29 mg/kg (BG 21 mg/kg)
- Copper 62.7 mg/kg (BG 29 mg/kg)
- Sodium up to 537 mg/kg (BG 110 mg/kg)
- Vanadium 75.3 mg/kg (BG 62 mg/kg)

Soil Findings
Hexavalent chromium 0.69 mg/kg south of RMHF fence line

Soil Findings
Selenium at 0.73 mg/kg (BG 0.655 mg/kg)

Soil Findings
Chromium 74.4 mg/kg (BG 36.8 mg/kg)

Soil Findings
At storm water culvert:
- Cobalt 152 mg/kg (BG 21 mg/kg)
- Copper 39.9 mg/kg (BG 29 mg/kg)
- Silver 9.95 mg/kg (BG 0.79 mg/kg)
- Zinc 329 mg/kg (BG 110 mg/kg)

Metals detected in groundwater are represented if concentrations have exceeded GWCCs and are considered site related (see Appendix D). Chemical concentrations are from the most recent samples collected from each well. Historical results are also presented for select wells that have historically contained significantly different results from most recent data

Metals are portrayed relative to risk based screening levels (RBSLs). Color code represents maximum ratio of individual metals detected above background compared to lowest respective RBSL at each sample location.

Undeveloped Land
RMHF Site
B4133 Site
B4029 Site
Report Group 5
Report Group 6
Report Group 7
Report Group 9
Outfall-003
RMHF-1
RMHF-2
RMHF-3
RMHF-4
B4133-1
B4133-2

Soil Findings
In Building 4029:
-Sodium up to 245 mg/kg (BG 110 mg/kg)
-Barium 185 mg/kg (BG 140 mg/kg)
-Lithium 60.8 mg/kg (BG 37 mg/kg)
-Nickel 37.9 mg/kg (BG 29 mg/kg)
-Zinc up to 133 mg/kg (BG 110 mg/kg)

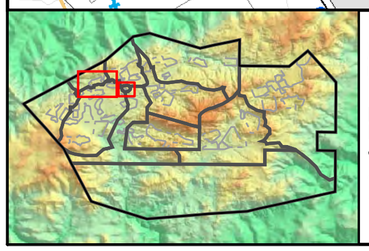
Soil Findings
Barium at 165 mg/kg (BG 140 mg/kg) along Building 4029 Access Road

Groundwater Findings
RD-92 (2008): All metals ND or below GWCCs

Groundwater Findings
RD-16 (1989): All metals ND or below GWCCs

Soil Findings
Zinc 328 mg/kg (BG 110 mg/kg) at the low point south of Building 4029; down drainage location within background range

Building 4029 Insert
1 inch = 125 feet
0 125 250 Feet



Base Map Legend
- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide / Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Elevation Contour

Groundwater Wells
- Near Surface
- Chatsworth

Corrective Measure Study Areas
- RMHF CMS Area
- Building 4133 CMS Area

Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

Metals Sample Results
- < Background or Nondetect
- < RBSLs
- < 10 x RBSLs
- < 100 x RBSLs
- > 100 x RBSLs

ug/L = micrograms / Liter
mg/kg = milligrams / kilogram

Metals Summary for Soil and Groundwater Group 7 Reporting Area

SANTA SUSANA FIELD LABORATORY

Document: RFI-Report-Group7-Dotmaps-Metals.mxd
Date: Jun 12, 2009

1 inch = 100 feet
0 100 200 Feet

MWH

FIGURE 4-6

Representative Ecological Receptors:

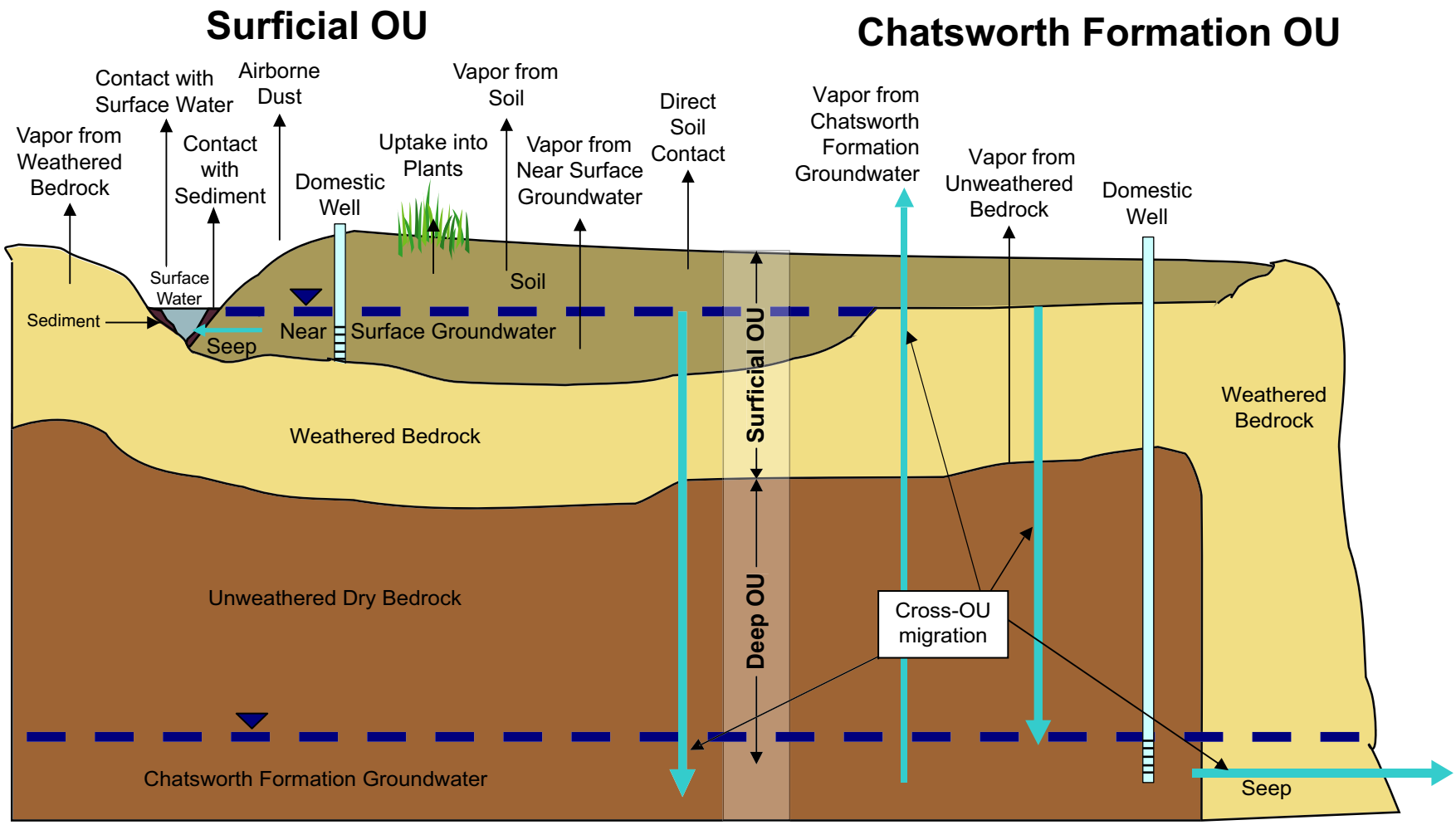
- Generic aquatic species (aquatic primary/secondary consumer)
- Great blue heron (aquatic tertiary consumer)
- Deer mouse (terrestrial primary/secondary consumer)
- Thrush (terrestrial primary/secondary consumer)
- Mule deer (terrestrial primary consumer)
- Red-tailed hawk (terrestrial secondary/tertiary consumer)
- Bobcat (terrestrial secondary/tertiary consumer)

Worker Receptor:

- Inhalation of dust (Surficial OU)
- Inhalation of vapors from soil and groundwater (Surficial OU and CFOU)
- Dermal contact with soil (Surficial OU)
- Ingestion of soil (Surficial OU)
- Dermal contact with surface water and sediment (Surficial OU)
- Ingestion of surface water and sediment (Surficial OU)
- Inhalation of vapors from bedrock

Future Residential Receptor:

- Inhalation of dust (Surficial OU)
- Inhalation of vapors from soil and groundwater (Surficial OU and CFOU)
- Ingestion of plants (Surficial OU)
- Dermal contact with soil (Surficial OU)
- Ingestion of soil (Surficial OU)
- Dermal contact with surface water and sediment (Surficial OU)
- Ingestion of surface water and sediment (Surficial OU)
- Ingestion of groundwater (Surficial OU and CFOU)
- Inhalation of vapors during domestic use (Surficial OU and CFOU)
- Dermal contact with groundwater (Surficial OU and CFOU)
- Inhalation of vapors from bedrock



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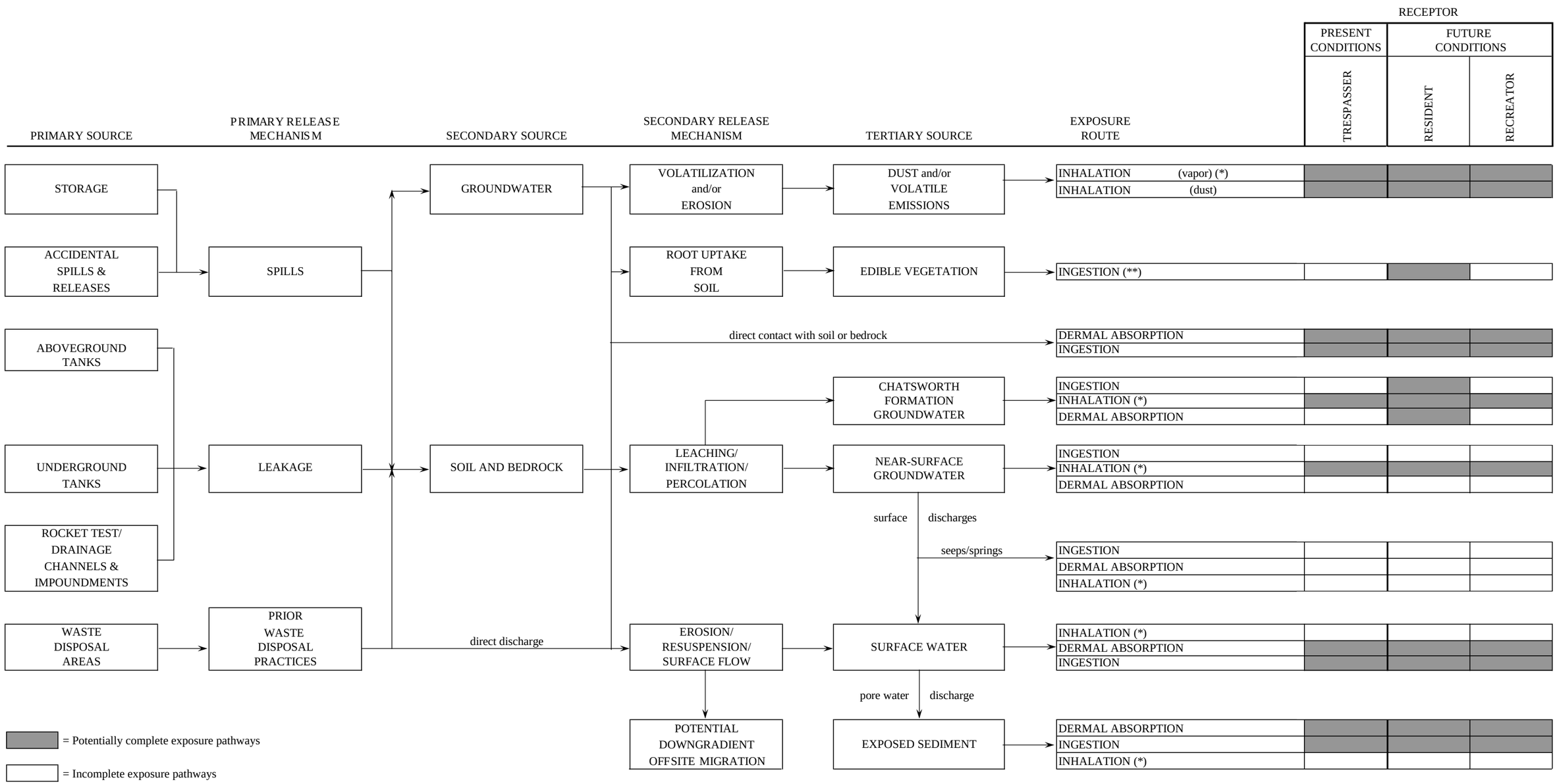
Santa Susana Field Laboratory (SSFL)
Illustrated Conceptual Site Model of Human Health and Ecological Exposures

FIGURE
5-1

Project/SSFL/Group 7 Report/Figure 5-1.ai

08/29/05



Notes:

See Figure 6-2 for a generalized Conceptual Site Model of ecological exposures. For RFI site-specifc Conceptual Site Models of human health exposures, see Appendix A, Figure A.4-1; Appendix B, Figure B.4-1; and Appendix C, Figure C.4-1.

As described in the SRAM (MWH 2005), note that risk estimates for the potential future recreational user (recreator) are used as surrogate risk estimates for the trespasser.

(*) Exposure limited to volatile compounds as defined in the text; residential receptors include both indoor and outdoor air exposure to volatiles; nonresidential receptors include only outdoor air exposure. For residents, inhalation of volatiles from shallow groundwater includes pathways associated with both domestic use and migration to indoor air, whereas, nonresidential exposure includes only migration to outdoor air for recreators. Exposure to fugitive dust is limited to non-volatile organic compounds.

(**) Exposures limited to bioacummulative compounds as defined in the text.

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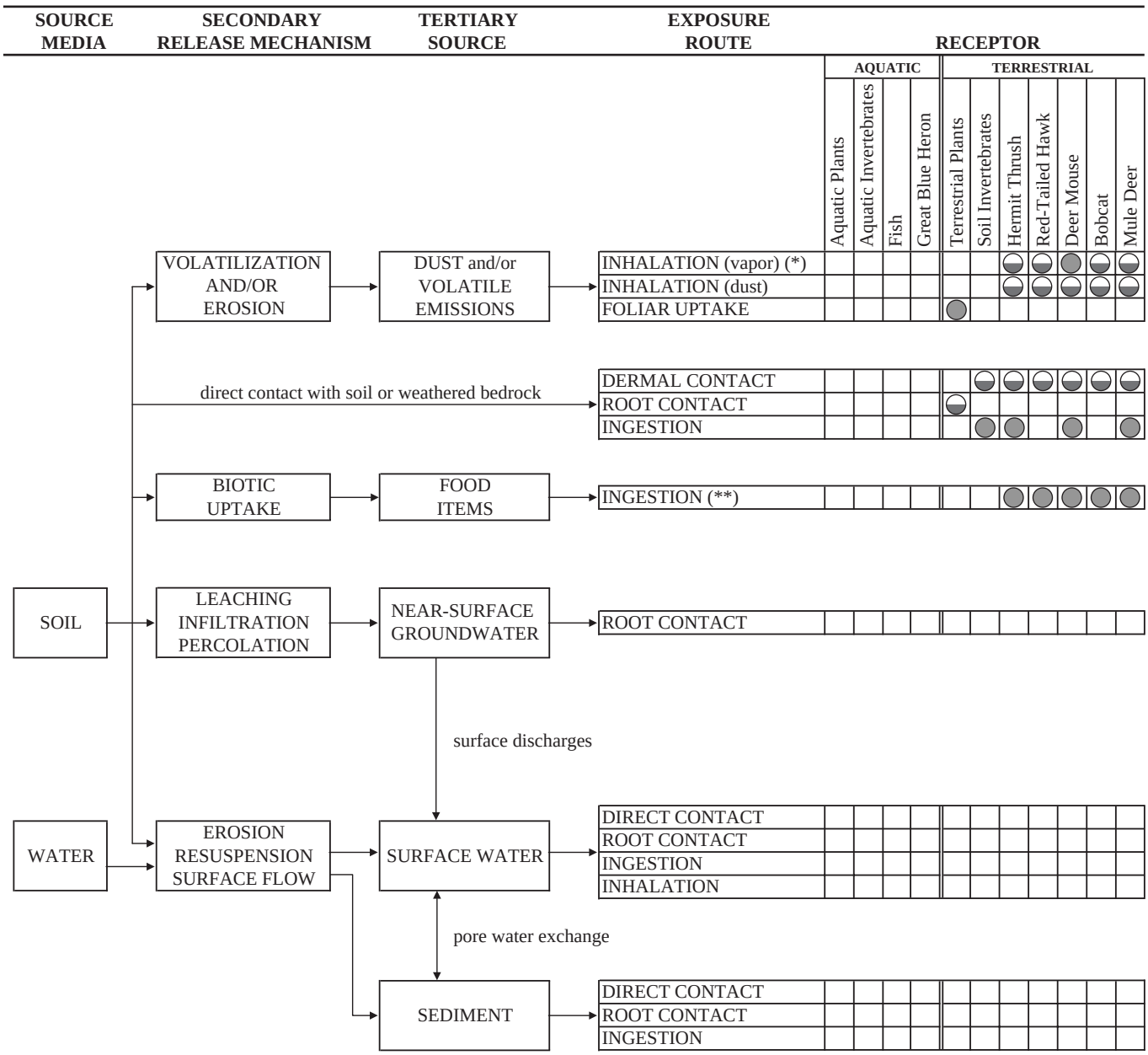
Santa Susana Field Laboratory (SSFL)
Generalized Conceptual Site Model of Human Health Exposures

FIGURE 6-1

Project/SSFL/Figure 6-1_409.ai

02/23/07



Notes:

See Figure 6-1 for a generalized Conceptual Site Model of human health exposures. For RFI site-specific Conceptual Site Models of ecological exposures, see Appendix A, Figure A.4-2; Appendix B, Figure B.4-2; and Appendix C, Figure C.4-2.

(*) Exposures limited to volatile compounds as defined in the text.

(**) Exposures limited to bioacummulative compounds as defined in the text.

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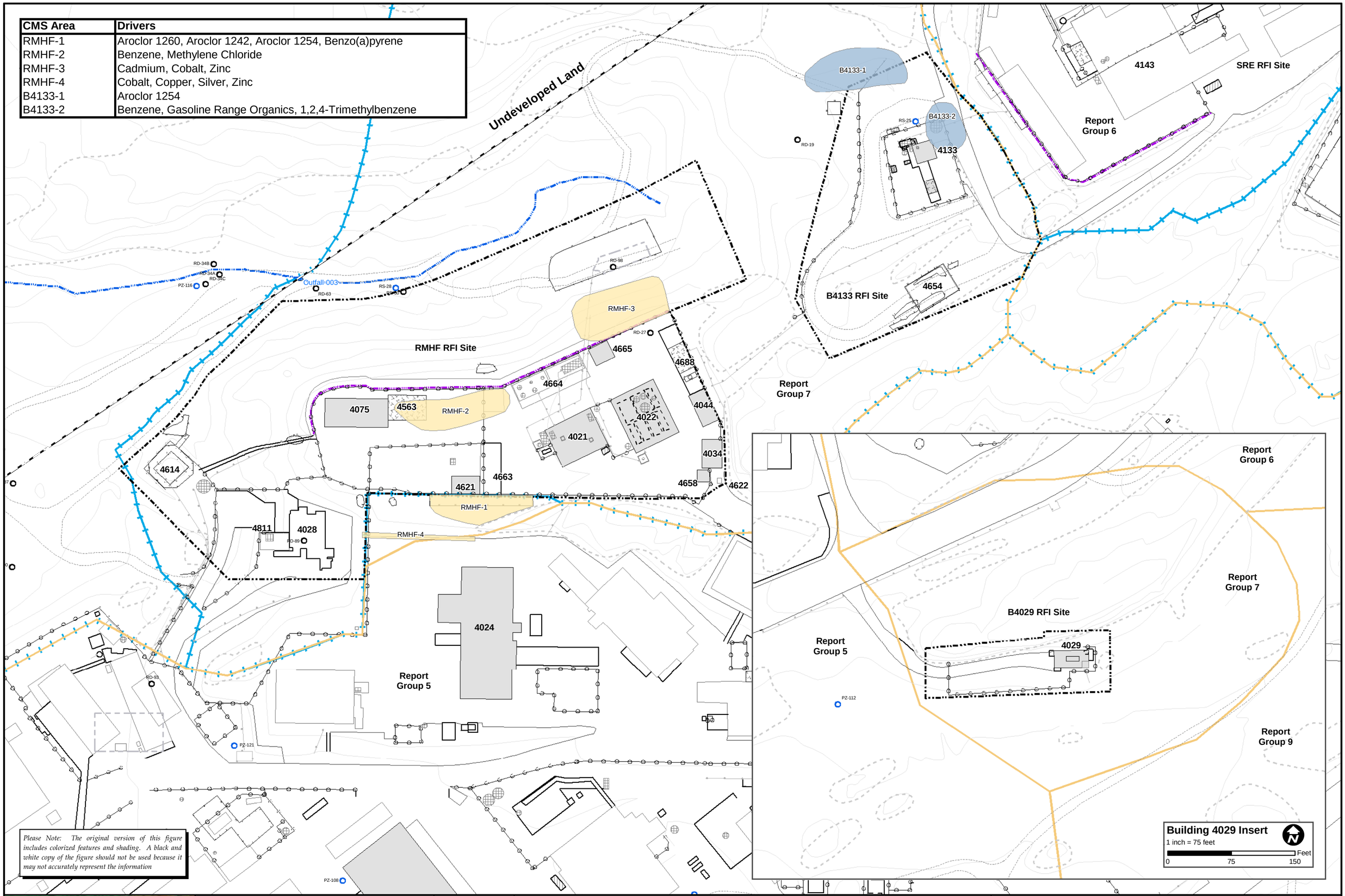
Generalized Conceptual Site Model of Ecological Exposures

FIGURE 6-2

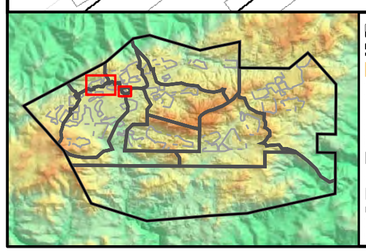
Project/SSFL/Figure 6-2_409.ai

02/23/07

CMS Area	Drivers
RMHF-1	Aroclor 1260, Aroclor 1242, Aroclor 1254, Benzo(a)pyrene
RMHF-2	Benzene, Methylene Chloride
RMHF-3	Cadmium, Cobalt, Zinc
RMHF-4	Cobalt, Copper, Silver, Zinc
B4133-1	Aroclor 1254
B4133-2	Benzene, Gasoline Range Organics, 1,2,4-Trimethylbenzene



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information



- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Sump
- Vaults and Pits
- Awning
- Ponds
- Pipe
- Leach Field
- Drainage
- Lined Drainage
- Surface Water Divide/Watershed Boundary
- Rock Outcrop
- Dirt Road
- A/C Paving
- Fence
- Elevation Contour

Groundwater Wells

- Near Surface
- Chatsworth

Corrective Measure Study Areas

- RMHF CMS Area
- Building 4133 CMS Area

SANTA SUSANA FIELD LABORATORY

Surficial Media Site Action Recommendations Group 7 Reporting Area

Document: RFI-Report-Group7-Bundle-CMS_Group7_2.mxd

Date: Jun 11, 2009

1 inch = 75 feet

0 75 150 Feet

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FIGURE 7-1