GROUP 8 – WESTERN PORTION OF AREA IV
RCRA FACILITY INVESTIGATION REPORT
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

VOLUME I – TEXT, TABLES, AND FIGURES

Prepared For:

THE BOEING COMPANY

AND

THE UNITED STATES DEPARTMENT OF ENERGY

Prepared By:

MWH
618 Michillinda Ave, Suite 200
Arcadia, CA 91007

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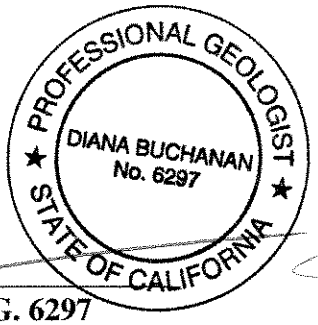

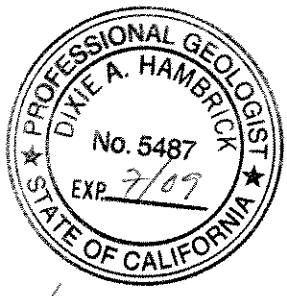

Diana L. Buchanan, P.G. 6297
Project Manager

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

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LIST OF ACRONYMS AND ABBREVIATIONS

AESE	AE Schmidt Environmental
AI	Atomics International
ACM	asbestos-containing material
AOC	Area of Concern
AST	aboveground storage tank
BBI	Brandeis-Bardin Institute
bgs	below ground surface
Boeing	The Boeing Company
B009 LF	Building 009 Leach Field
B056	Building 056
B100	Building 100
B886	Building 886
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene and xylenes
CCR	Current Conditions Report
CF	Chatsworth Formation
CFOU	Chatsworth Formation Operable Unit
cis-1,2-DCE	cis-1,2-dichloroethene
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CSM	conceptual site model
COPC	chemical of potential concern
CPEC	chemical of potential environmental concern
DCA	dichloroethane
DCE	dichloroethene
DHS	Department of Health Services
DHS-RHB	Department of Health Services- Radiological Health Branch
Dioxins/Furans	(a) - *see table below*
DOE	United States Department of Energy
DQO	Data Quality Objective
DTSC	Department of Toxic Substances Control

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

EIR	Environmental Impact Report
ECL	Environmental Chemistry Laboratory
EPC	exposure point concentration
ERA	ecological risk assessment
ESADA	Empire State Atomic Development Authority
ETEC	Energy Technology Engineering Center
°F	degrees Fahrenheit
Freon 11	trichlorofluoromethane
Freon 113	1,1,2-trichloro-1,2,2-trifluoroethane
FSDF	Former Sodium Disposal Facility
FLUTe	Flexible Liner Underground Technology
GRC	Groundwater Resources Consultants, Inc.
GWCC	groundwater comparison concentration
GWTS	groundwater extraction/treatment system
HERF	high-energy rate forging
HI	hazard index
HQ	hazard quotient
HML	Hazardous Materials Laboratory
HRA	human health risk assessment
HSA	Historical Site Assessment
H&A	Haley & Aldrich
ICF	ICF Kaiser Engineers
ILCR	incremental lifetime cancer risk
ISI	In-Service Inspection
LMEC	Liquid Metal Engineering Center
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
msl	mean sea level
NA	not applicable
NAA	North American Aviation

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

NDMA	N-nitrosodimethylamine
NFA	no further action
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NSGW	near-surface groundwater
Ogden	Ogden Environmental and Energy Services Company, Inc.
OMR	Organic Moderated Reactor
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PDU	Process Development Unit
pg/g	picograms per gram
ppb	parts per billion (µg/kg or µg/L)
ppm	parts per million (mg/kg or mg/L)
QA	quality assurance
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RME	reasonable maximum exposure
Rocketdyne	Rocketdyne Propulsion and Power
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SGR	Sodium Graphite Reactor
SNAP	Systems for Nuclear Auxiliary Power
SRAM	Standardized Risk Assessment Methodology
SSFL	Santa Susana Field Laboratory
STI	Sonoma Technology Inc.
Surficial OU	Surficial Media Operable Unit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
TCA	trichloroethane
TCE	trichloroethene
TEQ	toxicity equivalency quotient
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
trans-1,2-DCE	trans-1,2-dichloroethene
TRV	toxicity reference value
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
WDP	Waste Discharge Permit
WPA	RFI Work Plan Addendum
WPAA	RFI Works Plan Addendum Amendments

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

(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
TEQs	Toxic Equivalency Quotients (normalized to 2,3,7,8-TCDD)

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 8 Reporting Area, located in the western portion of Area IV at the Santa Susana Field Laboratory (SSFL). This report has been prepared to meet RFI requirements defined by the Department of Toxic Substances Control (DTSC) issued to the SSFL in regulatory permits or as requested in meetings or correspondence. 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.

The Group 8 RFI Report is the third of ten Group RFI reports that will present results and recommendations for large, interrelated portions of the SSFL. The Group 8 Reporting Area includes four RFI sites: the Building 009 Leach Field (B009 LF), the Building 056 Landfill (B056 Landfill), the Empire State Atomic Development Authority (ESADA) area, and the Former Sodium Disposal Facility (FSDF). The B009 LF received discharge of sanitary and liquid waste from Building 009, a nuclear research facility; the B056 Landfill was used for disposal of construction-related wastes; the ESADA area was used for pipe strength testing and drum storage; and the FSDF was used for disposal and treatment of sodium and sodium/potassium (Na/K) mixtures.

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 8 Reporting Area. Thousands of records (provided in the documents submitted in conjunction with this report) dating back to 1957 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 8 Reporting Area is sufficiently complete to estimate current and future risks to potential human and ecological receptors for all the primary chemical use

areas and other areas where chemicals were potentially used, and to support CMS evaluations. Group 8 site action recommendations have been made, and areas have been identified for: (a) further evaluation in the CMS ("CMS Areas"); (b) no further action ("NFA Areas"); and (c) interim surficial soil source area stabilization measures in some CMS Areas to 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. CMS or NFA Area recommendations are based on an integrated evaluation of site characterization and risk assessment results. Chemicals contributing to estimated risks above the most conservative lower end of the regulatory agency-published acceptable risk range (i.e., risks of 1 x 10^{-6}, or 1 in 1,000,000) and/or a Hazard Index of greater than 1 were identified. Sampling results were reviewed to locate areas where chemicals are present at concentrations contributing to or driving the estimated risks. For Group 8, this evaluation resulted in seven 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. The extent of CMS Areas shown on Figure ES-1 is approximate and comprehensive for all potential receptors. Portions of the Group 8 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; (3) metals and dioxins present at naturally-occurring concentrations; and/or, (4) RFI site-specific risk assessment results indicating that the detected chemical concentrations do not pose a risk to human or ecological receptors.

It is worth noting that extent of the CMS Areas depicted graphically are conservative and likely over-estimated. 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 cleanup to achieve acceptable risks. This is because individual soil sample results rather than area-average concentrations are compared to RBSLs as 'bright-line' criteria. Area-averaged concentrations will be used in the CMS to refine the cleanup extent at these recommended CMS Areas.

Within the Group 8 CMS Areas, stabilization measures are recommended for four locations to control potential contaminant migration via the surface water pathway. Stabilization Areas are recommended based on evaluation of chemical concentrations, gradients, and depth; topographic conditions; containment features (e.g., asphalt cover, dam); and proximity to drainages or sensitive ecological receptors. CMS Areas with stabilization recommendations are shown below and in Table ES-2 by an asterisk.

A brief summary of the historical operations, primary chemicals used, and CMS Area recommendations is presented below, and additional details are presented on Table ES-2.

TABLE ES-1
SUMMARY OF GROUP 8 RFI REPORTING AREA CMS RECOMMENDATIONS

RFI Site/Use	CMS Area	CMS Area Description	Chemical Risk Drivers and Significant Contributors
B009 LF (Area IV AOC) Building 009 contained two nuclear facilities, an organic modulated reactor (OMR), and a sodium graphite reactor (SGR). Leach field received discharge of sanitary wastes prior to 1961, and operational liquids prior to 1967 if these met radiological release criteria. Terphenyls, polychlorinated biphenyls (PCBs), kerosene, diesel, sodium, aluminum, and solvents used. Solar concentrator facility located to south included in site.	None	NA	NA
B056 Landfill (SWMU 7.1) Landfill and southern debris area used for disposal of materials generated from excavation of bedrock to create basement for Building 056 (never built). Most fill materials consist of soil and bedrock, with concrete, asphalt, scrap metal, wood products, and drums also present. Drum storage also occurred on top of landfill. Nearby B056 Excavation is filled with standing water and is about 65 feet deep with sloughed sediment/fill, and debris at its base. Small debris areas noted near facility entrance and near excavation.	B056-1	Landfill Materials (B056 Landfill and Southern Debris Area)	Cadmium, selenium, lead, molybdenum, PAHs, Aroclor 1254
	B056-2*	B056 Excavation Debris Area	Aroclors 1248, 1254, and 1260
	B056-3*	Building 100 Discharge Area	Dioxins

TABLE ES-2
GROUP 8 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS

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)	Worker Risks	Recreator Risks				
Building 009 Leach Field (B009 LF) (Area IV AOC) The B009 leach field received sanitary and liquid waste from Building 009. Building 009 contained two nuclear facilities: an organic moderated reactor (OMR) and a sodium graphite reactor (SGR). Chemicals used in operations included terphenyls, PCBs, kerosene, sodium, aluminum, and limited solvents. • Support facilities for B009 included: - Leach field and septic tank - Waste hold-up tanks - Underground storage of diesel fuels - Storage of fuels, solvents, lube oils - Transformers • Other site operations of the site included: - Solar concentrator facility, located approximately 325 feet southwest of Building 009	Human risk: 4 x 10^{-7} Human HI: 0.1	Human risk: 2 x 10^{-7} Human HI: 0.01	Human risk: 4 x 10^{-9} Human HI: 0.004	Deer Mouse: 0.9 Thrush: 1 Hawk:: 0 Bobcat: 0.01 Mule Deer: 2	**<u>Sanitary Operational Wastes:</u>** - Building 009 Leach Field (1a) - Building 009 Septic Tank (1b)	SVOCs, TPH, PCBs, terphenyls, metals, fluoride	--
					<u>Building 009:</u> - Building 009 (B009) (2a) - SGR Liquid Waste Hold-Up Tank and Pit (2b) - OMR Waste Hold-Up Tank and Pit (2c)	VOCs, SVOCs, TPH, metals, fluoride	--
					<u>UT-3 (3)</u>	VOCs, TPH	--
					<u>Oils / PCBs Areas:</u> - B009 Transformer Pad (Substation 709) (4a) - Transformer Pole X-32 (4b)	--	--
					<u>Solar Concentrator Facility (5)</u>	VOCs, metals	--
Building 056 (B056) Landfill (SWMU 7.1) The B056 Landfill RFI Site was used for: • Disposal of excavated soil, bedrock, concrete, asphalt, and minor amounts of scrap metal and wood products, and • Drum and equipment storage on top of landfill • Other areas of the site included: - B056 Excavation, a steep-sided pit containing water, sloughed sediment/fill, and some construction debris - Small soil debris pile noted near facility entrance and excavation	Human risk: 2 x 10^{-6} Human HI: 0.2	Human risk: 1 x 10^{-6} Human HI: 0.04	Human risk: 8 x 10^{-7} Human HI: 0.06	Deer Mouse: 29 Thrush: 4 Hawk: 100 Bobcat: 11 Mule Deer: 8	**<u>Landfill and drum storage:</u>** - Building 056 Landfill (1) - Southern Debris Area (2a) - B100 Discharge Channel (upgradient of 1 and 2a)	VOCs (soil vapor and soil matrix sediment), SVOCs, TPH, PCBs dioxins, metals, asbestos, fluoride	**• B056-1 (1 and 2a)** - Cadmium, selenium, lead, molybdenum, PAHs, Aroclor 1254 **• B056-3* (upgradient of 1 and 2a)** - Dioxins
					<u>Roadside Debris Area (2b)</u>	SVOCs, TPH, metals	--
					<u>Building 056 Excavation:</u> - Building 056 Excavation (3a) - Building 056 Excavation Debris Area (3b)	SVOCs, TPH, PCBs, metals	**• B056-2* (3b)** - Aroclors 1248, 1254, and 1260

TABLE ES-2
GROUP 8 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS

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)	Worker Risks	Recreator Risks				
Empire State Atomic Development Authority (ESADA) (SWMU 7.9) The ESADA RFI Site was used for: • Testing of pipe strength during sodium-water reactions • Testing of zirconium hydride (ZrH_2) covered surrogate fuel pellets • Drum storage of glycol-based solvents saturated with sodium • Tank storage • Support facilities included: - Steam supply boiler - High-pressure water storage tank - Sodium storage tank - Process development unit (PDU) "green liquor" tanks - Transformers • Other site operations included: - Pistol range	Human risk: 1×10^{-3} Human HI: 20	Human risk: 9×10^{-4} Human HI: 3	Human risk: 2×10^{-4} Human HI: 0.5	Deer Mouse: >1000 Thrush: >1000 Hawk: >1000 Bobcat: >100 Mule Deer: >1000	**ESADA Former Storage Yard (1)**	SVOCs, TPH, PCBs, metals	--
					ESADA Sodium Test Area (2)	--	--
					Former PDU AST Area (3)	SVOCs, TPH, PCBs, metals	--
					ESADA Pistol Range (4)	SVOCs, TPH, metals	**ESADA-1 (4)** - Lead, arsenic, antimony, selenium
					Transformer Area (5)	--	--
Former Sodium Disposal Facility (FSDF) (SWMU 7.3) The FSDF RFI Site was used (1950s – 1960s) for: • Treatment of residual Na and NaK from test components (pipes, valves, elbows) • Disposal of waste solvents, kerosene, terphenyls, PCBs; likely disposal of waste hydrocarbons • Burning of waste organics • Support facilities included: - Concrete Pool - Lower and Upper Ponds - Steam Lance • Other site operations included: - Western Drum Debris Area - Pistol Range	Human risk: 3×10^{-5} Human HI: 4	Human risk: 8×10^{-6} Human HI: 0.4	Human risk: 3×10^{-7} Human HI: 0.03	Deer Mouse: 48 Thrush: >1000 Hawk: >100 Bobcat: 4 Mule Deer: 16	**Former Disposal Areas** - Lower Pond (1a) - Upper Pond (1b) - Western Debris Area (1c) - B886 Concrete Pool Area (1d)	VOCs (soil vapor), SVOCs, TPH, PCBs, dioxins, metals, perchlorate	**FSDF-1 (southeast of Former Disposal Area)** - Perchlorate
					Former Steam Lance (2)	PAHs, TPH (removed soil)	--
					Southern Investigation Area (3)	VOCs, SVOCs, PCBs, dioxins, metals Perchlorate (removed soil)	--
					Former Drum Debris Area (4)	SVOCs, metals, PCBs	**FSDF-2* (4)** - Mercury
					FSDF Pistol Range (5)	Metals	**FSDF-3* (5)** - Lead

TABLE ES-2
GROUP 8 REPORTING AREA SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS

General 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.
Metals and dioxins are listed if detected above background.
CMS - Corrective Measure Study is recommended based on compounds considered to be risk drivers (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.

Notes:
(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., FSDF-1, FSDF-2, FSDF-3). The extent of CMS Areas shown on Figure ES-1 are approximate and reflect site action recommendations based on characterization and risk assessment results inclusive for all receptors (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) Worker risks include indoor air exposures in a hypothetical building built over high soil concentrations assumed to be present at shallow depths (e.g., 3 feet below grade at Building 009). No current workers would be expected to be exposed in this manner.

Acronyms:
AOC = Area of Concern
AST = aboveground storage tank
cis-1,2-DCE = 1,2-cis-dichlorothene
CMS = Corrective Measures Study
HI = Hazard Index
RFI = RCRA Facility Investigation
NFA = No Further Action
PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
PDU = Process Development Unit
RCRA = Resource Conservation and Recovery Act
SVOC = semivolatile organic compound
SWMU = Solid Waste Management Unit
TCE = trichloroethene
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

CMS Area	Drivers (Eco and HH)
B056-1	PAHs, Aroclor 1254, Selenium, Lead, Molybdenum, and Cadmium
B056-2	Aroclor 1248, 1254, and 1260
B056-3	Dioxins
ESADA-1	Antimony, arsenic, lead, selenium
FSDF-1	Perchlorate
FSDF-2	Mercury
FSDF-3	Lead

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 presented.

B056 LANDFILL

B009 Leach Field

FSDF

ESADA

B056-1

B056-2

B056-3

FSDF-1

FSDF-2

FSDF-3

ESADA-1

PZ-097, PZ-098, PZ-099, PZ-100, PZ-101, PZ-102, PZ-103, PZ-105, PZ-109, PZ-124, PZ-005

RD-57, RD-33C, RD-33A, RD-33B, RD-65, RD-23, RD-54B, RD-54C, RS-54, RD-54A, RD-22, RD-64, RD-21, RD-74, RD-07, RS-16, RD-25, RD-91, RD-20, RS-18, RS-23, RD-50, RD-13

Outfall 005, Outfall 006, Outfall 007

Shaded locations 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 driver or contributors (shown in inset table), are based on evaluation comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.

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
- Fence
- Rock Outcrop
- Elevation Contour
- Surface Water Divide
- Drainage
- Lined Drainage
- Pond
- Possible Pond
- Leach Field
- Pipe
- Well
- Abandoned Well
- NPDES Outfall

CMS Areas

- B056 Landfill CMS Area
- ESADA CMS Area
- FSDF CMS Area

B009 Leach Field has no areas recommended for CMS.

CMS Areas recommended for further evaluation in Corrective Measures Study (CMS)

Areas Recommended for Corrective Measures Study (CMS)

Date: Oct 01, 2007

Document: RFI-Report-Group8_CMS_Areas.mxd

1 inch equals 200 feet

0 200 400 Feet

SANTA SUSANA FIELD LABORATORY

MWH

FIGURE ES-1

RFI Site/Use	CMS Area	CMS Area Description	Chemical Risk Drivers and Significant Contributors
ESADA (SWMU 7.9) Facility used for testing of pipe burst-strength during sodium-water reactions. Area also used for drum storage of glycol-based solvents saturated with sodium, and tank storage. Southeastern part of site used as pistol range.	ESADA-1	ESADA Pistol Range	Lead, arsenic, antimony, selenium
FSDF (SWMU 7.3) Facility used for treatment of residual sodium (Na) and sodium/potassium (Na/K) on equipment by reactions with water. Site included two disposal ponds, a western debris area, and a concrete pool used for treatment. These areas excavated to bedrock and backfilled with clean soil. Site also included a steam lance, one channel debris area, and a former pistol range. Primary chemicals used, disposed of, or burned at site included solvents, kerosene, Na, Na/K, PCBs/terphenyls, and likely hydrocarbons.	FSDF-1	South of Former Disposal Area	Perchlorate
	FSDF-2*	Former Drum Debris Area	Mercury
	FSDF-3*	FSDF Pistol Range	Lead

* Indicates area also recommended for source stabilization to address potential surficial migration of contamination.

Recommendations in this report are for surficial media (soil, soil vapor, sediment, etc.) but 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 8 RFI Report will be reviewed once these additional evaluations are completed and, if 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 will identify areas that would be added to, not removed from, subsequent CMS decision-making.

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 8 Reporting Area located in the western 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 8 Reporting Area includes four RFI sites: the Building 009 Leach Field (B009 LF), Building 056 Landfill (B056 Landfill), Empire State Atomic Development Authority (ESADA) area, and Former Sodium Disposal Facility (FSDF).

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, 2004).

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) and undeveloped land areas to both the north and south (Figure 1-2). Areas I, III, and IV are owned by Boeing. Area II is owned by NASA. 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 8 Reporting Area, described further in Section 1.3, is primarily located in the western 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 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.) (Science Applications International Corporation [SAIC], 1994). Since 1996, operations at the SSFL have been conducted by Boeing. Predecessor companies to Boeing have included the Rocketdyne Propulsion and Power Division (Rocketdyne) of NAA and of the Rockwell International Corporation. 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 were used for cleaning rocket engine components. Trichloroethene (TCE) was the primary solvent used for this and 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 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). Operations were conducted by Atomics International (AI), a division of NAA, and Rocketdyne on behalf of DOE, with operations primarily from the 1950s through the mid-1990s. 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, 2004). Since the mid-1990s, activities in Area IV have focused on 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, 2004). Adjacent land use is shown in Figure 1-1.

Northern Adjacent Properties - The adjacent property to the northwest is occupied by the Brandeis-Bardin Institute (BBI), and the adjacent property to the northeast is occupied by the Mountains Recreation Conservancy Authority (MRCA). The BBI 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 BBI indicate that this property contains religious, teaching, and camping facilities. The MCRA property is zoned as open space; currently operates as Sage Ranch Park, a County of Ventura Park; and has a house where the park ranger resides.

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 5 miles southeast 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. Recently, a portion of Runkle Canyon located in this area has been proposed for development.

1.1.3 SSFL Environmental Programs

Four environmental programs at the SSFL are 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, 2004). Since these other environmental programs overlap and are relevant to some of the RCRA RFI sites, they are briefly described below:

- Waste Discharge Permits (WDPs) 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. Surface water discharges are regularly monitored at 18 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 Health Services-Radiologic Health Branch (DHS-RHB) oversees the Boeing-owned Radioactive Materials License, conducts facility verification surveys, evaluates the radioactive facility cleanup, and conducts environmental monitoring.

1.2 RCRA CORRECTIVE ACTION PROGRAM

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. 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, 2004) for descriptions of the other RCRA Programs.

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 of 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, 2004). 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, 2004) 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 133, and Building 029). Two sites were added when leach fields were regrouped to allow for planned reporting. 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, 2004), 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 characterization of all relevant environmental media present at the SSFL. Investigations of environmental media have been conducted following DTSC-approved work plans (ICF Kaiser Engineers [ICF], 1993; Groundwater Resources Consultants, Inc. [GRC], 1995a and 1995b; Ogden Environmental and Energy Services Company, Inc. [Ogden], 1996, 2000a, and 2000b; Montgomery Watson, 2000b; MWH, 2001, 2003a, 2003b, and 2005c). The scope and extent of sampling of the SSFL during the RFI is described in the Program Report (MWH, 2004).

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 for further evaluation during the RFI. 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 are prepared for DTSC review, and findings are published in a final CMS report for DTSC approval.

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.

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, 1999a). 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, 1999a). The OUs at the SSFL are:

- The Surficial Media OU (Surficial OU), comprised of saturated and unsaturated soil, sediment, surface water, 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 natural physical and chemical degradation processes. The OUs are depicted graphically on Figure 1-4.

The Surficial OU consists primarily of soil, sediment, and surface water, which 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 8 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 8 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 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, 2004), the Data Quality Objective (DQO) process (USEPA, 1994 and 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 ten Group Reporting Areas as shown on Figure 1-5. One of these areas, Group 7, includes two separate areas that will be 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 Surficial Media can be made and CMS evaluation areas 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 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 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 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 and finalize the areas to be evaluated in the CMS as described in this (and other) Group RFI Reports. 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 subsequent site-wide RFI evaluations.

The Group 6 RFI Report for the Northeastern Portion of Area IV (MWH, 2006b) and the Group 4 RFI Report for the Southern Portion of Area II (MWH, 2007d) were the first and second RFI Report, respectively, that were completed and submitted to DTSC. The Group 8 RFI Report for the Western Portion of Area IV is the third RFI Report to be submitted for DTSC review.

1.3 SCOPE, OBJECTIVES, AND INFORMATIONAL SOURCES FOR THE GROUP 8 RFI REPORT

The Group 8 RFI Report presents RFI findings and CMS recommendations for the western portion of Area IV. The scope, objectives, and informational sources for the Group 8 RFI Report are described below. The content and format of this report is also presented.

1.3.1 Scope

The Group 8 Reporting Area consists of approximately 110 acres located entirely within the western portion of Area IV (Figure 1-6). Areas adjacent to the Group 8 Reporting Area include two other RFI Group Reporting Areas to the east, the property occupied by BBI to the northwest, and private property (ranch land) to the west and southwest. The two adjacent RFI Group Reporting Areas are Reporting Group 5, which consists of both Boeing and DOE RFI sites, and Reporting Group 7, which consists of DOE RFI sites. The adjacent properties are described in Section 1.1.2. The undeveloped, Boeing-owned land to the northwest of the SSFL is included as part of the Group 8 Reporting Area.

Four RFI sites are included in the Group 8 Reporting Area:

B009 LF Site	Area IV AOC (Building 009 Leach Field)
B056 Landfill RFI Site	SWMU 7.1 (Building 056 Landfill)
ESADA RFI Site	SWMU 7.9 (ESADA Chemical Storage Yard)
FSDF RFI Site	SWMU 7.3 (Building 886 Former Sodium Disposal Facility)

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. As described in Appendices A, B, C, and D 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 14 of the 110 acres of the Group 8 area are contained within the outlines of the RFI site boundaries shown on Figures 1-5 and 1-6.

1.3.2 Objectives

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

- To present characterization results for the Group 8 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 8 Reporting Area.
- To present risk-based recommendations for 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 are considered to be defined sufficiently for CMS planning, although additional areas may be added following completion of the Site-Wide Groundwater Report and/or the Site-Wide Large-Home Range Risk Assessment Report.

1.3.3 Informational Sources

Historical documents for the Group 8 Reporting Area are being submitted to DTSC along with this report (Boeing, 2007a). These documents represent a compilation of information from multiple sources that were searched in an attempt to find SSFL documents relevant to the Group 8 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 8 Reporting Area. Documents pertaining to the entire SSFL are also included if they have relevant information also specific to Group 8. 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 8 Reporting Area are presented in this report. The historical document review, coupled with the site characterization data, provides a solid basis for the recommendations 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, the Group 8 RFI Report is divided into nine sections (seven sections of text, plus references and a glossary of terms), and six appendices. A diagram for the Group 8 RFI report structure is shown in 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 8 Report (Sections 1 through 9) presents an integrated summary of the detailed information presented in appendices (Volumes II through IV), 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 of this Group 8 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 drainages, groundwater, and biological conditions.

Section 3 – Group 8 Site History and Chemical Use. This section summarizes the history of the Group 8 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. In addition, this section describes 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 8. 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, C, and D, as described below.

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

Section 6 – Risk Assessment Summary. This section presents a summary of the human health and ecological risk assessment results for the Group 8 Reporting Area based on four RFI site risk assessments.

Section 7 – Group 8 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.

Volumes II and III:

Appendices A, B, C, and D – Site RFI Reports. Appendices A, B, C, and D present detailed site history, characterization findings, risk assessment results, and site action recommendations for the four RFI sites evaluated in the Group 8 RFI Report: B009 LF (Appendix A), B056 Landfill (Appendix B), ESADA (Appendix C), and FSDF (Appendix D), respectively. 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 three 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), and Attachment 3: Data Quality, Validation and Laboratory Reports.

Volume IV:

Appendix E – Chemicals in Groundwater. This appendix presents information regarding groundwater conditions in the Group 8 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 F – 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 (MWH, 2005), RFI site risk assessments, risk calculations, result tables, and all transport and fate modeling except for groundwater transport modeling (presented in Appendix E).

As stated above, historical documents for the Group 8 Reporting Area are being submitted to DTSC along with this Group RFI Report (Boeing, 2007a). Since historical document review is ongoing for the other RFI Groups, if other documents are identified that are pertinent to the Group 8 Reporting Area, these will be provided to DTSC as an addendum to the Group 8 historical document submittal.

2.0 PHYSICAL SETTING OF THE REPORTING AREA

This section describes the physical setting within the Group 8 Reporting Area. The RFI Program Report provides an overview of the physical setting at the SSFL (MWH, 2004). Additional specific information is also provided within each of the RFI site report appendices (A through D) and in the groundwater appendix (E).

2.1 TOPOGRAPHY

The Group 8 Reporting Area occupies approximately 110 acres with about 600 feet of topographic relief. A shaded relief map showing the site topography is provided as Figure 2-1. The Group 8 Reporting Area slopes generally to the north. South of the ESADA RFI Site, the surface elevation of the Group 8 Reporting Area reaches a maximum of approximately 2,120 feet above mean sea level (feet msl). The lowest surface elevation is approximately 1,520 feet msl north of B056 Landfill, where a natural surface water drainage leaves the Group 8 Reporting Area at the northern property boundary. Within former operational areas of the four Group 8 RFI sites, natural surface elevations range from approximately 1,750 feet msl at the northwestern edge of the B056 Landfill RFI Site, within a natural surface water drainage, to approximately 1,900 feet msl at the southern edge of the ESADA RFI Site. The Group 8 Reporting Area is characterized by topographically flat areas bordered by bedrock outcrops near and within the former operational areas of the RFI sites, steep slopes at the B056 Landfill RFI Site, and steep drainages adjacent to and north of the FSDF and B056 Landfill RFI Sites.

The base of the B056 Excavation, near the eastern boundary of the Group 8 Reporting Area, is at an elevation of approximately 1,735 feet msl. This excavation, located east of the landfill, is a vertically-walled circular pit that extends approximately 65 feet into bedrock. It was excavated in order to build the basement for Building 056, the Systems for Nuclear Auxiliary Power (SNAP) 8 Flight System Test Facility; however, the facility was never built.

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 70ºF 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 8 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 (Sonoma Technology Inc. [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 2006, 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 2007 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 8 Reporting Area are described in this section.

2.3.1 Soil

Group 8 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 8 Reporting Area. Soil in the southern portion of the Group 8 Reporting Area is also derived from the Santa Susana formation. Native soil (i.e., alluvium and colluvium), which is present primarily in topographic lows and stream drainages, ranges in thickness from less than 1 foot to approximately 12 feet. Fill materials have been used at two Group 8 RFI sites, the B056 Landfill and the FSDF, and may have been used in the southern portion of the B009 LF RFI Site. Based on soil boring logs and

information collected during site excavation activities (see Appendices A through D), the approximate soil and/or fill thickness ranges from less than 1 foot to approximately 20 feet at the B009 LF RFI Site, 3 to 14 feet at the ESADA RFI Site, and 2 to 12 feet at the FSDF RFI Site. At the B056 Landfill, the thickness of soil and/or fill (including landfill materials) ranges from less than 1 foot to approximately 20 to 25 feet.

Soils are generally thin and are comprised mostly of clay, silt, and sand with trace gravel. Clayey soils in the southern Group 8 Reporting Area are common, likely due to the presence of the Santa Susana formation, which consists primarily of micaceous claystone and siltstone with a few minor sandstone interbeds (Dibblee, 1992). Weathered sandstone and siltstone underlie the unconsolidated alluvium.

Soils and bedrock from the B056 Excavation were disposed of into the B056 Landfill and the nearby Southern Debris Area. Fill soils overlay a thin layer of alluvial soil, and typically range in thickness from less than 1 foot to approximately 20 to 25 feet. Fill soils primarily consist of silty fine sands, and sandy silts with sandstone gravels and cobbles (Appendix B).

The maximum depth of backfill in the area of the former FSDF pond excavation is about 13 feet below current grade based on topographic surveys performed following the excavation. Soils within the former excavation areas consist of DTSC-approved soils from an onsite borrow area. Fill soils are primarily comprised of fine-grained silty sands, clayey sandy silts, silty clays, and lean clay (Appendix D).

Disturbed native soils, ranging from less than 1 to about 5 feet thick, may have been used as fill in the southern portion of the B009 LF RFI Site in the vicinity of the solar concentrator facility, based on analysis of historical photographs and boring logs (Appendix A).

2.3.2 Bedrock

Figure 2-5 shows the geologic units present within the Group 8 Reporting Area. The Santa Susana formation is present in the southernmost portion of the area, and the Chatsworth formation is present in the northern portion. A stratigraphic column of the Chatsworth formation, which underlies most of the SSFL and the Group 8 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 are three stratigraphic members of the Chatsworth formation within the Group 8 Reporting Area. Each is briefly discussed below, from the youngest to the oldest. The Upper Burro Flats member is predominantly comprised of medium-grained sandstone with minor interbeds of siltstone and shale. The ELV member lies below the Upper Burro Flats member and is comprised of thinly interbedded fine-grained sandstone, siltstone, and shale. The Lower Burro Flats member underlies the ELV member and is predominantly comprised of medium-grained sandstone with significant siltstone/shale interbeds. The Santa Susana formation is predominantly composed of micaceous claystone and siltstone, with a few minor sandstone beds (Dibblee, 1992). Additional geologic information is presented in Appendix E.

Structurally, the Chatsworth and Santa Susana formations are separated by the Burro Flats Fault, located in the southern part of the Group 8 Reporting Area. This fault strikes approximately east-west in the vicinity of the ESADA RFI Site, as shown on Figure 2-5 (Dibblee, 1992; MWH, 2007e). To the north of the fault are the Upper Burro Flats, ELV, and Lower Burro Flats members of the Upper Chatsworth formation, and to the south of the fault is the Santa Susana formation (Dibblee, 1992; MWH, 2002e). A series of deformation bands is also present east and west of the FSDF RFI Site. These deformation bands generally strike northeast-southwest and have currently been defined by geologic site mapping to comprise the western extent of the North Fault zone (MWH, 2007e). The locations of the Burro Flats Fault and the deformation bands are shown in more detail on Plate E-1 in Appendix E.

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 8 Reporting Area wells. Bedrock properties are briefly discussed in Section 5 and presented in tables included within Appendices E and F.

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 8 surface water drainage basins and surface water flow directions are shown on Figure 2-7B. The following description of the surface flow

directions and drainage patterns within the Group 8 Reporting Area first presents overall drainage patterns, followed by more detailed site descriptions.

The majority of the Group 8 Reporting Area is north and west of a surface water divide that forms most of the eastern boundary of Group 8. The small portion of the Group 8 Reporting Area that is east of the surface water divide includes only the B056 Excavation, a vertical-walled excavation into bedrock east of the B056 Landfill. Surface water flow in this portion of the Group 8 Reporting Area is into the B056 Excavation, which does not have any natural surface discharge point. This excavation contains a mixture of rainwater, surface water, and groundwater, and is the only permanent surface water body within the Group 8 Reporting Area. All other surface water within the Group 8 Reporting Area exists only as intermittent discharge resulting from rain events.

In March 1999, dewatering of the B056 Excavation was initiated to prevent groundwater seepage into the lower basement of Building 059, located approximately 250 feet northeast of the excavation (GRC, 1999). During the initial dewatering period from March 23 to May 14, 1999, approximately 2.5 million gallons of water were removed from the excavation. This water was conveyed away from the excavation through a pipeline and discharged to a lined drainage along G Street. The water then flowed south to the R-2 Pond and then to Outfall 002, located in the Group 9 Reporting Area (GRC, 1999). At the time of its installation, the excavation dewatering system was equipped with an automatic control to keep the water level in the excavation below approximately 1,748 feet msl. Following the demolition of Building 059 in 2004, the dewatering system was shut down.

Except for the B056 Excavation area, surface water discharge within the remainder of the Group 8 Reporting Area is from the RFI sites in the south to natural drainages located in the undeveloped SSFL land to the north. These channels lead to the Meier Canyon drainage on BBI property. Meier Canyon flows into the Arroyo Simi in Simi Valley (Figure 2-7A). Within the RFI sites located in the south, surface water discharge is generally via sheet flow or lined discharge channels leading to north- and northeast-trending natural drainages (Figure 2-7B). Surface water discharge from the ESADA RFI Site is predominantly to the north toward the FSDF RFI Site. Discharge from the B009 LF RFI is also to the north, likely joining a north-trending natural drainage that joins the northeastern drainage from the FSDF RFI Site. Surface water from the B056 Landfill Site also flows to the north, joining with the FSDF drainage Channel C. At this confluence, FSDF Channel D begins and continues offsite to the property owned by the Brandeis-Bardin Institute (BBI). Surface water flow

patterns for the Group 8 Reporting Area are shown in Figure 2-7B and described in more detail below for each RFI site.

Surface water is monitored at three established NPDES monitoring locations in this area of the SSFL (Figure 2-7B): Outfalls 005 and 006 at the FSDF RFI Site, and Outfall 007 south of the B056 Landfill Site.

B009 LF RFI Site

Surface water flow at the B009 LF RFI Site is predominantly controlled by concrete- and asphalt-lined ditches that discharge to a natural drainage located to the west of the leach field. South of the B009 RFI Site, surface water discharge from the eastern boundary of the ESADA RFI Site drains via sheet flow to the solar concentrator facility, where it is directed into a gunite-lined ditch that discharges along H Street. Runoff from Building 009 is diverted into an asphalt-lined channel along its southern perimeter. This diversion ditch discharges into a storm water culvert located southeast of the building or to a concrete-lined channel to the west along the leach field. The storm water culvert to the southeast discharges into the storm water drain along G Street. From G Street, surface water flows via storm water drains into the R-2 Pond (SWMU 5.26), and eventually discharges at Outfall 002. The concrete-lined channel near the leach field drains northward to a natural channel, which ends at a rock outcrop located approximately 150 feet north of the leach field. Surface water appears to infiltrate at this location and may resurface north of the outcrop, where another channel carries surface water to the north.

B056 Landfill RFI Site

Surface water flow at the B056 Landfill RFI Site is predominantly to the north. As described above, east of the surface water divide, surface water flows into the B056 Excavation. West of the surface water divide, surface water discharge is via sheet flow over the topographically flat portions of the site toward a well-developed, natural drainage to the west. The northern portion of the landfill drains to an east-west tributary to the primary north-south drainage. The primary drainage begins south of the B056 Landfill, north of Building 100. Surface water discharge from the developed area at Building 100 (located in Group 5 just beyond the Group 8 boundary) is directed to asphalt-lined ditches that drain north toward Outfall 007. Below Outfall 007, the drainage flows north, along the west side of the Southern Debris Area and the B056 Landfill. The natural drainage continues north, joining the northeastern drainage that leads from the FSDF RFI Site (i.e., Channel C). At the confluence, the

drainage is called Channel D. Surface water in Channel D flows to the north and offsite to the BBI property and eventually joins the Meier Canyon drainage.

ESADA RFI Site

With the exception of the northeast corner of the ESADA RFI Site, surface water discharge is via sheet flow to the northeast toward the FSDF RFI Site. Surface flow is into a diversion channel that was constructed during the 2000 FSDF IM to divert water around the FSDF excavation area. This diversion drainage also receives surface water flow from the southern portion of the FSDF RFI Site (south of the dirt road), and this water flows to the northeast into a culvert beneath H Street. The culvert discharges into a north-east trending drainage (Channel B) along the east side of the FSDF RFI Site. Prior to the IM, surface water at the ESADA RFI Site was generally similar; however, the southern diversion channel did not exist, so sheet flow across the road into the southern portion of the FSDF site and then into the northeast drainage (now Channel B) may have occurred.

FSDF RFI Site

Historically, the FSDF RFI Site contained the Upper and Lower Ponds, which were basins filled with water to treat residual sodium and sodium/potassium (NaK) mixtures on equipment and parts. In 1976, the ponds were drained, but water occasionally accumulated there following precipitation at the site (Ebasco, 1991). In 1995, the ponds were covered with tarps, and gunite-lined diversion ditches were created around the pond area to prevent water infiltration. Prior to the installation of these diversion ditches, surface water from the FSDF area would drain toward the northeast into Channel B. After the diversion ditches were installed, the area northwest of the Lower Pond began to drain more directly to the north into Channel A (Rockwell, 1995). As part of an interim measure (IM) that began in 2000, a large portion of the FSDF site, including the former Upper and Lower Ponds, was excavated down to bedrock. Thee areas were backfilled in 2001, and the area was graded to slope gently toward the north-northeast. Most surface water discharge is now directed toward Channel B, and a smaller portion is directed toward Channel A (IT, 2002).

Outfall 005 is located along Channel A north of the former excavation area. Below the outfall, Channel A is a natural drainage leading to the north, where it joins a northeast-trending drainage from the western edge of the FSDF RFI Site. After this confluence, Channel A continues down to the confluence with the northern portion of Channel B. Channel B begins northeast of the former ponds and drains northeast. Surface water from the diversion ditch created during the 2000 IM also flows into Channel B. The portion of

Channel B upstream of Outfall 006 was excavated during the FSDF IM. Outfall 006 is located where Channel B becomes a defined natural drainage.

Channels A and B converge approximately 350 feet northeast of the site, forming Channel C. Surface water in Channel C flows northeast and, as described above, joins a major north-south trending drainage leading from the B056 Landfill RFI Site. Below this confluence, the drainage is called Channel D. Except within the former FSDF area and the lower reaches of Channel D, Channels A through D are typically very steep drainages with abundant rock outcrops and few bank deposits. The lower portion of Channel D is much less steep, with bank deposition and riparian vegetation. Channel D joins the Meier Canyon drainage, which flows into the Arroyo Simi in Simi Valley.

2.5 GROUNDWATER

Discussions of the groundwater system and monitoring network in RFI Group 8 are presented in Appendix E. 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 8 Reporting Area. Figures 2-9 and 2-10 depict groundwater conditions for perched and Chatsworth formation groundwater. Figure 2-12 provides hydrogeologic cross-sections for the Group 8 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 in a Draft Preliminary Memorandum 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 E 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 (1999 and 2007b). Perched versus continuous groundwater occurrence is described for NSGW and CFOU groundwater as appropriate for characterization, transport and fate, and risk assessment. Appendix E provides a more detailed description of the occurrence of these conditions for Group 8.

Both NSGW and CFOU groundwater are present in the Group 8 Reporting Area. NSGW is present in localized areas across the SSFL. However, the CFOU groundwater is a regional unit, present throughout the area. The general relationship of the NSGW and CFOU groundwater units in the Group 8 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 (Haley & Aldrich [H&A], 2006a and b).

The monitoring wells, piezometers, and springs in and near the SSFL have been divided into ten 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 on- and offsite wells, springs, and seeps are evaluated, and discussions of such are included in the Group Report.

NSGW and CFOU groundwater occurrence and quality for the Group 8 Reporting Area, including springs and seeps, 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 recently approved

by DTSC (DTSC, 2007d and 2007e). Furthermore, a work plan to complete the groundwater characterization program at the SSFL will be submitted to the DTSC in January 2008. 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

B009 LF RFI Site

NSGW beneath the B009 LF RFI Site is monitored by one piezometer (PZ-102) screened in weathered bedrock (Figure 2-9). Measurable groundwater has been present in PZ-102 during only a few monitoring events. The groundwater elevation within PZ-102 (when groundwater was present) was compared to groundwater elevations in adjacent wells. This comparison shows that the groundwater elevation in PZ-102 (1,783 ft msl in April 2003) was similar to groundwater elevations in adjacent Chatsworth formation wells. This evaluation suggests that the NSGW in PZ-102 monitors the regional CFOU groundwater, and is not perched. Groundwater is present in both weathered and unweathered bedrock in well RD-91, where the depth to water has averaged approximately 17 feet bgs (1,801 feet msl) since May 2005.

B056 Landfill RFI Site

At the B056 Landfill RFI Site, one piezometer (PZ-124) and one shallow well (RS-16) were installed to monitor groundwater conditions in NSGW (Figure 2-9). Dewatering of the B056 Excavation has had a significant affect on NSGW occurrence at this site. During the initial dewatering effort, conducted from March 23 through May 14, 1999, approximately 2.5 million gallons of water were pumped from the B056 Excavation (GRC, 1999). During this period, the water level in the B056 Excavation was lowered by a total of 49 feet. An automatic pumping system was installed in the excavation to maintain the water level below 1748 feet msl and prevent water seepage into the basement of nearby Building 059. Periodic pumping of the B056 Excavation continued thereafter until August 2004, when Building 059 was demolished and dewatering was no longer warranted. Prior to dewatering activities, NSGW was encountered in well RS-16 at depths as shallow as 6.3 feet bgs (1803 feet msl). Water levels measured in nearby well RD-07 were typically 40 to 50 feet lower than those measured in RS-16, suggesting that the NSGW monitored by well RS-16 was perched above the regional water table. Perched groundwater elevations dropped below the screened

interval of RS-16 during dewatering and returned only briefly after two consecutive years of above-average rainfall in 2004 and 2005. No information is available regarding the temporal variability of groundwater occurrence at PZ-124 because this well has been dry since construction, but field records indicate that groundwater was encountered during well installation at a depth of 22 feet bgs (1743 feet msl).

ESADA RFI Site

NSGW near the ESADA RFI Site can be either perched above or vertically continuous with CFOU groundwater. Groundwater is usually present in well RS-23 only following periods of heavy rainfall. When perched groundwater is present, groundwater levels in RS-23 are nearly 60 feet higher than those measured in RD-50; however, groundwater in RD-50 has occasionally been measured at depths similar to those in RS-23, indicating that NSGW at RS-23 can also be vertically continuous with CFOU groundwater. Although groundwater is usually not encountered at well RS-23, it has been measured at depths as shallow as approximately 6 feet below the top of the well casing (TOC), equivalent to approximately 1,881 feet msl.

FSDF RFI Site

At the FSDF RFI Site, five piezometers (PZ-097, PZ-098, PZ-099, PZ-100, and PZ-101) and two shallow wells (RS-54 and RS-18) were installed to monitor groundwater conditions in NSGW (Figure 2-9). Well PZ-099 was subsequently abandoned in 2006 during the installation of surface water erosion controls at nearby Outfall 005. NSGW is perched above CFOU groundwater in the FSDF RFI Site area, and its extent is shown in plan view in Figure 2-9. At FSDF, NSGW is encountered at average depths ranging from 8 feet bgs (1795 feet msl) at RS-18, to 21 feet bgs (1825 feet msl) at RS-54. Although NSGW at this site is temporally persistent, the lateral extent of this groundwater unit is constrained by surficial bedrock outcrops to the east and west, and has varied over time as a result of groundwater extraction at RS-54. NSGW flow is to the north, with a horizontal gradient of approximately 0.11 foot/foot (ft/ft) (MWH, 2003c).

2.5.2 Chatsworth Formation Groundwater

B009 LF RFI Site

CFOU groundwater beneath the B009 RFI Site is monitored by RD-91 (Figure 2-9). Groundwater encountered at RD-91 saturates both weathered and unweathered Chatsworth formation bedrock. Groundwater was first encountered at approximately 100 feet bgs during

the installation of well RD-91 in 2004, but the depth to water has averaged approximately 17 feet bgs (1,801 feet msl) since May 2005. As noted in the boring log for RD-91, weathered sandstone is present from approximately 8 feet bgs to 46 feet bgs. As noted above in Section 2.5.1, PZ-102 also appears to monitor CFOU groundwater and, when present, NSGW, which is vertically continuous with CFOU groundwater.

B056 Landfill RFI Site

At the B056 Landfill RFI Site, two wells (RD-07 and RD-74) were installed to monitor CFOU groundwater (Figure 2-9). Water levels in RD-74 are highly responsive to seasonal rainfall, and can vary over 40 feet within a season (e.g., from 1736 msl to 1779 msl). These large fluctuations may be attributable to the fact that RD-74 is located near a drainage, where recharge may be higher relative to areas outside of the drainage. Water levels in RD-07 are typically less affected by seasonal precipitation, but they do appear to have been significantly influenced by groundwater extraction from well RD-24, located to the east.

ESADA RFI Site

CFOU groundwater beneath the ESADA RFI Site is monitored by RD-50 (Figure 2-9). In this area, CFOU groundwater is encountered at depths ranging from approximately 38 feet below TOC to 112 feet below TOC (1,877 feet msl to 1,803 feet msl). Chatsworth formation groundwater elevations in RD-50 can increase by over 60 feet following periods of heavy rainfall.

FSDF RFI Site

At the FSDF RFI Site, 12 wells (RD-21, RD-22, RD-23, RD-33{A,B,C}, RD-54{A,B,C}, RD-57, RD-64, and RD-65) were installed to monitor CFOU groundwater (Figure 2-9). CFOU groundwater at the FSDF RFI Site is encountered at average depths ranging from 101 feet bgs (1766 feet msl) at RD-21 to 305 feet bgs (1548 feet msl) in RD-22. Depths to CFOU groundwater are quite variable at this site due to a combination of stratigraphic and topographic features that are discussed further in Appendix E.

Groundwater extraction was initiated in April 1997 at wells RD-21 and RS-54, and continued with few interruptions until 2003, when pumping activities were terminated to allow for CFOU characterization activities. Water levels in FSDF Chatsworth formation wells were not significantly affected by pumping activities at either of these locations. This observation is consistent with the results of the RD-54B pumping test, which showed little influence at RD-21. RD-21 is located about 440 feet from RD-54B (from the midpoints and the open

intervals). In addition, extraction of groundwater from RS-54 does not directly influence water levels in FSDF area Chatsworth formation wells since it is screened within a perched groundwater unit.

Several offsite wells (OS-3, OS-4, OS-5, OS-5A, and the RD-59 cluster) are used to monitor groundwater conditions downslope of the FDSF RFI Site (Figure 2-9). Groundwater elevations measured in these wells are significantly lower than those measured in wells within the FSDF RFI Site boundary. Artesian conditions are observed in several of these wells.

Within the Group 8 Reporting Area, CFOU groundwater flow is toward the northwest. In proximity to the RFI sites, the estimated horizontal gradient is 0.1 ft/ft based on recent groundwater elevations. A more detailed description of groundwater flow and occurrence is presented in Appendix E.

2.5.3 Springs and Seeps

There are six springs (FDP 900, FDP 900A, FDP 900B, S19, S20, and S21) located offsite to the north of the Group 8 Reporting Area (Figure 2-9). Groundwater emerging at these springs is described further in Appendix E and in Sections 4 and 5 below.

2.6 BIOLOGY

Biological conditions at the four Group 8 RFI sites as they existed prior to the 2005 Topanga Fire are shown on Figure 2-13, which depicts vegetation types and sensitive species. In June 2007, reconnaissance-level vegetation mapping was conducted at the Group 8 RFI sites in support of the site-specific ecological risk assessment, and the vegetation map is included as Attachment F6 of Appendix F.

During the September/October 2005 Topanga Fire, no vegetation within the B009 LF and ESADA RFI Site boundaries was burned (MWH, 2006b). However, much of the surrounding areas and the northern and eastern portions of the FSDF and B056 Landfill RFI Sites were burned, and significant ash was deposited across the Group 8 Reporting Area, especially in drainages (MWH, 2006b). 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 are comprised of ruderal habitat, non-native grassland, coast live oak woodland, and rock outcrops. Developed land within the Group 8 Reporting Area exists only at the B009 LF RFI Site, although some erosion control ditches and roads are present throughout the area. Other vegetation types include chaparral and native scrub. Coast live oak woodland characterizes most of the northern drainages, leading to a riparian habitat in the lower reach of FSDF Channel D on BBI property (IT, 2002).

Sensitive species present at and near the Group 8 RFI sites are mule deer, San Diego black tailed jackrabbit, great blue heron, southern California black walnut, Santa Susana tarplant, coast live oak, Braunton's milk vetch, and Plummer's mariposa lily.

3.0 GROUP 8 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 8 Reporting Area. Additional details are presented in the RFI Site Reports in Appendices A, B, C, and D. A Group 8 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. Thousands of records (provided in the documents submitted in conjunction with this report [Boeing, 2007a]) 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 8 RFI sites. The sites are presented in Section 3.1 in the order they are described in Appendices A through D. 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 four RFI sites have been identified and used to target sampling conducted under DTSC-approved work plans (Ogden, 1996, 2000a, and 2000b; GRC, 1995a and b; Montgomery Watson, 2000b; MWH, 2001 and 2003a), or as requested by DTSC during the RFI. The known and potential chemical use areas for the Group 8 Reporting Area are described briefly in this section and combined into nine general categories:

- Solvents
- Petroleum Fuels
- Oils/PCBs
- Metals/Inorganic Compounds (excluding debris areas)
- Debris Areas
- Perchlorate
- Landfills
- 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.

3.1 RFI SITE HISTORIES

The following sections summarize operational histories for each of the four RFI sites included in the Group 8 Reporting Area.

Site operations and history information was compiled during a comprehensive records review of facility documents described above (Boeing, 2007a). Primary previously published sources of information include the RFA (SAIC, 1991 and 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 (Sapere, 2005); and site investigation reports and work plans (GRC 1989, 1990, and 1999; ICF, 1997; IT, 1999). Detailed historical and reference information is presented in the RFI Site Reports (Appendices A through D). Historical documents for the RFI sites included in Group 8 are provided to DTSC in conjunction with this report (Boeing, 2007a).

3.1.1 B009 LF

The B009 LF RFI Site occupies approximately 4 acres in the central portion of the Group 8 Reporting Area and consists of the Building 009 area and the solar concentrator facility (Figure 3-1). Building 009 was constructed for nuclear research operations, and the leach field (an Area IV AOC) was used for sanitary and liquid waste disposal. The leach field was located approximately 50 feet north of the building and contained six leach lines, ranging in length from 15 to 42 feet. The leach lines extended north from a 2,340-gallon septic tank that was located outside the northwestern portion of Building 009. The B009 leach field was reported to include approximately 300 total linear feet of leach lines (ICF, 1993). The leach field consisted of 4-inch diameter terra cotta clay piping surrounded by large gravel and buried at depths ranging from 4 to 5 feet bgs.

The leach field provided for the disposal of both sanitary and liquid waste before a central sewage system was installed at the SSFL in 1961 (Rockwell, 1979; AI, 1958; ICF, 1993).

After 1961, only liquid waste generated from Building 009 operations would have been discharged into the leach field. The discharge of liquid waste into the leach field ceased in 1967, when operations ended at the Sodium Graphite Reactor (SGR) located in Building 009 (AI, 1968). The leach field, leach lines, and septic tank were removed in 2002 (Boeing, 2007b). The septic tank, 18-inch leach tiles, miscellaneous demolition debris, and approximately 50 tons of soil were disposed of offsite at an appropriate facility in accordance with applicable regulations. Liquids from the removed septic tank contained PCBs and metals, with concentrations ranging up to 1.1 micrograms per liter (µg/L) of Aroclor 1254, and up to 68 µg/L of zinc (highest of detected metals).

Building 009 was constructed to house two nuclear facilities in side-by-side, concrete high-bay areas. It was built in two phases. During the first phase, in 1957, the Organic Moderated Reactor (OMR) was constructed in the western portion of the building. The SGR was added in the eastern portion of the building during the second phase, completed in 1958. Both reactors were low-power critical assemblies in which different fuel-moderator configurations could be examined (AI, 1958b and 1959b).

Since each half of the Building 009 facility was built at different times, there were two separate systems installed to handle liquid and gaseous effluents (Rockwell, 1979). Two 1,000-gallon hold-up tanks (UT-4 and UT-5) were installed in underground reinforced concrete vaults outside of Building 009 to store radioactive liquid waste from the SGR and OMR, respectively (Rockwell, 1993a). Liquids from floor, shower, and sink drains were stored in the hold-up tanks. Liquid waste from the hold-up tanks was routed to the leach field after sampling of the hold-up tanks and subsequent radiometric assay showed that the radioactive content was within acceptable levels (AI, 1958 and 1959b).

Two other USTs were also used at the Building 009 facility. A 1,200-gallon storage tank (UT-59) was installed inside Building 009 in a 10 foot-deep pit in the OMR (west) side of the building. UT-59 was used for the storage of Santowax-R, a terphenyl coolant mixture (AI, 1958; Tuttle, 1993). UT-3 was a 1,500-gallon underground tank installed to store diesel/fuel oil for the Building 009 facility for use in case of a power outage. It was located southeast of the building and was installed at approximately the same time as the OMR in 1957 (AI, 1958).

OMR and SGR nuclear research operations were conducted at Building 009 between 1959 and 1969. Between 1959 and 1965, a series of low-power nuclear experiments involving a

heterogeneous, organic-moderated reactor utilizing slightly enriched uranium metal fuel were conducted at the OMR facility. In 1965, all radiation-producing devices and radioactive material were removed from the OMR reactor room (AI, 1965b). Between 1960 and 1967, low-power experiments with graphite-moderated reactors utilizing slightly enriched uranium fuel were performed at the Building 009 SGR facility. In most cases, solid aluminum was employed in the SGR reactor core to simulate the nuclear properties of liquid sodium (AI, 1959). In 1969, all reactor fuel and the graphite moderator were removed from the SGR facility (AI, 1969a).

In the 1970s, Building 009 was redesignated as the Engineering Development Facility, and sodium fire experiments intentionally exposing air to sodium were conducted in the OMR high bay in order to develop new ways to extinguish the ensuing fires (Rockwell, 1988b). Also during this period, depleted uranium was stored in the OMR counting room under the Accident Debris program (Rockwell, 1979). From the early 1980s until the 1990s, the former SGR high-bay (located in the eastern half of the building) was used for the storage and under-water testing of Rocketdyne's In-Service Inspection (ISI) equipment, which was used for inspecting commercial power reactors offsite (Sapere, 2005). In the late 1980s, Building 009 was used for high-energy rate forging (HERF), which included handling of high-enriched uranium. Eight hundred pounds of depleted uranium were stored in the facility and shipped offsite in the early 1990s (Sapere, 2005).

In 1987, UT-3 was removed. Following its removal, fuel hydrocarbons were detected in the soil, and the UT was placed in the Leaking Underground Fuel Tank (LUFT) program under the oversight of VCEHD. Additional sampling and assessment of potential risks were performed in 1998, and the case was closed by VCEHD in 1999 (VCEHD, 1999).

There have been several radiological removal actions at the Building 009 facility. In 1989, the SGR liquid waste hold-up tank (UT-4) located northeast of the building was removed, along with other associated facility structures (sink and drain lines) (Rockwell, 1990). In 1995, the SGR liquid waste hold-up tank pit was filled with a cement/sand slurry and capped with 4-inch asphaltic cement (Parsons, 1995). In 1995/1996, approximately 4 cubic yards of concrete were removed from the SGR pit area, along with other facility structures (fume hood, ducting, etc.) (Rockwell, 1995). These materials were disposed of offsite as radiological waste. Radiological surveys conducted after removals indicated that all areas met the limits for unrestricted release (Boeing, 1998). In 1998 and 1999, the DHS-RHB conducted a final verification survey at Building 009 and released the building for

unrestricted use in 1999 (DHS, 1999). In 2002, USEPA reviewed the prior radiological surveys performed at Building 009 and concluded they had been appropriately performed (Tetra Tech, 2002).

Following release for unrestricted use in 1999, Building 009 was used for non-nuclear research and development, including laser research (MWH, 2006a). Operations at Building 009 ceased in mid-2007.

The solar concentrator facility was constructed in 1985 approximately 325 feet southwest of Building 009. This facility was used in experiments aimed at harnessing solar power, and consisted of a 25 kilowatt (kWt) parabolic dish and a support trailer. In 1995/1996, the parabolic dish at the solar concentrator facility was removed. A weather station and an astronomical observatory were constructed in the area during the late 1990s, and they remain in use at the site (USEPA, 1997; Boeing, 2007a).

3.1.2 B056 Landfill

The B056 Landfill RFI Site occupies approximately 4 acres in the eastern portion of the Group 8 Reporting Area and consists of the B056 Landfill (SWMU 7.1), associated debris/fill areas, and the B056 Excavation (Figure 3-1). The landfill was reportedly used between 1960 and 1969 for disposal of soil, bedrock, and minor construction debris (asphalt, concrete, scrap metal, etc.) that was generated during the initial Building 056 construction activities (ICF, 1993). The B056 Excavation, located east of the landfill, is a vertically-walled circular excavation that extends approximately 65 feet into bedrock. This excavation was performed in order to build the basement for Building 056, the SNAP 8 Flight System Test Facility, although Building 056 was never built. Other construction activities in Area IV, such as the Sodium Component Test Installation (SCTI) excavation, also used the B056 Landfill for the disposal of construction-related wastes (ETEC, 1992; ICF, 1993).

During the period the landfill was used, soil was disturbed and fill was placed in an area identified as the 'Southern Debris Area,' located south of the B056 Landfill. The B056 Landfill and the Southern Debris Area encompass historical topographic lows (valleys) and cover hill slopes adjacent to the previous valleys, although the central and eastern portions of the Southern Debris Area comprise a generally flat surface topography (MWH, 2003a). Soil from the SCTI facility excavation was used to cover the B056 Landfill in 1969 (SAIC, 1994).

Historical photographs show that the B056 Landfill and the Southern Debris Area were used in the 1960s and 1970s (Boeing, 2007a). Historical photographs taken after 1980 do not indicate any other large soil disturbance areas near this site (Boeing, 2007a).

Prior to 1980, drums containing hazardous and non-hazardous wastes were occasionally stored on top of the landfill (ETEC, 1987; MWH, 2003a; Ogden, 1996). The drums located on the top of the landfill contained oils, alcohols, sodium, sodium reaction products, grease, phosphoric acid, asbestos, rags, and rope (ETEC, 1987; ICF, 1993). In the early 1980s, these 89 drums were removed from the top of the landfill and sent to a hazardous waste disposal site (ETEC, 1987). Empty rusty drums were also observed at the base of the ravine along the western edge of the southern debris area (USEPA, 1997). Areas where drums were observed or stored are illustrated on Figure B.2-1.

The B056 Landfill RFI Site has been inactive since the 1980s following the drum removal activities described above. Radiological surveys at the landfill in 1988, 1996, 1999, and 2002 indicated radiation levels were within acceptable limits (ETEC, 1988; Rocketdyne, 1996: Sapere, 2005, Boeing, 2007c). Similar findings were indicated by surveys conducted prior to and during RFI sampling (Appendix B).

3.1.3 ESADA

The ESADA RFI Site occupies approximately 1.5 acres in the southern portion of the Group 8 Reporting Area. The area once contained buildings, drum storage areas, and a pistol range (Figure 3-1). The ESADA area was used between 1964 and 1968 for testing piping burst characteristics under sodium-water reaction conditions at Building 814. Underground piping connected Building 814 to a concrete pool located at the FSDF RFI Site (see Section 3.1.4) (Boeing, 1999). Following the late 1960s, portions of the ESADA RFI Site were used for chemical drum storage (SWMU 7.9), surrogate fuel pellet impact testing, and as a pistol range.

Impact testing was conducted using zirconium-hydride (ZrH_2) covered surrogate fuel pellets in the eastern portion of the ESADA RFI Site between 1966 and 1973. Reviewed documents did not indicate that these were radioactive fuel pellets (Sapere, 2005; Boeing, 2007a).

Drums were stored in the central portion of the ESADA RFI Site from the 1970s to 1983, both north and south of the access road through the site. More than 500 drums containing

Dowanol™ and ethanol, and empty drums (number unspecified in reviewed documents), were stored in the southern storage area (Rockwell, 1983a and 1983b). Dowanol™ is a trade name for a series of glycol ethers used as a solvent to clean metal components. Ethanol is an alcohol (VOC) used for a similar purpose. Approximately 120 drums contained Dowanol™ that was nearly saturated with sodium. This material was generated during the cleaning of piping and components at the Sodium Reactor Experiment (SRE) RFI Site in the northeast section of Area IV (AI, 1964). The ethanol drums had varying concentrations of sodium, and some of them were known to have leaked (Rockwell, 1983b). In the northern portion of the storage area, approximately 100 empty drums were stored (Rockwell, 1983a). The drums located both north and south of the road were removed in 1983. The alcohol waste was sent to the Component Handling Cleaning Facility (CHCF), Building 463, located east of the B100 Trench RFI Site (SWMU 7.5). The sodium waste was disposed of at ETEC (location not specified) (SAIC, 1994).

In 1980, a pistol range was constructed in the southeastern portion of the site, in the area formerly used for surrogate fuel pellet impact testing. SSFL site security personnel would conduct firearm practice by firing shotgun and hand gun rounds at targets placed in front of an earthen berm located along the southeast site boundary, approximately 90 feet south of the firing locations. Target practice activities were suspended in 1995. Approximately 8,500 pounds of lead were estimated to have been used and deposited at the pistol range during this time (Boeing, 1999).

The majority of the site features at the ESADA area have been demolished, with three concrete building foundations and road pavement still remaining. In 2000, during the FSDF IM, the northern portion of the ESADA RFI Site was regraded and a drainage ditch constructed south of H Street.

3.1.4 FSDF

The FSDF RFI Site occupies approximately 4.3 acres in the central portion of the Group 8 Reporting Area, and consists of a large central area that contained facilities and disposal ponds, adjacent debris areas, a pistol range, and downgradient channels (Figure 3-1). The FSDF (SWMU 7.3) was primarily used during the 1960s and 1970s to clean residual metallic sodium and NaK from testing equipment, such as pumps and valves, by an exothermic reaction with water (ICF, 1997). Components were either steam cleaned with a steam lance,

or placed in water in the former Upper or Lower Ponds, which were low-lying areas surrounded by earthen berms.

Combustible materials used as heat transfer agents, including kerosene, organic solvents, biphenyls, and terphenyls, were also disposed of in the former FSDF ponds (GRC, 1990). The combustible materials were generated in the Liquid Metals Research Program (LMRP) operations in Area IV (Rockwell, 1987). West of the ponds, the Western Debris Area was used for the storage and burial of components and barrels (Ebasco, 1991). The FSDF was also used for the burning of non-radioactive waste organic liquids (ICF, 1997).

The FSDF site became inactive in 1976 (ICF, 1993). Residual debris was cleared and disposed of as scrap metal (Ebasco, 1991), and all equipment/containers (referred to as tanks in the RFA) were removed and transferred to either Building 029 for secured storage or to the new Sodium Burn Facility at Building 133 (SWMU 7.2) (SAIC, 1994). The access gate to FSDF was locked, and only documented items were admitted, although reportedly unlabeled materials were left at the gate for disposal (SAIC, 1994; Ebasco, 1991). The pool and ponds were drained and surveyed for radioactivity. Radioactive contamination was found in the Lower Pond, the concrete pool walls, and in other localized areas. To decontaminate these areas, small pieces of debris (e.g., pipes, machined metal parts, and tubes) were excavated and properly disposed of offsite as low-level radioactive waste (Ebasco, 1991).

During the 1950s though the 1970s, the FSDF Pistol Range was used by Rocketdyne security personnel for pistol target practice and training. The area consisted of an asphalt pad, a target area consisting of multiple covered shooting stations on a concrete pad, and a downfield berm situated against a rock outcrop approximately 90 feet to the northwest (Sapere, 2005).

In 1980, radiation surveys identified cesium-137 and strontium-90 in the Lower Pond area (IT, 1999), and approximately 20 cubic yards of soil were removed (ICF, 1993) and properly disposed of offsite as low-level radioactive waste. Investigative trenching at the site was performed in 1987 as part of a site characterization study (Rockwell, 1987), and a Hydrogeologic Assessment Report was prepared (GRC, 1990). In 1992 and 1993, the RWQCB determined that the Lower Pond should be considered for cleanup under the Toxic Pit Cleanup Act (TPCA) and required a Closure Plan (RWQCB, 1991). Following modification, the Closure Plan was jointly approved by the RWQCB and DTSC (RWQCB, 1992). Additional radiological surveys were also conducted in 1987 and 1991 to characterize the ponds and the surrounding areas (Rockwell, 1988a and 1992). Results indicated that only

localized contamination needed to be removed. Soil excavation was initiated, and approximately 12,000 cubic yards of chemical, radioactive, and mixed waste soils were removed (ICF, 1997). A diversion ditch was also cut around the excavation areas to prevent surface water flow over the previous excavation. In 1992, the RWQCB notified Rockwell that all RWQCB requirements had been met for the closure of the Lower Pond (RWQCB, 1992b). The first shipment of hazardous soil waste (including only soils that did not originate in a radioactive materials management area) were disposed of offsite at a Class I Landfill operated by Chemical Waste Management in Kettleman City (DOE, 2000). Soil that contained low-level radioactive waste, including mixed waste and soils classified as radioactive only, were disposed of at Nuclear Regulatory Commission (NRC)-licensed Envirocare waste disposal site in Olive, Utah (DOE, 2000). At that time, further action at the site was halted pending determination of cleanup goals and confirmation sample collection. Oversight of the continued cleanup activities was transferred to DTSC following implementation of the Lower Pond Closure Plan.

Additional investigation of the site and down gradient channels was performed between 1992 and 1995 (McLaren/Hart, 1993, 1995a, and 1995b; ICF, 1997). In 1995, DTSC directed that additional interim measures (IM) be implemented to mitigate contamination migration (DTSC, 1995). While the IM work plan was prepared, tarps were placed over the excavated areas, and weirs were installed to collect channel sediment. In 1997, an interim groundwater remediation system was installed and used at FSDF to treat VOC- and perchlorate-impacted groundwater (H&A, 2006a). The system was shut off temporarily due to the 2000 IM activities, and again in March 2003 to facilitate aquifer testing and to support the ongoing CFOU characterization program.

A post-remediation survey and analysis of additional soil and rock samples were conducted in 1994 and 1995, respectively, for radioactive contamination (Rockwell, 1994; Rockwell, 1996). Results indicated that the area was acceptable for release for use without radiological restriction. In 1998, the DHS-RHB confirmed the release of the FSDF site for unrestricted use based on a final gamma radiation survey and sampling results (DHS, 1998). In 1999, the IM Work Plan addressing action in the Upper Pond, the Western Area, and Channels A, B, and C, was submitted for agency review. Following plan modifications, DTSC approved the FSDF IM work plan in December 1999 (DTSC, 1999b).

In 2000, the IM Work Plan removal action was implemented to address elevated dioxins, PCBs, mercury, and perchlorate. Soil within the Upper and Lower Ponds and the upper

portion of Channel B was excavated to bedrock (IT, 2002). Soils were also removed from the Western Area and the Southern Metal Anomaly Area located south of H Street, as shown in Figure D.2-4. Drainage sediments and over-bank deposits were removed from Channels A, B, and C. Removed soils were disposed of offsite at a Class I Landfill operated by Safety Kleen in Buttonwillow, California (IT, 2002). The Upper and Lower Pond excavation and upper Channel B were backfilled to depths reaching approximately 13 feet bgs with clean soil from a DTSC-approved Area IV Soil Borrow Area (IT, 2002; DTSC, 2000). The backfill was compacted, an infiltration monitoring system installed, and the area re-vegetated. During the IM, a diversion ditch was constructed south of H Street to control surface water runoff and direct it to Channel B. A total of 14,928 tons (approximately 12,000 cubic yards) of soil, debris, bedrock, and construction materials were disposed of offsite during the 2000 FSDF IM. Rainwater infiltration and groundwater monitoring at the FSDF site are ongoing.

3.1.5 Non-RFI Site Report Area

As described in Section 1, the RFI site boundaries depicted on maps in this Group 8 RFI Report are shown as representative outlines that generally encompass historical site operations. The creation of these RFI site boundaries did not limit characterization in any way, and potential chemical use was evaluated within the entire Group 8 Reporting Area. Debris areas and transformers located in areas outside operational boundaries have been identified as potential chemical use areas and are discussed in Section 3.3. Review of historical documents, including historical and aerial photographs for the remainder of the Group 8 Reporting Area, and various site reconnaissance inspections did not indicate the existence of any additional chemical use areas.

3.2 CURRENT SITE CONDITIONS AND SIGNIFICANT ALTERATIONS

The focus of this Group 8 RFI Report is to characterize current conditions of the Group 8 Reporting Area with respect to chemical contamination. Current conditions at most of the Group 8 RFI sites are different from the past operating conditions. This section summarizes how current conditions differ from past operating conditions. For the majority of the Group 8 characterization activities (i.e., sampling), site conditions remained approximately constant. Also, the 2005 Topanga Fire caused considerable impacts in some portions of the Group 8 Reporting Area. Any changes in site conditions affecting RFI sample information are described and detailed in the RFI Site Reports provided in Appendices A, B, C, and D. Soil

disturbance areas within the Group 8 Reporting Area include building removal areas, excavation and backfill areas, excavation areas with no backfill, landfill areas, and areas where surface water erosion control measures have been installed according to best management practices (BMPs). Group 8 soil disturbance areas are shown on Figure 3-2.

The B009 LF RFI Site is currently inactive and vacant with the exception of activities at the weather station. Building 009, the observatory, the weather station, and a few supporting structures near the solar concentrator facility (e.g., pipe supports, asphalt paving, electrical distribution systems, etc.) are still in place. As observed in historical aerial photographs, numerous dirt roads were constructed in the 1950s and 1960s near and through the B009 LF RFI Site (USEPA, 1997). Other historical aerial photographs indicate soil disturbance areas at the solar concentrator facility and just to its west (near the ESADA area) in the mid- to late-1970s and in 1988 (Figure 3-2). In the western portion of this disturbance area, a soil scarp was created, and it appears this area may have been used as a soil borrow area. Facility records do not indicate any chemical use in this area (Boeing, 2007a). These soil disturbance features predate soil sampling conducted for the RFI. The leach field and the septic tank at B009 were removed in June 2002, and RFI sampling was conducted prior to soil backfill of that excavation. During the September/October 2005 Topanga Fire, no vegetation within the B009 LF RFI Site boundary was burned (MWH, 2006b), but visible ash was deposited.

The B056 Landfill RFI Site is currently inactive and vacant, with no former structures except for two chain-link fences, one at the entrance to the landfill and the other around the B056 Excavation. The primary disturbance features at the B056 Landfill RFI Site are the B056 Excavation and the two large fill areas (B056 Landfill and Southern Debris Area) (Figure 3-2). Soils and bedrock from the B056 Excavation were deposited into the B056 Landfill and the Southern Debris Area. Fill materials primarily consist of soil, bedrock, concrete (blocks up to 5 feet in diameter), asphalt, and minor amounts of scrap metal and wood products. Partially buried drums were observed on the west slope of the Southern Debris Area. Soil disturbance occurred immediately upstream of Outfall 007 in 2005 and 2006, when surface water erosion controls were installed. All soil disturbance features at the site predate soil sampling conducted for the RFI. During the September/October 2005 Topanga Fire, vegetation across the entire B056 Landfill RFI Site was burned, and significant ash was deposited, especially in drainages.

The ESADA RFI Site is currently inactive and vacant, with no remaining structures except for asphalt paving, three concrete building foundations, and one concrete pad associated with

Building 820. The buildings and concrete foundations were removed prior to RFI sampling, so the recorded soil sample depths represent the depths from current surface grade. The extent of soil disturbance at or near the ESADA RFI Site is shown Figure 3-2. As described above, historical aerial photographs indicate soil disturbance near the eastern boundary of the ESADA RFI Site in the mid- to late-1970s and in 1988 (Figure 3-2). In the 2000 FSDF IM, a diversion ditch was constructed south of H Street to direct and control surface water runoff. During the September/October 2005 Topanga Fire, no vegetation within the ESADA RFI Site boundary was burned (MWH, 2006b).

The FSDF RFI Site is currently inactive and vacant, with no remaining structures, although an aboveground tank is present to hold surface water discharge pending offsite transport and disposal. Cleanup actions that have been conducted at the FSDF have altered the surface topography through extensive excavation, backfilling, and grading. The last removal action, the 2000 FSDF IM, encompassed the previous two excavation areas (Figure 3-2). FSDF cleanup action soil disturbance features encompass most of the former facility operational areas, with the exception of the steam lance location, the former Drum Debris Area, and the FSDF Pistol Range. Soil sampling at the FSDF site has been conducted prior to, during, and following the cleanup removal actions. Sample locations as shown on figures in this report reflect current, in-place soils, and sample depths have been adjusted according to current grade for all in-place samples, unless otherwise noted. As described above, soil disturbance at the site included construction of an east-west diversion ditch south of H Street, in the northern portion of the ESADA RFI Site (Figure 3-2). Soil immediately upstream of Outfalls 005 and 006 was also disturbed in 2005 and 2006, when surface water erosion controls were installed. During the September/October 2005 Topanga Fire, vegetation in the northwestern portion of the FSDF RFI Site and in the channels downstream from FSDF was burned, and significant ash was deposited, especially in drainages (MWH, 2006b).

3.3 CHEMICAL USE

As described above, potential chemical use areas have been grouped into general categories (Table 3-1). These are: solvents, petroleum, oils/PCBs, metals/inorganic compounds (excluding debris areas), perchlorate, hydrazine, debris, landfill, 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 8 RFI site. The table 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, C, and D.

The RFI sampling program targeted known or suspected chemical use areas at the four 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 8 Reporting Area (Boeing, 2007a). One of the chemical use categories listed in Table 3-1, hydrazine, has not been documented and is considered unlikely for the Group 8 Reporting Area based on review of historical documents and sampling information. Figure 3-3 depicts all potential chemical use areas identified for the Group 8 Reporting Area. Figures 3-4 through 3-11 show individual chemical use areas for each chemical group represented at the Group 8 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 8 Reporting Area.

It should be noted that chemicals used for routine maintenance or construction activities are not included in the RFI as potential chemical use areas. Routine maintenance chemicals would include pesticides, herbicides, or rodenticides used to reduce weed growth or respond to rodent or insect infestations. 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. Pesticides, herbicides, and rodenticides would have been applied and explosives would have been used according to label instructions and legal requirements. 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 E, 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 four RFI sites in the Group 8 Reporting Area. Based on facility records and sampling results (see Section 4), the highest solvent use area was at the FSDF, with only minor amounts of solvents used at Building 009 or stored at

the ESADA RFI Site. Potential solvent chemical use areas in the Group 8 RFI sites are shown on Figure 3-4 and include the following:

- B009 LF: Building 009 was identified as a solvent chemical use area. Small amounts of solvents were used for hand-wipe operations and cleaning of equipment within Building 009 (Boeing, 2006a and b; MWH 2006a). Solvents used included acetone, ethanol, and isopropyl alcohol (Boeing, 2006a and b; MWH 2006a). A commercial solvent, Turco 3878 LF-NC (a glycol ether mixture), was also used at Building 009 (ICF, 1993).
- B056 Landfill: Drums stored on the landfill contained alcohols (ETEC, 1987) and potentially other solvents. Since historical photographs show drum storage near the location of well RD-07, both the northern B056 Landfill and the Southern Debris Area are included in this category.
- ESADA: The drum storage area was identified as a solvent chemical use area. Drums stored onsite included Dowanol™ and ethanol (ICF, 1993; Rockwell, 1983a and 1983b), and potentially other solvents.
- FSDF: The Upper and Lower Pond areas were identified as solvent chemical use areas at this site. Solvents were disposed of in the ponds (GRC, 1990), and early samples of waste from the ponds contained high concentrations of VOCs (IT, 1999). In addition, VOCs were detected in discrete soil samples that were collected from the Lower Pond, the Upper Pond, and the Western Debris Area in 1987 (GRC, 1990).

3.3.2 Petroleum

Areas where petroleum hydrocarbons may have been potentially stored or used in the Group 8 Reporting Area are associated primarily with supporting operations, such as pipe or equipment cleaning or fuel oil storage at the Building 009 and FSDF RFI sites. Potential petroleum use areas in the four Group 8 RFI sites are shown on Figure 3-5 and include the following:

- B009 LF: This site had two petroleum chemical use areas. Kerosene was used for cleaning of pipes and valves of the OMR within the building (AI, 1959a). Diesel/fuel oil was stored in UT-3, located to the southeast of the building (AESE, 1995).
- FSDF: Three petroleum chemical use areas were identified at FSDF. Kerosene was used at the steam lance unit (Rockwell, 1987; Ebasco, 1991). The Upper and Lower Pond areas were also identified as petroleum chemical use areas based on early samples of pond wastes, which contained high concentrations of TPH (IT, 1999). In addition, TPH was detected in discrete soil samples that were collected from the Lower Pond, the Upper Pond, and the Western Debris Area in 1987 (GRC, 1990).

VOCs, including of benzene, toluene, ethylbenzene, and xylenes (BTEX), and polynuclear aromatic hydrocarbons (PAHs) are potential components of some of the fuel-range petroleum hydrocarbons gasoline and diesel/oils, respectively. The petroleum use areas identified for

the Group 8 Reporting Area have been screened for potential impacts related to these chemical compounds.

3.3.3 Oils/PCBs

Hydraulic, lubricating, and insulating oils were used at various locations in the Group 8 Reporting Area. Within the Group 8 Reporting Area, these types of oils were used as insulation against heat buildup in reactors and transformers. Transformers manufactured before 1980 may have used insulating oils containing PCBs. Areas in the Group 8 Reporting Area where oils/PCBs may have been used are shown on Figure 3-6 and include the following:

- B009 LF: Three oil/PCB chemical use areas were identified at Building 009. Terphenyls were used as a coolant for OMR operations within the building (AI, 1959b and 1964; Rockwell, 1985). Oils possibly containing PCBs may have been used at a pad-mounted transformer southeast of the building or at a pole transformer located north of the building.
- B056 Landfill: Drums containing oils and grease were stored on the landfill (ETEC, 1987). Since historical photographs show drum storage near the location of well RD-07, both the northern B056 Landfill and the Southern Debris Area are included in this category.
- ESADA: One oil/PCB chemical use area was identified at the pole transformer located in the eastern portion of the site.
- FSDF: The Upper and Lower Pond areas were identified as oil/PCB chemical use areas at this site based on disposal of these heat-transfer agents in the ponds (GRC, 1990; Ebasco, 1991; Rockwell 1987).

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 8 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 8 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, nuclear research and testing, various machine shop and laboratory operations, or the use of possibly corrosive liquids. Potential metal waste areas associated with site operations are shown on Figure 3-7 and include the following:

- B009 LF: One metal chemical use area was identified at this site. Sodium and aluminum were used for SGR operations within the building (AI, 1959b and 1975). Mercury was also stored onsite, and boron trifluoride was reported in SGR operations (AI, 1960; ICF, 1993). Also, use of hydrochloric and phosphoric acids was reported for Building 009 operations (Rockwell, 1981).
- B056 Landfill: Drums containing sodium and sodium reaction products were stored on the landfill (ETEC, 1987). Since historical photographs show drum storage near the location of well RD-07, both the northern B056 Landfill and the Southern Debris Area are included in this category.
- ESADA: Three metals chemical use areas were identified for this site. Pipe-burst strengths were tested at Building 814 using sodium-water reactions (AI, 1964 and 1965a). Drums containing sodium-saturated Dowanol™ and sodium hydroxide were stored onsite (ICF, 1993; SAIC, 1994). In the southeastern portion of the site, metals use occurred both as lead shot associated with the ESADA Pistol Range and as zirconium hydride (ZrH_2), which was used for surrogate fuel pellet testing (Sapere, 2005).
- FSDF: Four metals chemical use areas were identified for this site. The Upper and Lower Pond areas and the concrete pool were identified as metal chemical use areas because they were used to treat residual Na and NaK on equipment (GRC, 1990; Ebasco, 1991; Rockwell 1987). The FSDF Pistol Range is also included in this category.

3.3.5 Debris Areas

Debris areas are generalized locations where small amounts of solid waste have been identified at the Group 8 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 8 RFI sites are shown on Figure 3-8 and include the following:

- B056 Landfill: Two debris chemical use areas were identified for this site. One is near the B056 Landfill entrance and consisted of concrete, asphalt, scrap metal, and a paint can. Disturbed soils up to 5 feet thick were noted in this area. The second debris area consisted of drum and paint cans east of the B056 Excavation.

- FSDF: Four debris chemical use areas were identified at the FSDF. These included three locations within the former disposal area (the Upper Pond, Lower Pond, and the Western Debris Areas) since they were found to contain drums and scrap metal pieces (GRC, 1990; Ebasco, 1991; Rockwell 1987). The fourth debris area was identified as the former Drum Debris Area, located in the drainage channel to the west of the primary operational areas of the site.

3.3.6 Landfills

A landfill area is where large amounts of solid, buried waste have been identified at the Group 8 RFI sites. Landfill materials have only been identified in two areas at the B056 Landfill RFI Site: the northern B056 Landfill and the Southern Debris Area as shown in Figure 3-9. Fill depths extend up to 20 to 25 feet bgs in the northern portion of the site and up to 14 feet bgs in the Southern Debris Area. Fill materials in these areas consist primarily of soil and bedrock that was removed during construction of the B056 Excavation. Other materials identified in the landfill included concrete and asphalt, with minor amounts of scrap metal and wood products. Partially buried drums were found on the western slope of the Southern Debris Area. Glass, concrete, asphalt, and scattered metal debris (nuts, bolts, rebar, etc.) have been noted on the surface of these two areas.

3.3.7 Perchlorate and Energetic Compounds

Perchlorate use or disposal was not documented in records reviewed for the Group 8 Reporting Area. However, it has been detected in both soil and groundwater at the FSDF RFI Site (see Section 4), and is therefore considered to be a likely chemical either used or disposed of at this site. The potential perchlorate use areas associated with site operations are shown on Figure 3-10. Based on reviewed documents and other sampling data, perchlorate use at the other Group 8 RFI sites is unlikely. Although perchlorate was detected in two samples collected from discrete groundwater intervals at the B056 Landfill RFI Site (see Section 4), these detections have not been replicated, nor has perchlorate been detected in other groundwater or soil samples from the B056 Landfill RFI Site.

As described above, energetic compounds may have been used for subsurface bedrock construction activities. Energetic compounds were considered as part of the screening suite for down-slope samples at the B056 Landfill since landfill materials may have contained small residual amounts of these chemicals.

3.3.8 Leach Fields

Sanitary leach fields were identified as AOCs during the RFA (SAIC, 1991 and 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).

Within the Group 8 Reporting Area, only one leach field chemical use area was identified, the B009 LF, and is shown on Figure 3-11. Reviewed records indicate that this leach field also received operational liquid waste that was discharged once the liquids were shown to be within acceptable radiation limits (AI, 1958 and 1959b). Liquid waste from Building 009 operations may have included solvents, kerosene, oils/PCBs (including terphenyls), and metals. These chemicals were included in screening analyses at the leach field.

3.3.9 Areas Screened for Potential Chemical Use or Disposal

Several additional areas at the Group 8 RFI sites were or may have been used for chemical or equipment storage, handling, or disposal. Screening areas include underground tanks designed to store radioactive waste, drum or equipment storage areas, the solar concentrator area, or possible disposal areas. 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 upgradient chemical use areas, analytical suites for RFI assessment of potential areas can also vary. The Group 8 RFI potential chemical use areas are shown on Figure 3-11 and include the following:

- B009 LF: Four potential chemical use areas were identified at Building 009. These are the SGR hold-up tank, the OMR hold-up tank, the septic tank, and the solar concentrator facility.
- B056 Landfill: One potential chemical use area was identified for this site, the B056 Excavation. Sediment and construction debris (concrete, asphalt, etc.) were noted at the bottom of this excavation when it was pumped dry.
- ESADA: One potential chemical use area was identified for this site, north of the drum storage area. Two ASTs were stored at this location, and one was identified as being from the Process Development Unit (PDU) RFI Site (SWMU 7.10) located in the Group 5 Reporting Area. The PDU was used for coal gasification, so sampling at this chemical use area at ESADA included screening for organic chemicals and metals..

- FSDF: One potential chemical use area was identified for the FSDF. The southern Investigation Area, south of H Street, was included in this category since no operational information was available for it. During the 2000 IM, a metal anomaly was identified and soils were removed in the eastern portion of this chemical use area (IT, 2002).

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4.0 NATURE AND EXTENT OF CHEMICALS IN GROUP 8

This section provides an overview of nature and extent findings for environmental media within the Group 8 RFI Reporting Area. The characterization overview provides a description of group-wide chemical concentrations for investigated media. Section 5, Transport and Fate, is based on these findings. A discussion of characterization completeness within chemical use areas and recommendations for further evaluation in the CMS are provided in Appendices A, B, C, and D.

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, C, and D. 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 8 RFI Sites are presented by the seven major chemical groups included in the Group 8 RFI laboratory analytical program:

- VOCs
- SVOCs
- Total Petroleum Hydrocarbons (TPH)
- PCBs
- Dioxins
- Metals/Inorganic Compounds
- Perchlorate

The seven chemical groups listed above represent the primary targeted RFI sampling suites for the types of known or potential chemical use identified in the Group 8 Reporting Area as described in Section 3. Figures 4-1 through 4-7 present results for these chemical groups. 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, risk-based screening levels (RBSLs), and site action recommendation areas.

The site action recommendation areas shown in Figures 4-1 through 4-7 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 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 as described in the RFI Site Reports in Appendices A, B, C, and D. CMS Area recommendations and the criteria used in making those decisions are presented in Section 7. Portions of Group 8 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 4-7, 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 and methodologies detailed in the SRAM and in this report. A description of RBSL derivation is provided in Appendix F. 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. 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. Color coding basis for each chemical group is described in more detail on each figure (4-1 through 4-7).

The following presents a summary of the basis used to generate the colored symbols shown for soil sampling data on Figures 4-1 through 4-7:

- Colors are assigned to show the most conservative result (i.e., the concentration with the greatest percentage above 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, industrial, 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, 2005b). If background is exceeded, the concentration is then compared to the lowest of the RBSLs, and the associated color is assigned.
- For dioxins, color coding is assigned based on a comparison of the sample's toxicity equivalency quotient (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), and perchlorate, ecological RBSLs were adjusted to account for available baseline toxicity reference values (baseline TRVs) (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 were used to prepare Figure 4-4 (PCBs), Figure 4-6 (metals), and Figure 4-7 (perchlorate).

Consistent with RFI work plans (Ogden, 1996 and 2000a), risk criteria (i.e., 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, C, and D are described in text and depicted on figures in relation to the RBSLs that were developed using the risk assessment work plan criteria for all potential human and ecological receptors. The comparisons to RBSLs presented in this section of the Group 8 Report, however, vary from those described in Appendices A through D because of the application of baseline TRVs for the PCB, metals, and perchlorate compounds listed above.

Groundwater information depicted on Figures 4-1 through 4-7 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 E.

The following sections present a description of RFI sampling results by chemical group. In addition to the seven primary chemical groups listed above (VOCs, SVOCs, TPH, PCBs, dioxins, metals, and perchlorate), glycols, terphenyls, and fluoride were targeted for sampling at Group 8 RFI sites. Glycol RFI sampling results are described below with SVOCs in Section 4.2, and results are included on Figure 4-2. Terphenyl sampling results are described

below with PCBs in Section 4.4, and results are included on Figure 4-4. Fluoride sampling results are described with metals in Section 4.6, and results are included on Figure 4-6.

Additional chemicals are included in the groundwater monitoring program as required by DTSC. These results, described in Appendix E, 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

More than 80 soil vapor samples and more than 130 soil matrix samples from the Group 8 Reporting Area were analyzed for VOCs. In addition, more than 40 soil vapor samples were analyzed for methane only. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 8 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 that were detected in Group 8 soils were generally detected at low concentrations, with most detections occurring at the FSDF RFI Site.

VOC soil vapor and soil matrix sampling results for the RFI sites within the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- VOCs were not detected in soil vapor samples collected this site. In soil matrix, acetone, ethylbenzene, and total xylenes were detected at concentrations less than the RBSLs, at concentrations up to 17 micrograms per kilogram (µg/kg).

B056 Landfill RFI Site:

- At the B056 Landfill and the Southern Debris Area (CMS Area B056-1), chlorinated VOCs were not detected in soil vapor. Methane was detected in 12 soil vapor samples, at concentrations up to 27 µg/L.
- At the B056 Landfill and the Southern Debris Area (CMS Area B056-1), methylene chloride, acetone, and trichlorofluoromethane (Freon 11) were detected in soil matrix samples at low concentrations.

- Methylene chloride (up to 23 µg/kg, above RBSLs) and acetone (up to 5,000 µg/kg, less than RBSLs) were detected but considered to be laboratory contaminants, because (1) these chemicals are common laboratory contaminants, and (2) most samples from the site did not contain detectable concentrations of these chemicals.
- Freon 11 (up to 900 µg/kg, above RBSLs) was detected in a 1987 soil sample. Subsequent samples collected in the same area and in other portions of the site did not contain detectable concentrations of Freon 11.

ESADA RFI Site:

- VOCs were not detected at this site.

FSDF RFI Site:

- VOCs were detected in two areas at the site at concentrations exceeding RBSLs: within the backfill at the Lower Pond (Chemical Use Area 1a), and near the excavation in the Southern Investigation Area (near CMS Area FSDF-1).
  - Within the former Lower Pond, eight VOCs were detected in two soil vapor samples and one soil matrix sample collected from the backfill. Concentrations of TCE and 1,1-dichloroethene (1,1-DCE) were detected above the RBSLs, ranging up to 12.3 µg/L TCE in vapor. Concentrations were higher in deeper samples than in shallow samples.
  - As described above, soils were completely removed from the former pond areas (excavation down to and including weathered bedrock). In the removed soils, TCE concentrations ranged up to 740,000 µg/kg (GRC, 1990).
- Within the Southern Investigation Area, PCE and benzene were originally detected at concentrations above RBSLs (up to 3.4 µg/L PCE in vapor, and up to 1 µg/kg benzene in soil matrix). Subsequent soil vapor and soil matrix samples from these locations did not contain detectable concentrations of PCE or benzene.

4.1.2 Near-Surface Groundwater

VOCs in NSGW are characterized by analytical data for approximately 90 samples from nine piezometers and wells within Group 8. VOC sampling results above screening levels for the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- TCE was the only VOC detected above its screening level in a groundwater sample from PZ-102 (at 6 µg/L). TCE and cis-1,2-dichloroethene (cis-1,2-DCE) were also detected in RD-90. TCE concentrations ranged from 81 µg/L to 130 µg/L, and cis-1,2-DCE concentrations varied from 11 µg/L to 21 µg/L

FSDF RFI Site:

- TCE and TCE breakdown products were the primary VOCs detected at this site above regulatory criteria.
  - TCE and/or TCE breakdown products were detected at concentrations above regulatory criteria in five piezometers/wells (PZ-98, PZ-99, PZ-101, RS-18, and RS-54) at concentrations historically ranging up to 4,500 µg/L in RS-54. Current concentrations have decreased to about 1,500 µg/L. 1,1-DCE is also present at concentrations above 1,000 µg/L.
  - TCE concentrations are generally highest in wells within the FSDF RFI Site, near areas where the highest concentrations of VOCs were detected in pre-excavation soil samples. TCE concentrations in the wells upslope of these areas and to the west of the site are generally low or nondetectable. Concentrations have generally decreased over time. TCE concentrations also decrease to the north, ranging up to 390 µg/L in RS-18 and 29 µg/L in PZ-098. PZ-97 is a dry well; hence, groundwater samples have not been collected.
- Other VOCs detected above regulatory levels at the site include benzene and total xylenes in RS-54, and PCE, 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane, and methylene chloride in RS-18 and RS-54.

Additional information on NSGW occurrence, quality and temporal variability is provided in Appendix E.

4.1.3 Bedrock

In the Group 8 Reporting Area, over 200 bedrock samples were collected from corehole C-8, which is located within the central portion of the FSDF RFI Site (within the former Lower Pond). Bedrock samples were analyzed for a subset of VOCs (TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, and 1,1-DCE.), 1,4-dioxane, and 1,1,2-trichloro-1,2,2-trichlorofluoromethane (Freon 113). A description of the sampling methodology can be found in the FSDF Chatsworth formation OU investigation work plan (MWH, 2001).

Results from rock porewater analyses at C-8 show that TCE is present above 5 µg/L to a depth of approximately 270 ft bgs. The majority of the TCE mass (>99.9 percent) was present in the vadose zone, which had a thickness of about 180 feet. TCE was the most prevalent of the VOCs detected in porewater, at concentrations ranging up to about 70,000 µg/L. Below 150 feet bgs, TCE porewater concentrations were less than about 1,000 µg/L. Other VOCs detected in porewater included PCE, cis-1,2-DCE), and

1,1-dichloroethene (1,1-DCE), but at concentrations much lower than TCE (UW, 2007). Additional information is provided in Appendix E.

4.1.4 Chatsworth Formation Groundwater

VOCs in Chatsworth formation groundwater are characterized by analytical data for more than 600 samples from 16 onsite monitoring wells, and more than 200 samples from seven offsite wells. VOC sampling results above screening levels for the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- TCE and TCE breakdown products have been detected above screening levels in groundwater samples from RD-91, with concentrations ranging up to 130 µg/L TCE in 2004.

B056 Landfill RFI Site:

- TCE and TCE breakdown products have been detected above screening levels in groundwater samples at RD-07, ranging up to 73 µg/L cis-1,2-dichloroethene (cis-1,2-DCE) and up to 0.28 µg/L (estimated) trans-1,2-DCE in 2007. TCE was detected in RD-07 above regulatory criteria at a maximum concentration of 130 µg/L in 1986 and 1987, and concentrations are currently below detection limits. Neither TCE nor breakdown products have been detected in well RD-74.

ESADA RFI Site:

- Benzene and toluene have been detected in samples collected from RD-50 since August 2003. The highest benzene concentration (1.2 µg/L, which exceeds regulatory criteria) was detected following the installation of a Flexible Liner Underground Technology (FLUTe) discrete interval monitoring system in January 2003. BTEX constituents have been detected at low concentrations associated with FLUTe monitoring equipment elsewhere at SSFL.

FSDF RFI Site:

- TCE and TCE breakdown products were the primary VOCs detected at this site above regulatory criteria.
    - TCE or TCE breakdown products were detected above regulatory criteria in seven monitoring wells (RD-21, RD-23, RD-33A, RD-54A, RD-54B, RD-64 and RD-6), historically ranging up to 2,900 µg/L TCE in RD-21.

  - TCE concentrations are generally highest in wells within the FSDF RFI Site, near areas where the highest concentrations of VOCs were detected in pre-excavation soil samples. Concentrations have generally decreased over time. TCE has decreased to concentrations below regulatory criteria or nondetectable concentrations in five wells (RD-33A, RD-33B, RD-54B, RD-54C, and RD-57).
  - In wells outside the FSDF RFI Site, TCE concentrations have been nondetectable or below regulatory criteria since 2003 or longer (RD-22, RD-57, RD-33 {A,B,C}).
- Other VOCs detected above regulatory levels at the site include carbon tetrachloride (RD-21 and RD-59A), PCE (RD-23), benzene (RD-21, RD-64, and RD-65), 1,1-DCA (RD-23, RD-54A, and RD-65), 1,2-DCA (RD-23, RD-54A, RD-64, and RD-65), and methylene chloride (RD-54A, RD-64, and RD-65).

Two VOCs, acetone and cis-1,2-DCE, were detected once at concentrations less than regulatory screening levels in spring S-19 in the undeveloped land north of Group 8. Acetone was detected at 7.6 µg/L (estimated) and is considered a likely laboratory contaminant. Cis-1,2-DCE was detected at 0.41 µg/L (estimated) in 2006. Acetone and cis-1,2-DCE were not detected in two other samples from this spring. Several VOCs have been detected sporadically at wells RD-59A, RD-59B, RD-59C, OS-3, OS-4, OS-5, and OS-5A. Analysis of samples from these locations typically result in non-detects for VOCs, however. Additional information on groundwater quality at offsite locations is presented in Appendix E.

4.1.5 Surface Water

For the RFI, three surface water samples for VOC analysis have been collected from the B056 Excavation at the B056 Landfill RFI Site. VOCs were not detected in the RFI surface water samples collected.

As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. When tested, VOCs have not been detected in these samples at concentrations above NPDES permit limits.

4.1.6 Completeness of Characterization

Soil and soil vapor samples were collected from known or potential solvent source areas and downstream discharge areas within Group 8 and analyzed for VOCs. In addition, soil vapor screening was conducted at representative locations to provide characterization of potential VOC impacts at the Group 8 RFI sites. The VOCs predominantly detected above RBSLs are TCE and associated breakdown products at the FSDF RFI Site, with current sampling data ranging up to 12.3 µg/L TCE in vapor and 1,500 µg/L in perched shallow groundwater. These detections are primarily attributed to site operations at the FSDF RFI Site, which included the potential and known disposal of numerous chemicals including organic solvents at the former ponds. Since (a) soil was excavated to bedrock at this location, (b) clean soil was used to backfill the excavation, and (c) groundwater is shallow, detected VOC concentrations in post-excavation soil samples are considered to originate from bedrock and groundwater VOC impacts.

VOCs detected in soil above RBSLs at the other Group 8 RFI sites were generally low and either not replicated in subsequent collocated samples or considered to be a likely result of laboratory contamination. The source of benzene and toluene in groundwater samples collected from RD-50 and RD-07 is considered to be equipment contamination (i.e., FLUTe). The source of VOCs detected in groundwater at the other Group 8 RFI Sites is uncertain based on current sampling results from known or potential chemical use areas identified within the reporting area. TCE detections in groundwater north of the B009 LF Site (PZ-102 and RD-91) and at the B056 Landfill Site (RD-07) may be the result of small spills or incidental discharges at or near these sites, although current soil sample data do not indicate that a significant release occurred. Further evaluation of potential sources for the VOC groundwater impacts observed in these wells is ongoing, and the results will be reported in the Group 5 RFI Report and the Site-Wide Groundwater RFI Report.

Although the source of some VOC impacts in groundwater are uncertain, adequate soil sampling has been performed so that VOC-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C, and D.

For the purposes of risk assessment, NSGW well RS-54 was selected for evaluation of direct exposures since it is the most impacted well within the Group 8 Reporting Area (primarily on the basis of its VOC detections, but as described below, this well also contains elevated

concentrations of several metals and perchlorate). Similarly, for assessment of indirect exposures, the following wells were selected for evaluation based on their shallow depth to water and VOC detections: PZ-102 (B009); RD-50 (ESADA); RS-16 (B056 Landfill), and RS-54 (FSDF).

4.2 SVOCs

4.2.1 Soil/Sediment

More than 140 samples were collected from within the Group 8 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 8 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, when present, were detected at generally low concentrations and below RBSLs in samples collected within the Group 8 Reporting Area. Only two locations (both within the B056 Landfill) had detections above RBSLs. Overall, more than 20 different SVOCs (excluding tentatively identified compounds [TICs]) were detected, primarily comprised of PAHs. Glycol was not detected as a TIC in any site samples. SVOC sampling results for the RFI sites within the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- No SVOCs detected at this site exceeded RBSLs. Concentrations of PAHs ranged up to 180 µg/kg for naphthalene and up to 13 µg/kg for benzo(a)pyrene.

B056 Landfill RFI Site:

- PAHs were detected above RBSLs at two locations within the landfill, ranging up to 960 µg/kg benzo(a)pyrene in a split sample (430 µg/kg in primary). PAHs were not detected above RBSLs in down-drainage samples.

ESADA RFI Site:

- No SVOCs detected at this site exceeded RBSLs. Concentrations of PAHs ranged up 140 µg/kg for 2-methylnaphthalene, and up to 32 µg/kg for

benzo(a)pyrene in the northern portion of the site. Phthalates were also detected in site soils (up to 720 µg/kg).

FSDF RFI Site:

- No SVOCs detected at this site exceeded RBSLs. Concentrations of PAHs ranged up 30 µg/kg (pyrene) in the Southern Investigation Area. Benzo(a)pyrene was detected at concentrations of up to 32 µg/kg. Phthalates were also detected in site soils (up to 540 µg/kg).

4.2.2 Near-Surface Groundwater

SVOCs in NSGW are characterized by the analytical data for samples collected from six piezometers/shallow wells within the Group 8 Reporting Area. SVOCs were not detected, except for low concentrations of naphthalene detected at the FSDF and B009 LF RFI Sites (0.09 µg/L at PZ-099 and 0.07 µg/L (estimated) at PZ-102, respectively). These concentrations are below regulatory criteria. Additional information on NSGW occurrence, quality and temporal variability is provided in Appendix E.

4.2.3 Bedrock

No bedrock samples were collected for SVOCs analysis in the Group 8 Reporting Area.

4.2.4 Chatsworth Formation Groundwater

SVOCs in Chatsworth formation groundwater are characterized by sample analytical data collected from 10 onsite CFOU groundwater monitoring wells within the Group 8 Reporting Area and six offsite wells north of Group 8. SVOCs were not detected, except for bis(2-ethylhexyl)phthalate (9.9 µg/L at RD-57 and 400 µg/L at RD-59C) and benzoic acid (140 µg/L at RD-50). Bis(2-ethylhexyl)phthalate is a plasticizer and is commonly encountered as a laboratory contaminant. Additional information on CFOU groundwater occurrence, quality and temporal variability is provided in Appendix E.

4.2.5 Surface Water

RFI surface water samples were not analyzed for SVOCs. As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI

Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. When tested, SVOCs have not been detected in these samples above NPDES permit limits.

4.2.6 Completeness of Characterization

Soil and groundwater samples were collected from known or potential SVOC source areas and downstream discharge areas with the Group 8 Reporting Area. PAHs are the SVOCs most commonly detected in Group 8 soil samples, with most concentrations much lower than RBSLs. Soil samples from two locations within the B056 Landfill contained PAHs above screening levels (up to 960 µg/kg benzo(a)pyrene). SVOCs were generally not detected in Group 8 groundwater samples.

SVOC-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C, and D.

4.3 PETROLEUM FUELS

4.3.1 Soil/Sediment

More than 150 soil samples were collected from within the Group 8 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 8 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. TPH exceeding RBSLs in Group 8 were primarily detected in samples collected at the B009 LF and B056 Landfill RFI Sites. TPH was detected at concentrations up to 23,000 milligrams per kilogram (mg/kg) at the landfill.

Locations with maximum detections of petroleum hydrocarbons exceeding RBSLs at Group 8 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.

B009 LF RFI Site:

- Gasoline-range TPH was detected in three samples at concentrations exceeding the lowest RBSL, ranging up to 4 mg/kg. Benzene was not detected in collocated

or nearby soil vapor or soil matrix samples, and gasoline-range hydrocarbons were not detected in the sample collected from the channel north of the site.

- Diesel-range TPH was detected at concentrations up to 710 mg/kg (less than the lowest RBSL in samples collected from soils beneath the former UT-3.

B056 Landfill RFI Site:

- At the B056 Landfill (CMS Area B056-1), 21 samples contained detectable concentrations of TPH. Most were less than RBSLs, although one sample contained diesel-range TPH at 23,000 mg/kg. PAHs above RBSLs were also detected in this sample. At the northern toe of the landfill, lubricant oil-range hydrocarbons were detected up to 1,100 mg/kg, less than RBSLs. TPH was not detected in samples collected in the downgradient drainage.

ESADA RFI Site:

- All TPH detections were less than RBSLs, ranging up to 11 mg/kg (estimated) near the former pistol range.

FSDF RFI Site:

- All TPH detections were less than RBSLs, ranging up to 75 mg/kg 'high boiling' petroleum hydrocarbons (equivalent to kerosene, diesel, and lubricant-range TPH) south of the former pond area.

4.3.2 Near-Surface Groundwater

TPH in NSGW is characterized by analytical data for samples collected from three piezometers located at the B009 LF and FSDF RFI Sites. TPH was not detected in the NSGW samples collected from these wells. NSGW at the B056 Landfill RFI site has not been sampled for TPH, but RS-16 and PZ-124 are typically dry. TPH data will be collected at this location if these wells become saturated. Also, TPH data are being collected from RS-54 to characterize TPH at the former FSDF ponds.

Summary results are presented on Figure 4-3, and additional information is provided in Appendix E.

4.3.3 Bedrock

No bedrock samples were collected from the Group 8 Reporting Area for TPH analysis.

4.3.4 Chatsworth Formation Groundwater

Petroleum hydrocarbons in Chatsworth formation groundwater are characterized by the analytical data for samples from five wells at the ESADA and FSDF RFI Sites. At the ESADA area, gasoline range organics (C6-C12) have historically been detected at concentrations up to 150 µg/L in RD-50, with recent concentrations of approximately 60 µg/L (estimated). At the FSDF, total extractable hydrocarbons (C16-C25) were analyzed for on one occasion and were detected at a concentration of 9,000 µg/L at RD-33A, which is located on undeveloped land to the northwest of the site. Petroleum hydrocarbons at seven CFOU wells were detected at concentrations ranging from 13 µg/L to 600 µg/L. Detections of total recoverable petroleum hydrocarbons (TRPH) at FSDF wells ranged from 50 µg/L (RD-22) to 600 µg/L (RD-23). TRPH is an analytical method (EPA Method 418.1) that does not speciate carbon ranges, and is no longer used to quantify petroleum hydrocarbon concentrations at the SSFL.

Additional information on CFOU groundwater occurrence, quality and temporal variability is provided in Appendix E.

4.3.5 Surface Water

RFI surface water samples were not analyzed for TPH. As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. Oil and grease was detected in one NPDES sample at concentrations above the NPDES permit limits at Outfall 006. This single detection was during the 2000 IM.

4.3.6 Completeness of Characterization

Soil and groundwater samples were collected from known or potential TPH source areas and downstream discharge areas with the exception of groundwater samples at the B056 Landfill RFI Site. The highest concentrations were detected in soil within one portion of the northern B056 Landfill (CMS Area B056-1), ranging up to 23,000 mg/kg diesel-range hydrocarbons. In most cases where soil TPH concentrations exceeded RBSLs, collocated or nearby soil samples were analyzed for the potential risk constituents, benzene and PAHs. TPH concentrations in groundwater within the Group 8 Reporting Area were generally low,

although the source of low concentrations of gasoline-range TPH and benzene in RD-50 has not been identified. The TPH detected in samples from RD-50 is considered related to historical incidental spills or releases in the area that, based on surficial media data, are no longer present in soil (Appendix C).

TPH-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C, and 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 8 Reporting Area. However, as described above, additional TPH groundwater data are being collected for the Group 8 RFI Sites and will be provided to DTSC when available.

4.4 PCBs/TERPHENYLS

4.4.1 Soil/Sediment

More than 270 soil samples were collected and analyzed for PCBs and more than 40 soil samples were collected and analyzed for terphenyls within the Group 8 Reporting Area. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 8 Reporting Area PCB sampling results are depicted on Figure 4-4, with most detections occurring at the FSDF and B056 Landfill RFI Sites. Each sample location is represented by a color corresponding to the maximum ratio of detected PCB concentrations at that location relative to respective RBSLs. Since there are no RBSLs established for terphenyl compounds, these results are noted on the figure where detected in soil samples. As described in Section 4.0, color depictions for PCB samples represent comparisons with adjusted RBSLs for four Aroclors (1254, 1260, 1262, and 1268). These RBSLs were adjusted using baseline TRVs that were used in the ecological risk assessment (Appendix F).

PCBs were detected at generally low concentrations or were nondetectable in samples collected within the Group 8 Reporting Area. Detected PCBs primarily consisted of Aroclor 1254, and terphenyls were detected at only one site (B009 LF). PCB and terphenyl sampling results for the RFI sites within the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- PCBs were detected at concentrations less than RBSLs, ranging up to 26 µg/kg Aroclor 1254 (estimated) within the leach field.
- Terphenyls were detected at concentrations up to 0.955 mg/kg at one location in the leach field.

B056 Landfill RFI Site:

- In the B056 Landfill (CMS Area B056-1), PCBs were detected in two sample locations. Aroclor 1254 was detected up to 1,000 µg/kg, exceeding the lowest RBSL, and Aroclor 1260 was detected up to 200 µg/kg, less than RBSLs. Down-stream drainage samples did not contain detectable concentrations of PCBs.
- At the B056 Excavation Debris Area (CMS Area B056-2), PCBs were detected in two soil samples that targeted an empty drum location. Concentrations ranged up to 246 µg/kg (Aroclor 1248), 134 µg/kg (Aroclor 1254), and 99.8 µg/kg (Aroclor 1260), with the Aroclor 1248 concentration exceeding RBSLs. PCBs were not detected in the B056 Excavation sediments.
- Terphenyls were not detected in soil samples.

ESADA RFI Site:

- PCBs were detected in five samples at concentrations less than RBSLs, ranging up to 30 µg/kg Aroclor 1254 (estimated) near the former PDU storage tank (Chemical Use Area 3).
- Terphenyls were not analyzed in soil samples from the ESADA RFI Site.

FSDF RFI Site:

- PCBs were detected in a total of 64 samples from the Former Disposal Area (Chemical Use Area 1), the Southern Investigation Area (Chemical Use Area 3), and Channels A through D, located downstream of the site. Thirty-three samples contained detectable concentrations of Aroclor 1254 at concentrations that exceeded RBSLs, and all results were less than the FSDF IM clean-up goal (IT, 2002). PCBs at the site are localized in small areas and concentrations overall across the site are generally low. Only six samples had PCB concentrations above 300 µg/kg.
    - South of the Former Disposal Area and within the Southern Investigation Area, Aroclor 1254 was detected up to 360 µg/kg, slightly exceeding RBSLs.
    - In Channel A, Aroclor 1254 and Aroclor 1260 were detected at concentrations up to 520 µg/kg, exceeding the RBSLs, and Aroclor 1260 up to 330 µg/kg, above the RBSLs. PCB concentrations decreased away from and downstream of these samples.
    - In Channels B and C, Aroclor 1254 and 1260 were detected at concentrations up to 250 µg/kg, less than RBSLs.

  - In Channel D, all detected concentrations were less than RBSLs, ranging up to 91 µg/kg, Aroclor 1254.

- Terphenyls were not detected in any recent samples. Terphenyls up to 880 mg/kg were detected in pre-excavations samples, which represent soils that were removed from the Lower Pond during clean-up actions (GRC, 1990).

4.4.2 Near-Surface Groundwater

NSGW samples were not collected from Group 8 wells for PCBs or terphenyls analysis because PCBs were not detected in groundwater samples from other SSFL RFI sites that contained high PCB concentrations in soil (see MWH, 2006b). However, PCB/terphenyl data are being collected from RS-54 to assess the presence or absence of these chemicals in NSGW at the FSDF RFI site. Additional information is provided in Appendix E.

4.4.3 Bedrock

Bedrock samples were collected and analyzed for PCBs at the FSDF RFI Site. Terphenyls were not analyzed in any bedrock samples collected in the Group 8 Reporting Area. PCBs were detected in one sample at 190 µg/kg, collected at the bottom of the 2000 IM excavation.

4.4.4 Chatsworth Formation Groundwater

CFOU samples were not collected from Group 8 wells for PCBs or terphenyls analysis because PCBs were not detected in groundwater samples from other SSFL RFI sites that contained high PCB concentrations in soil (see MWH, 2006b). PCB data are being collected from RD-74 at the B056 Landfill RFI Site to assess the presence or absence of these chemicals in CFOU groundwater. Additional information is provided in Appendix E.

4.4.5 Surface Water

RFI surface water samples were not analyzed for PCBs or terphenyls. As part of NPDES monitoring, storm water discharge has been routinely sampled for PCBs at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. When tested, PCBs have not been detected in these samples at concentrations above NPDES permit limits.

4.4.6 Completeness of Characterization

Soil samples were collected from known or potential PCB or terphenyl source areas and in downstream discharge areas. Aroclor 1242, 1248, Aroclor 1254, and Aroclor 1260 are the only PCBs detected in samples collected in the Group 8 Reporting Area, with concentrations ranging up to 1,000 µg/kg at the B056 Landfill RFI Site (CMS Area B056-1). Terphenyls were detected in one recent sample from the B009 LF RFI Site at less than 1 mg/kg.

PCB- and terphenyl-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C, and D. Additional groundwater samples from RS-54 at the FSDF RFI Site and RD-74 at the B056 Landfill RFI Sites are being collected to assess the presence or absence of these chemicals in groundwater; these are the nearest wells to existing soil samples containing PCBs above RBSLs. Based on analytical results for PCBs in groundwater at other RFI sites with elevated PCBs in soil, the detection of these compounds at high concentrations in groundwater is considered unlikely. The additional PCB groundwater data being collected for the Group 8 RFI Sites will be provided to DTSC when available.

4.5 DIOXINS

4.5.1 Soil/Sediment

More than 90 soil samples were collected and analyzed for dioxins based on site use (known or suspected chemical use areas) and sample results (step-outs). Group 8 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). Dioxins (as 2,3,7,8-TCDD TEQ) were detected above the lowest RBSL in samples collected from the discharge area north of Building 100 (south of the B056 Landfill RFI Site) and at the FSDF RFI Site. Dioxin sampling results for the RFI sites within the Group 8 Reporting Area are summarized as follows:

B056 Landfill RFI Site:

- In the discharge area north of Building 100 (CMS Area B056-3), dioxins were detected above background (0.87 nanograms per kilogram [ng/kg] TEQ) in three samples. Dioxin TEQ concentrations ranged up to 16.95 ng/kg in a duplicate sample, exceeding RBSLs. The primary sample dioxin TEQ concentration was 3.08 ng/kg, exceeding only the ecological RBSL.

FSDF RFI Site:

- Dioxins were detected above background (0.87 ng/kg TEQ) in 16 samples collected within the Former Disposal Area (Chemical Use Area 1), in the Southern Investigation Area (Chemical Use Area 3), and in Channels A and B. Dioxin TEQ concentrations ranged up to 6.7 ng/kg, with five samples exceeding the ecological RBSL. All results were less than the residential RBSL and the FSDF IM clean-up goal.

4.5.2 Near-Surface Groundwater

One sample has been collected and analyzed for dioxins in one NSGW well (RS-54) located within the former Disposal Area at the FSDF RFI Site in 2007. Dioxins were not detected in RS-54. Additional information on NSGW occurrence, quality, and temporal variability is provided in Appendix E.

4.5.3 Bedrock

Bedrock samples were collected and analyzed for dioxins at the FSDF RFI Site. Fourteen samples collected at the bottom of the 2000 IM excavation (0 to 10 feet bgs) contained TEQs above background. One dioxin TEQ was 10.7 ng/kg, exceeding the RBSL. Data for these samples were not available electronically, but these results are noted on Figure 4-5.

4.5.4 Chatsworth Formation Groundwater

No CFOU groundwater samples from wells in the Group 8 Reporting Area have been analyzed for dioxins. However, additional groundwater sampling will be conducted at RD-91 (B009 LF RFI Site) to confirm the absence of dioxin groundwater impacts. Based on the dioxin sampling results for RS-54 at FSDF, dioxin detections in CFOU groundwater are considered unlikely. Additional information on CFOU groundwater occurrence, quality and temporal variability is provided in Appendix E.

4.5.5 Surface Water

RFI surface water samples from the B056 Landfill and FSDF RFI sites were not analyzed for dioxins. As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. Dioxins were detected in the NPDES samples at concentrations above

the NPDES permit limits at Outfalls 005 and 006 (9 times) and at Outfall 007 (6 times) (Boeing, 2005; 2006c; 2007a).

4.5.6 Completeness of Characterization

Soil samples were collected from areas of known or potential dioxin source areas and downstream discharge areas. Dioxins were detected near the Building 100 discharge area (CMS Area B056-3), and further evaluation of potential dioxin sources for this occurrence will be conducted for the Group 5 RFI Report. Detections of dioxins at the FSDF RFI Site may be related to historical operations, since wastes were burned in the disposal ponds, or to deposition of ash from regional fires that occurred at or very near this area in October 2003 (Piru Fire) and September/October 2005 (Topanga Fire).

Dioxin-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C and D.

4.6 METALS AND FLUORIDE

4.6.1 Soil/Sediment

More than 340 soil samples were collected from the Group 8 Reporting Area and analyzed for metals. Sample locations were based on site use (known or suspected chemical use areas) and previous sample results (step-outs). Group 8 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 F). The sodium results described below are compared to background since no RBSL exists for this metal (it is considered an essential nutrient and not considered in risk assessment).

Fluoride results are also presented in this section since background concentrations have been developed for this inorganic chemical (MWH, 2005). Figure 4-6 includes presentation of fluoride results. Within the Group 8 Reporting Area, more than 40 samples were collected

and analyzed for fluoride. No detected concentrations, ranging up to 5.69 mg/kg at the FSDF RFI Site, exceeded background levels.

Metals in the Group 8 Reporting Area were detected above background in samples collected from all four RFI sites, with the highest concentrations detected at the former ESADA and FSDF Pistol Ranges. Seventeen (17) metals were detected at concentrations exceeding background, as follows: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium, sodium, mercury, vanadium, and zinc. Beryllium and molybdenum were detected above background in only one sample each. Sodium was the metal most frequently detected above its background comparison level (54 of the 186 background exceedances, or 29%), followed by selenium (37 of the 186 background exceedances, or 20%), mercury (29 of the 186 background exceedances, or 16%), and aluminum (24 of the 186 background exceedances, or 13%).

As described above, the B009 LF and ESADA RFI Sites, and the southern portion of FSDF RFI Site had several soil samples that contained aluminum at concentrations above background (20,000 mg/kg). Within or between these sites, there are no discernable patterns or concentration gradients in the aluminum concentrations above background except that these occurrences are associated with higher concentrations of clay in the soil. Although solid aluminum was used at Building 009, this use would not result in a widespread distribution of aluminum in soil. The presence of aluminum in soil above its background level is considered to be related to the clay-rich Santa Susana formation, which is present in the southern portion of the Group 8 Reporting Area and exposed on the hill slope to the south. As described in Section 2, this geologic formation is comprised of micaceous claystone and siltstone, and soil from this material will likely yield high naturally-occurring aluminum concentrations. Clay-rich soils from the Santa Susana formation may also be a source of the other metals detected at these sites, including barium and vanadium. As described below, elevated concentrations of these metals are sometimes collocated with elevated aluminum detections.

Areas with aluminum concentrations that did not pass the Wilcoxon Rank Sum test for comparison to background at the B009 LF and ESADA RFI Sites were not recommended for further evaluation in the CMS based on aluminum's naturally-occurring source and risk assessment results. As described further in Section 6, calculated aluminum exposure risks for ecological receptors are based upon toxicity values derived from soluble aluminum, which is not expected to be present in soils at the Group 8 RFI Sites. The soluble and toxic

forms of aluminum are only present in soil under soil pH values of less than 5.5 (USEPA, 2003), and within Group 8, soil pH ranged from 6.5 to 9.6 in areas where aluminum was present above background.

Metals sampling results for the RFI sites within the Group 8 Reporting Area are summarized as follows:

B009 LF RFI Site:

- At the leach field and hold-up tanks (Chemical Use Areas 1a, 2b, and 2c), aluminum, antimony, sodium, and mercury were detected above background concentrations. Of these metals, aluminum and antimony concentrations exceeded ecological RBSLs, ranging up to 22,400 mg/kg and 9.8 mg/kg, respectively. Both these results are just slightly above background concentrations for these metals (20,000 mg/kg for aluminum and 8.7 mg/kg for vanadium). Sodium concentrations ranged up to 390 mg/kg (background at 110 mg/kg).
- Near the solar concentrator facility (Chemical Use Area 5), aluminum, barium, chromium, sodium, and vanadium were detected above background. Of these metals, aluminum, barium, and vanadium exceeded ecological RBSLs, and vanadium exceeded the residential RBSL.
  - Aluminum concentrations ranged up to 28,000 mg/kg (background at 20,000 mg/kg). These concentrations are considered naturally-occurring as a result of clayey soils related to the nearby Santa Susana formation.
  - Barium (up to 243 mg/kg), chromium (at 39.7 mg/kg), and vanadium (at 78 mg/kg) were detected above background at one location only, near the center of the solar concentrator facility. Similar to the occurrence of aluminum described above, these metal concentrations are considered naturally-occurring since they are associated with clayey soils and are either very deep (barium, immediately above bedrock), or just slightly exceed the soil background concentrations (chromium background at 36.8 mg/kg and vanadium background at 62 mg/kg).
  - Sodium (up to 240 mg/kg) was detected above background (110 mg/kg).

B056 Landfill RFI Site:

- At the B056 Landfill (northern portion of CMS Area B056-1), 11 metals were detected at concentrations exceeding background levels. Of these, ten metals were detected above ecological RBSLs (barium, boron, cadmium, copper, lead, mercury, molybdenum, selenium, sodium, and zinc). Most concentrations above background or RBSLs were detected in one to five samples. The most frequent or noteworthy metal detections in this area are as follows:

- Hexavalent chromium was detected in one sample at a concentration of 0.3 mg/kg, exceeding the RBSL. This sample was analyzed where total chromium results exceeded background and RBSLs.
- Selenium was the metal most frequently detected above background and RBSLs. Selenium concentrations ranged up to 5.3 mg/kg and were detected above RBSLs in 17 samples.
- Sodium was detected up to 390 mg/kg above background in six samples (at 110 mg/kg).

- In the Southern Debris Area (southern portion of CMS Area B056-1), six metals were detected at concentrations exceeding background levels. Of these, five metals were detected above ecological RBSLs (aluminum, boron, cadmium, copper, and selenium). Most concentrations above background or RBSLs were detected in one to two samples. The most frequent or noteworthy metal detection in this area is as follows:
  - Selenium was the metal most frequently detected above background and RBSLs. Selenium concentrations ranged up to 3.4 mg/kg and were detected above RBSLs in 11 samples.
- In the combined FSDF-B056 drainage north of the site (Channel D), arsenic was detected above background in five samples from one localized area near and just beyond the property boundary.
  - At this location, arsenic concentrations ranged up to 34.9 mg/kg (background at 15 mg/kg). The highest concentrations were in samples collected adjacent to and near a shale bedrock outcrop, and are considered to be naturally-occurring.
  - Concentrations decrease downstream from this shale location to less than background within 200 feet of the outcrop.
  - Arsenic was not detected above background in any of the soil samples (over 80 samples) collected at B056 Landfill RFI Site, including samples of drainage sediments leading to this outcrop area.

ESADA RFI Site:

- At the Former Storage Yard (Chemical Use Area 1), aluminum, sodium, and vanadium were detected above background concentrations. Concentrations of aluminum and vanadium exceeded ecological RBSLs, but were less than residential RBSLs.
  - Aluminum concentrations (up to 31,100 mg/kg) exceeded background (20,000 mg/kg) at locations in and around the northern and southern storage areas. These concentrations are considered to be naturally-occurring as a result of clayey soils related to the nearby Santa Susana formation.
  - Sodium exceeded background in 54 soil samples. The highest concentrations (ranging up to 732 mg/kg) were detected in samples from the southern storage

area. Sodium concentrations generally decreased with increasing distance from Building 814, where pipe-burst testing using sodium was performed.

- Vanadium exceeded the background concentration at one location (at 64.8 mg/kg), near the northwest portion of the Former Storage Yard. All other vanadium concentrations were less than background.

- In the northern portion of the site, near the former PDU AST (Chemical use Area 3), concentrations of three metals (aluminum, sodium, and mercury) exceeded background in three samples. Of these metals, only aluminum concentrations (up to 26,900 mg/kg) exceeded the ecological RBSL. Sodium was detected up to 319 mg/kg (background 110 mg/kg). The aluminum and sodium detections are similar to those elsewhere at the ESADA RFI Site.

- At the ESADA Pistol Range (CMS Area ESADA-1), concentrations of five metals (antimony, arsenic, boron, lead, and selenium) exceeded background concentrations and RBSLs:

  – The maximum concentrations of antimony (up to 870 mg/kg), arsenic (up to 350 mg/kg), and lead (up to 27,000 mg/kg) were detected in samples collected in the target area (i.e., south) of the former ESADA Pistol Range. The concentrations of these metals decreased with increasing distance from the southern target area, and concentrations in the samples collected farthest from the target area were below background.

  – Selenium and boron concentrations (up to 1.2 mg/kg and 14 mg/kg, respectively) did not exceed the residential RBSL. Boron concentrations (up to 14 mg/kg) exceeded the ecological RBSL at one location near the pistol range.

FSDF RFI Site:

- At the Former Disposal Area (Chemical Use Area 1) and down-stream in Channels A and B, mercury and sodium were detected above background. Mercury was detected up to 0.35 mg/kg, less than RBSLs. Sodium was detected up to 301 mg/kg (background 110 mg/kg).

- As described above, in the combined FSDF-B056 drainage north of the site (Channel D), arsenic was detected above background in five samples from localized area near and slightly beyond the property boundary.

  - At this location, arsenic concentrations ranged up to 34.9 mg/kg (background at 15 mg/kg). The highest concentrations were in samples collected adjacent to and near a shale bedrock outcrop, and are considered to be naturally-occurring.

  - Concentrations decrease downstream from this shale location to less than background within 200 feet of the outcrop.

  - Arsenic was not detected above background in over 40 FSDF RFI Site samples, including samples of drainage sediments leading to this outcrop area. Arsenic was only present at concentrations above background in five samples.

- At the Southern Investigation Area (Chemical Use Area 3), aluminum, mercury and sodium were detected above background. Of these, concentrations of aluminum exceeded the ecological RBSL.
  - Aluminum concentrations (up to 26,900 mg/kg) exceeded background (20,000 mg/kg) at two locations. These concentrations are considered to be naturally-occurring as a result of clayey soils related to the nearby Santa Susana formation.
  - Sodium was detected up to 360 mg/kg (background 110 mg/kg), similar to concentrations at the ESADA RFI Site.
- At the former Drum Debris Area in the channel west of FSDF (CMS Area FSDF-2), mercury was detected in three samples above background and RBSLs, at concentrations up to 6.1 mg/kg. Mercury decreases to below background in the sample farthest downstream, just upstream of the confluence with Channel A.
- At the FSDF Pistol Range (CMS Area FSDF-3), lead was detected above background and RBSLs at a concentration of 420 mg/kg in one sample collected beneath the former target area. Concentrations decrease to within background in all directions and at depth. Mercury (up to 0.35 mg/kg) and sodium (up to 230 mg/kg) were also detected at this location above background and RBSLs.

4.6.2 Near-Surface Groundwater

Both filtered (more than 25 samples) and unfiltered (more than five samples) groundwater samples have been collected for metals analysis from five NSGW piezometers and wells located at the FSDF RFI Site. At the direction of DTSC (DTSC, 2007c), both filtered (for characterization) and unfiltered (for risk assessment) groundwater samples were collected. Unfiltered samples have been collected from four piezometers or shallow wells at the B009 LF and FSDF RFI Sites. Filtered groundwater samples have only been collected from two groundwater wells the FSDF RFI Site. NSGW wells at the B056 Landfill RFI Site have been dry in recent years. In general, metals concentrations in unfiltered samples (i.e., "total" metals) are higher than metals concentrations in filtered samples (i.e., "dissolved" metals) due to the association of metals with soil particulates contained in unfiltered samples. As such, concentrations of total metals reported for unfiltered samples are not directly comparable to GWCCs, which were developed using only data from filtered samples (i.e., "dissolved" metals data). For reference, unfiltered "total" metals results are shown in Table E-24, Appendix E.

Several metals were detected in filtered samples collected from FSDF NSGW monitoring wells and piezometers at concentrations above GWCCs. Of these detections, cadmium (up to 6.1 µg/L), cobalt (up to 230 µg/L), copper (up to 50 µg/L), manganese (up to 970 µg/L),

molybdenum (up to 71 µg/L), nickel (up to 990 µg/L, estimated), and selenium (up to 16 µg/L) results from RS-54 at the FSDF RFI Site are considered related or potentially related to historical site operations (see Section 5). Additional information on NSGW occurrence, quality and temporal variability is provided in Appendix E. A summary of NSGW metals information is contained in Table 3-2B of Appendices A through D, and a detailed evaluation is presented in Table E-22.

4.6.3 Bedrock

Bedrock samples were collected from the FSDF RFI Site for mercury. Mercury was detected above background in five bedrock samples taken at the bottom of the 2000 IM excavation at depths between 0 and 10 feet bgs within the former Disposal Area. Concentrations ranged up to 0.28 mg/kg, below RBSLs.

4.6.4 Chatsworth Formation Groundwater

Metals in Chatsworth formation groundwater are characterized by analytical results for more than 220 filtered samples from 10 monitoring wells within the Group 8 Reporting Area, and over 90 samples from six offsite wells. One unfiltered sample has been collected from one Chatsworth formation monitoring well located at the FSDF RFI Site. Similar to NSGW, several metals were detected in CFOU wells at concentrations above GWCCs. Dissolved metals data for the Chatsworth formation wells in the Group 8 Reporting Area that are considered related or potentially related to site historical operations are summarized as follows:

B056 Landfill RFI Site:

- Dissolved copper (up to 12 µg/L) and selenium (up to 4 µg/L) were detected above GWCCs at RD-07. These metals were also detected in soil above background levels at the B056 Landfill RFI Site (CMS Area B056-1) and are considered possibly related to site operations.

ESADA RFI Site:

- Dissolved lead (at 18 µg/L) was detected above its GWCC at RD-50 (lead was below GWCCs in RD-21). Since high soil lead concentrations were detected at the ESADA Pistol Range (CMS Area ESADA-1), this detection in groundwater is considered possibly related to site operations.

FSDF RFI Site:

- Dissolved metal concentrations above GWCCs in RD-54A include manganese (up to 660 µg/L), molybdenum (up to 7.9 µg/L) and selenium (up to 5 µg/L). These metals are considered likely related to historical site operations based on elevated groundwater concentrations relative to GWCCs and historical operations at the former ponds where disposal occurred.

Additional information on CFOU groundwater occurrence, quality and temporal variability is provided in Appendix E. A summary of Chatsworth formation groundwater metals is contained in Table 3-2B of Appendices A through D, and a detailed evaluation is presented in Table E-23. Further description regarding the basis for determination of whether metal detections are related to the RFI sites is provided in Section 5.

4.6.5 Surface Water

Unfiltered RFI surface water samples from the B056 Landfill Excavation were analyzed for metals, and samples from the FSDF RFI Site were analyzed for mercury. Mercury was not detected in any of the samples collected from either site. Low concentrations of barium (up to 0.03 mg/L), manganese (up to 0.58 mg/L) and iron (up to 0.33 mg/L) were present in the samples collected from the B056 Excavation. Of these detections, only the manganese detection (150 mg/L) is greater than the GWCC.

As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. Mercury was detected at Outfalls 005 and 006 above NPDES permit limits prior to implementation of the FSDF IM in 2000. Antimony was also detected at Outfall 006 above NPDES permit limits prior to implementation of the FSDF IM in 2000. Since that interim measure, copper and mercury have been detected above the NPDES permit limits at Outfalls 005 and 006 four times each. At Outfall 007, copper, lead, and antimony have been detected above NPDES permit limits three times, twice, and once, respectively (Boeing, 2000, 2001, 2003, 2003, 2005, 2006c, 2007d and 2007e).

4.6.6 Completeness of Characterization

Soil and groundwater samples were collected and analyzed at known or potential metals source areas and in downstream discharge areas. Several metals were detected in soils and groundwater at concentrations above screening levels, with the most frequent detections

including aluminum, sodium, mercury, and lead in soil samples and copper, lead, and mercury in filtered groundwater samples. In soil, metals above RBSLs were detected primarily in samples from the two pistol target areas (CMS Areas ESADA-1 and FSDF-3). Sodium detections above background are likely related to sodium use at the ESADA area, where pipe-strength testing was performed and sodium-saturated solutions were stored; at FSDF, which was used for treatment and cleaning of Na/K equipment; or at the B056 Landfill, where drums of sodium materials were stored. Aluminum detections above background are considered to be naturally-occurring and related to clayey soils associated with the nearby Santa Susana formation, which is present in the southern portion of the Group 8 Reporting Area. Similarly, arsenic detections in soil are also considered to be naturally-occurring, because they occur in one localized area adjacent to and downstream of a shale outcrop, far removed from any SSFL facilities or operations. In groundwater, almost all metals have been detected at concentrations above GWCCs in at least one well. Based on historical operations, groundwater concentrations and temporal data distribution, and number, magnitude and proximity of soil concentrations exceeding background, some metals are considered potentially site related in groundwater. These are summarized in Section 5 and a detailed evaluation of site related metals is presented in Tables E-22 and E-23 (Appendix E).

Metals-related chemical use areas are characterized sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendices A, B, C, and D.

4.7 PERCHLORATE

4.7.1 Soil/Sediment

Based on potential historical chemical site use, more than 160 samples were collected at the B056 Landfill and FSDF RFI Sites for perchlorate analysis. At the B056 Landfill RFI Site, perchlorate was not detected in any of the 50 soil samples that were collected and analyzed. At the FSDF RFI Site, perchlorate was detected in eight samples that were collected in the southeastern portion of the RFI site. In this area (CMS Area FSDF-1), perchlorate concentrations in soil leachate ranged up to 2,600 µg/L (considered equivalent to a soil matrix concentration of µg/kg; see Appendix D). Only the maximum detected concentration of perchlorate in this area exceeded the TRV-adjusted RBSL for perchlorate (21 µg/kg; Appendix F). Perchlorate was also detected in soil leachate samples from some locations in Channels A and B, at concentrations ranging from 0.056 to 6 µg/L, less than the RBSL.

No bedrock samples were collected from Group 8 Reporting Area for perchlorate analysis.

4.7.2 Groundwater

Perchlorate has been routinely detected above regulatory levels in both perched NSGW and CFOU groundwater samples collected from the FSDF RFI Site. Between 1997 and 2005, 55 samples were collected from six perched piezometers/wells (PZ-98, PZ-99 [abandoned], PZ-100, PZ-101, RS-18, RS-54) and 12 Chatsworth formation wells (RD-21, RD-22, RD-23, RD-33A, RD-33B, RD-33C, RD-54A, RD-54B, RD-54C, RD-57, RD-64 and RD-65) for perchlorate analysis. Perchlorate has been detected above regulatory criteria in RD-21, RD-54A, and RS-54 at concentrations ranging from 3.7 to 18 µg/L, with the highest levels detected in RS-54. These detections in groundwater are considered to be related to former use or disposal activities at the FSDF RFI Site and are consistent with soil detections in the area.

Single detections of perchlorate have occurred in samples from two discrete monitoring depths within RD-07 at the B056 Landfill RFI Site. Perchlorate was detected, ranging up to 11 µg/L during one sampling event in February 2003. Perchlorate was not detected in the three previous samples from RD-07 or in subsequent discrete interval samples collected in 2004. Perchlorate was also not detected in any samples from other wells at the B056 Landfill Site. Since perchlorate was not detected in over 50 soil samples at this RFI Site, the non-repeatable historical detections of perchlorate in RD-07 are not considered related to current soil conditions at the B056 Landfill RFI Site. Perchlorate was not detected in groundwater samples collected from the B009 LF or ESADA RFI Sites (RD-91 and RD-50, respectively).

Perchlorate was not detected in a sample collected from Spring S-19 in 2002. At offsite CFOU well RD-59A, perchlorate was detected one time at a concentration of 5 µg/L. Over 20 subsequent samples from RD-59A and samples from RD-59B and RD-59C have not contained detectable perchlorate.

4.7.3 Bedrock

No bedrock samples were collected from the Group 8 Reporting Area for perchlorate analysis.

4.7.4 Surface Water

Perchlorate was not detected in RFI surface water samples from the B056 Landfill Excavation and FSDF. As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. Perchlorate has been detected only once at these outfalls. The single concentration of 4.26 µg/L (just above laboratory reporting limits) was detected in 1998 at Outfall 006, and subsequent samples at this outfall did not contain elevated perchlorate.

4.8 NITRATE

Sampling for nitrate in soil has not been conducted for the RFI because of its limited use in SSFL operations, and its low toxicity and lack of toxicity criteria for soil-related exposures (nitrite criteria set for infant exposures through drinking water). A total of 141 groundwater samples were collected at the Group 8 Reporting Area and analyzed for inorganic compounds (including nitrate). Nitrate was detected in the Chatsworth formation groundwater up to 47 mg/L at B009 LF (RD-91), up to 44.7 mg/L at B056 Landfill (RD-74), up to 27 mg/L in the ESADA area (RD-50), and up to 10.2 mg/L at FSDF (RD-21). No bedrock samples were collected in the Group 8 Reporting Area for nitrate analysis.

Nitrate was not detected in RFI surface water samples from the B056 Landfill Excavation (nitrate was not analyzed in FSDF RFI surface water samples). As part of NPDES monitoring, storm water discharge has been routinely sampled at Outfalls 005 and 006 at the FSDF RFI Site, and at Outfall 007 upstream of the B056 Landfill RFI Site since 1992. Nitrate was detected in the NPDES samples at concentrations above the permit limits at Outfall 005 11 times. These detections are considered to be related to naturally-occurring dioxins in ash deposited at the site following regional fires at or very near the SSFL (Boeing, 2005; 2006c; 2007a). Continued evaluation of NPDES exceedances is ongoing. No nitrate exceedances have occurred at Outfalls 006 or 007.

4.9 ASBESTOS

Asbestos-containing material (ACM) was identified and removed from five locations during investigations of the B056 Landfill and the Southern Debris Area (CMS Area B056-1). Bulk

insulation material collected by Boeing contractors contained 20% amosite and floor tiles contained 3% chrysotile (T&T, 2003). Six soil samples were collected from beneath suspected ACM and analyzed for asbestos. ACM was removed from seven acres at the B056 Landfill RFI Site. Only one soil sample contained trace amounts of chrysotile and less than 1% amosite. In 1993, a small amount of asbestos was reportedly removed from the Lower Pond excavation at the FSDF RFI Site (Rockwell, 1993a). Samples were not collected at other Group 8 RFI sites for asbestos analysis.

4.10 SUMMARY OF POST-TOPANGA FIRE BACKGROUND SAMPLING

Potential post-Topanga fire impacts on metals and dioxins concentrations in soil were evaluated as described in Appendices A, B, C and D. This evaluation was done to determine if any elevated concentrations of dioxins in soil samples collected after the fire could be due to the presence of as and burned materials deposited in surficial soil. Only those surficial soil samples (0- to 12-inch depth) collected 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.

A total of 24 post-fire Group 8 site soil samples were analyzed for metals, and 4 post-fire samples were analyzed for dioxins. One of these samples from the B056 Landfill RFI Site contained metals at concentrations suggestive of fire impacts, and similarly, one of these samples from the FSDF RFI Site contained dioxin concentrations suggestive of fire impacts. RFI site-specific discussions of the post-Topanga Fire data evaluation are presented in Appendices A, B, C and D.

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5.0 CONTAMINANT TRANSPORT AND FATE

This section presents a discussion of 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 (i.e., 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 8 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 8 Reporting Area.

5.1 CONCEPTUAL SITE MODEL

A CSM[1] 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 CSM for the Group 8 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)

[1] 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 in the groundwater system.

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

Contaminants 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 water to soil
- Within groundwater to down-gradient locations
- To surface water as seeps/springs
- From perched groundwater to the Chatsworth formation groundwater

5.2 TRANSPORT AND FATE TOOLS USED FOR EVALUATION

The transport and fate evaluation for the Group 8 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 8 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 E and F.

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 F, Attachment F-7.

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 F, Attachment F-7.

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 F, Attachment F-7.

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 and commercial exposure scenarios.

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 and commercial exposure scenarios. 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. Plans for the validation are described in the Vapor Migration Modeling Validation Study Work Plan (MWH, 2005c). A report describing the results of this study has been recently submitted to DTSC (MWH, 2007c). The vapor validation study report concludes that the proposed model conservatively over-predicts migration from Chatsworth formation groundwater based upon the results of flux chamber measurements. The results of the field validation activities 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 RME or 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 F. 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 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- 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 F.

Two dispersion models are used for SSFL risk assessments as described in the SRAM. 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 8 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 models and parameters for groundwater flow and contaminant transport through fractured bedrock, as described in the Site Conceptual Model Update (Cherry, McWhorter, and Parker, 2007) and in the Perchlorate Source Evaluation and Technical Report (MWH, 2003b).

Based on groundwater contaminant concentrations within and surrounding the Group 8 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. However, 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 the source areas do decrease over time, hence future concentrations will be lower. A description of this decision for the Group 8 Reporting Area is presented in Appendix F.

5.2.2 Qualitative Tools

Several qualitative tools have been used to evaluate the potential for contaminant migration at the Group 8 RFI sites. These are described in this section.

As described in Sections 3 and 4, extensive cleanup actions and soil removal have occurred at the FSDF RFI Site, limiting continued transport of soil contamination to air, surface water, and groundwater. This is described in more detail in Section 5.3 below.

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 8 RFI site-related contaminants. Sampling and analysis to assess chemical distributions in surficial soils and sediments were based, in part, on 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. For organic compounds, 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. 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 concentrations, spatial relationships, historical site operations, groundwater elevations and hydraulic gradients, and other hydrogeologic relationships, conclusions were made regarding whether each metal was potentially site-related or naturally-occurring. This evaluation is summarized below in Section 5.3.5 and presented in more detail in Appendices A through E. In particular, the reader is referred to Tables 3-2B in Appendices A through D, and Tables E-22 and E-23 in Appendix E.

5.3 TRANSPORT AND FATE FINDINGS FOR SITE-RELATED GROUP 8 CHEMICALS

The following sections provide a brief summary of transport and fate evaluation findings for the Group 8 Reporting Area for the evaluation tools previously listed. Each of these

summaries has a more detailed description in either Appendix E (Groundwater) or Appendix F (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 8 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 F, Attachment F-7.

5.3.2 Vapor from Soil

Several VOCs, including PCE, TCE and 1,1-DCE, were detected in soil in the Group 8 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 F, Attachment F-7.

5.3.3 Migration Within Groundwater

As discussed in Appendix E, 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 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 RS-54 (at the FSDF RFI Site) are considered to be representative of a source input location (i.e., those that are the highest within an area of impacted groundwater). As such, the concentrations in this well were selected to represent concentrations for current indirect exposure scenarios. This well was also selected to represent concentrations for future hypothetical exposures that include direct exposure to 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 represent exposure concentrations. Dissolved concentrations of chemicals in groundwater flowing away from source zones will be lower than those at the source, hence the application of any modeling would result in predicted concentrations in plumes lower than those measured in the selected well (RS-54) due to its position at or near the source input location.

5.3.4 Surficial Soil/Sediment Migration

A transport and fate discussion is presented here for the Group 8 Reporting Area based on the distribution of site chemicals summarized in Section 4 and presented in the RFI Site Reports (Appendices A, B, C and D). 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 Best Management Practices (BMPs) have been implemented to control erosion and surface water transport of contaminants at a number of areas within the SSFL, including use of plastic tarp to cover soils at the FSDF Pistol Range (MWH, 2006a). Based on sampling results and evaluations conducted for this report, additional erosion control measures are recommended at three additional CMS areas as described in Section 7 and Appendix D. These measures are focused on areas most likely to undergo erosion, potentially resulting in the transport of contaminants. These conditions typically occur where steep slopes are present and where chemical concentrations significantly exceed RBSLs and/or background, or if contaminant migration could potentially affect a more sensitive receptor. Current erosion control measures, if any, at the RFI sites are described in Section 3 and in Table 3-2A of Appendices A, B, C and D. Recommended areas for stabilization measures are further described in Section 7.

Results presented on Figures 4-1 through 4-7 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 relative to the lowest appropriate RBSL 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 data distributions.

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.

The majority of the Group 8 Reporting Area is west of a surface water divide that forms most of the eastern boundaries of the Group 8 Reporting Area. The small portion within the Group 8 Reporting Area that exists east of the surface water divide is restricted to the B056 Excavation, a vertical-walled excavation into bedrock east of the B056 Landfill. Surface water flow in this portion of the Group 8 Reporting Area is into the B056 Excavation, which does not have any natural surface discharge point. This excavation contains a mixture of rainwater, surface water, and groundwater, and is the only permanent surface water body within the Group 8 Reporting Area. All other surface water within the Group 8 Reporting Area exists only as intermittent discharge resulting from rain events.

Except for the B056 Excavation area, surface water discharge within the Group 8 Reporting Area is from the RFI sites to natural drainages located in the undeveloped SSFL land to the north. These channels lead to the Meier Canyon drainage on BBI property. Meier Canyon flows into the Arroyo Simi in Simi Valley (Figure 2-7A). Within the RFI sites located in the south, surface water discharge is generally via sheet flow or lined discharge channels leading to north- and northeast-trending natural drainages (Figure 2-7B). Surface water discharge from the ESADA RFI Site is predominantly to the north to the FSDF RFI Site. Discharge from the B009 LF RFI is also to the north, likely joining a north-trending natural drainage that joins the northeastern drainage from the FSDF RFI site. Surface water from the B056 Landfill Site is also to the north, again joining the same northeast-trending drainage from the FSDF RFI Site. Surface water flow patterns for the Group 8 Reporting Area are shown in Figure 2-7B, and are described in more detail in Section 2 of this report and in the RFI Site Reports (Appendices A through D).

Surface water is monitored in three established NPDES monitoring locations in this area of the SSFL (Figure 2-7B), Outfalls 005 and 006 at the FSDF RFI Site, and Outfall 007 south of the B056 Landfill Site.

5.3.4.1 VOCs

Group 8 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, B, C and D).

As shown on Figure 4-1 and described in Section 4, the VOC concentrations are of limited occurrence and extent in the Group 8 Reporting Area. TCE concentrations in soil vapor and soil range up to 12.3 µg/L and 18 µg/kg, respectively, at the former FSDF Lower Pond. In the Southern Investigation Area of FSDF, TCE concentrations in soil vapor were in the range of 1 µg/L, and soil matrix VOCs (e.g., benzene, toluene, methylene chloride) ranged up to approximately 3 µg/kg. As noted in Section 4, TCE was detected at concentrations up to 740,000 µg/kg in soil prior to the removal activities at this site. Extensive soil excavation was conducted at the ponds and in Channels A and B, removing all known VOC impacts (current samples reflect minor impacts to soil at depth from underlying groundwater); therefore, no migration of VOCs is expected down the drainages leading offsite. In addition, VOCs were not detected in channel soil samples collected during the 1995 characterization performed prior to excavation, indicating that surface water transport of these compounds was not significant.

Trichlorofluoromethane was detected at 900 µg/kg in a single historical sample from the Southern Debris Area at the B056 Landfill RFI Site, but this chemical was not detected in a later adjacent sample. Methylene chloride and acetone were detected in several drainage samples, but are considered to be laboratory contaminants. No other VOCs were detected in these samples or any other B056 Landfill samples; therefore, the potential for downstream migration of VOC impacts is considered to be negligible.

VOCs were not detected in surficial soil samples or in soil vapor samples from the ESADA and B009 LF RFI Sites. Low VOC concentrations were detected only at depth within the Building 009 leach field and at the former UT-3 excavation. Therefore, the potential for surface migration of VOCs from these sites is considered to be negligible.

5.3.4.2 SVOCs

Group 8 RFI soil SVOC results are summarized in Section 4.2 and on Figure 4-2. Detailed evaluations of SVOC sampling results (primarily PAHs and phthalates) by chemical use area are provided in each RFI Site Report (Appendices A, B, C, and D).

As shown on Figure 4-2, PAHs (e.g., benzo(a)pyrene) were detected above the RBSLs at two locations within the Group 8 Reporting Area, at the B056 Landfill (CMS Area B056-1). Benzo(a)pyrene was detected up to 960 µg/kg in a split sample (430 µg/kg in the primary sample), and is surrounded by samples in which benzo(a)pyrene was either not detected or below RBSLs. SVOCs (PAHs) were not detected in most landfill samples; where detected, concentrations were below the RBSLs (including concentrations in drainage samples). SVOCs were not detected in a sample collected from the drainage immediately below the northern landfill toe.

SVOCs (PAHs and phthalates) were detected in samples at the ESADA, FSDF, and B009 LF RFI Sites, at concentrations below RBSLs. Based on low concentrations in samples from the ESADA and Building 009 areas, the potential for migration of SVOCs from these sites is considered to be negligible. As described above for VOCs, extensive excavation was conducted at the FSDF site and downstream in Channels A and B. Soil samples that were collected the former FSDF ponds during the pre-excavation characterization sampling in 1995 contained detectable concentrations of SVOCs, but no SVOCs were detected in sediment samples from Channels A or B. Based on these data and the extensive excavation conducted within the ponds and channels, the potential for surface migration of SVOCs from the FSDF RFI Site is considered negligible.

5.3.4.3 TPH

Group 8 RFI soil TPH results are summarized in Section 4.3 and on Figure 4-3. Detailed evaluations of TPH sampling results by chemical use area are provided in each RFI Site Report (Appendices A, B, C, and D).

TPH was detected at five locations at concentrations exceeding RBSLs:

- Lubricant oil range TPH at 23,000 mg/kg and 1.8 mg/kg gasoline range TPH, at two locations within the B056 Landfill (CMS Area B056-1).
- Gasoline range organics ranging from 1.3 to 4 mg/kg at three locations within the B009 LF RFI Site.

The highest concentrations of these compounds were detected at depth and have little potential for surface migration. With few exceptions, other detected hydrocarbons are lubricant oil range, and all are well below RBSLs. TPH was not detected in down-drainage samples north of the B009 leach field, and TPH concentrations in drainage samples close to the B056 Landfill were either nondetectable or well below RBSLs. TPH was not detected in samples approximately 200 feet downstream of the landfill.

Diesel range TPH was detected at the former UT-3 location at concentrations up to 710 mg/kg. Given the sample depth of 15 feet bgs, this TPH occurrence is not subject to surface transport.

Lubricant oil-range TPH was detected in samples from the FSDF and ESADA RFI Sites (maximum 75 mg/kg "high boiling point" petroleum hydrocarbons) at concentrations well below the RBSLs. As described above for VOCs and SVOCs, extensive excavation has been conducted at the FSDF, removing identified TPH impacts from the site. Moreover, during the 1995 characterization (prior to excavation), a maximum of 750 mg/kg lubricant oil range TPH was detected within the FSDF ponds, and no TPH was detected within the channel sediments. Therefore, the potential for surface migration of TPH from these sites is considered to be negligible.

5.3.4.4 PCBs/Terphenyls

Group 8 RFI soil PCB/terphenyl results are summarized in Section 4.4 and on Figure 4-4. Detailed evaluations of PCB/terphenyl sampling results by chemical use area are provided in each RFI Site Report (Appendices A, B, C, and D).

PCBs were detected above RBSLs at four locations in the Group 8 Reporting Area (using baseline TRV-adjusted values):

- Aroclor 1260 at 1,000 µg/kg at the toe of the B056 Landfill (CMS Area B056-1); PCBs were not detected in three drainage sediment samples collected downstream of this location.
- Aroclor 1246 and 1254 up to 246 µg/kg at the location of a former drum on a slope leading to the B056 Excavation (B056-2); PCBs were not detected in seven samples collected from within the excavation downslope of this location.
- Aroclor 1254 at 520 µg/kg in one sample collected from Channel A; PCBs concentrations were either below detection limits or below RBSLs.
- Aroclor 1254 up to 360 µg/kg in the FSDF Disposal Area; the highest nearby detected PCB concentration is Aroclor 1254 at 290 µg/kg (below the RBSL) in the nearby Southern Investigation Area; concentrations of PCBs in all other surrounding and downslope samples are well below the RBSL or nondetectable.

PCBs in all remaining site and down-drainage samples were either nondetectable or below RBSLs. PCBs were detected below RBSLs in samples from Channels B, C, and D, indicating down-drainage migration has occurred. However, as described above, extensive excavation was performed in Channels A and B, limiting future contaminant migration. Low concentrations detected in samples from Channel D (up to 91 µg/kg Aroclor 1254) indicate that limited migration occurred prior to the removal actions.

Terphenyls were not detected at the FSDF RFI Site, but were detected up to 0.955 mg/kg at the B009 LF RFI Site. Given that this detection was at 7.5 feet bgs, this terphenyl occurrence is not subject to surface transport.

5.3.4.5 Dioxins

Group 8 RFI soil dioxin results are summarized in Section 4.5 and on Figure 4-5. Detailed evaluations of dioxin sampling results by chemical use area are provided in each RFI Site Report (Appendices A, B, C, and D).

Dioxins (as 2,3,7,8-TCDD TEQ) were detected in soil above the lowest RBSL at five locations throughout the Group 8 Reporting Area:

- At the Building 100 discharge area (CMS Area B056-3), upstream of the B056 Landfill, up to 16.9 ng/kg. Detections in both upstream and downstream samples are within the background range for dioxin TEQ concentrations. Characterization of dioxins at Building 100 will be performed as part of the Group 5 RFI Report.
- At the FSDF Southern Disposal Area and Southern Investigation Area between 4 and 4.7 ng/kg. Detections in surrounding and down-slope samples are within the background range or below RBSLs.

- At the FSDF Channels A and B up to 6.7 ng/kg; most samples within these drainages are below background or RBSLs.

As described above, extensive excavation occurred at the FSDF to remove source area and down-gradient channel sediments, limiting future migration of dioxins. Background concentrations detected in Channel D indicate limited migration prior to removal actions.

As reported in Section 4.5.5, dioxins have been detected above NPDES permit limits in surface water samples collected at Outfalls 005, 006, and 007. These detections have been considered to be related to naturally-occurring dioxins in ash deposited at the site following regional fires at or very near the SSFL (Boeing, 2005; 2006c; 2007a). Continued evaluation of NPDES exceedances is ongoing, and further evaluation of potential sources for the dioxins detected at the Building 100 Discharge Area will be described in the Group 5 RFI Report.

5.3.4.6 Metals

Group 8 RFI soil metals results are summarized in Section 4.6 and on Figure 4-6. Detailed evaluations of metals sampling results by chemical use area are provided in each RFI Site Report (Appendices A, B, C and D).

Detected metals exceed background and RBSLs at all four Group 8 RFI sites:

- Metals detected above background and RBSLs in the ESADA area include:
  - Aluminum up to 31,000 mg/kg (background 20,000 mg/kg); considered naturally-occurring and related to clayey soils derived from the Santa Susana formation to the south (see Appendix C), concentrations decrease north toward FSDF to within established background range.
  - Sodium up to 732 mg/kg (background 110 mg/kg); related to pipe strength testing and storage of sodium-saturated fluids in the ESADA area, concentrations decrease to the north toward FSDF.
  - Lead up to 27,000 mg/kg (background 34 mg/kg) at the ESADA Pistol Range (CMS Area ESADA-1); concentrations are localized and decrease down-slope to within background range.
- Metals detected above background and RBSLs at FSDF include:
  - Mercury up to 6.1 mg/kg (background 0.09 mg/kg) in the former Drum Debris Area; mercury decreases downstream to within background range.

  - Lead up to 420 mg/kg in Channel B near the FSDF Pistol Range (CMS Area FSDF-3); lead decreases downstream to within background range.
  - Sodium up to 360 mg/kg in the Southern Investigation Area and the drainage to the east, and in Channel B.
  - Aluminum (see above for ESADA area)
- Metals detected above background and RBSLs at B009 LF RFI Site include:
  - Mercury at 0.53 mg/kg and antimony at 9.8 (background 8.7 mg/kg) in the leach field (7 feet bgs); soils at depth not subject to surface transport.
  - Aluminum (see above for ESADA area)
- Metals detected above background and RBSLs at the B056 Landfill include:
  - Cadmium, copper, and selenium within the Southern Debris Area; selenium is the most widespread and elevated metal above background, up to 3.4 mg/kg (background 0.655 mg/kg) in 12 samples.
  - Cadmium, copper, lead, mercury, and selenium within the B056 Landfill; selenium is the most widespread metal above background, up to 5.3 mg/kg in 17 samples.

Samples within drainages downstream of these four sites contain metals that are, with few exceptions, within background ranges. Arsenic was detected above background in five sediment samples collected near a shale outcrop that is present in and near Channel D; three samples collected downstream of these contained no metals exceeding background ranges. Based on these data, the potential for surface migration of metals in site soils/sediment is considered to be negligible.

As reported in Section 4.6.4, several metals have been detected at concentrations above NPDES permit limits in surface water samples from Outfalls 005, 006, and 007. Metals detected in surface water samples above permit limits include mercury, antimony, copper, and lead. Based on the detection of mercury (up to 0.35 mg/kg) in recent soil samples from the FSDF Pistol Range area, site soil concentrations may have contributed to mercury detections in NPDES samples at concentrations above permit limits (CMS Area FSDF-3), although this area has been covered by a plastic tarp since the Fall of 2005 following the Topanga Fire. There is no identified operational soil source within the Group 8 Reporting Area for elevated metals detections in surface water at Outfall 007. At all three outfalls, detections in surface water above NPDES permit limits may be related to naturally-occurring metals in ash deposited at the site following regional fires at or very near the SSFL (Boeing, 2005; 2006c; 2007a). Continued evaluation of NPDES exceedances is ongoing.

5.3.4.7 Perchlorate

Based on historical site operations, perchlorate was analyzed in soil at the FSDF and B056 Landfill sites. Sampling results for these sites include:

- Two non-repeatable detections in samples from discrete groundwater monitoring intervals at the B056 Landfill site; perchlorate was not detected in any other soil or groundwater samples collected at this site.
- South of the former disposal ponds at FSDF, perchlorate was detected up to 2,600 µg/L in a soil leachate sample. It was also detected in one NPDES surface water sample collected at Outfall 006 (4.26 µg/L in 1998); perchlorate has not been detected in any subsequent NPDES samples.

As described above, extensive removal actions have been performed at the FSDF former ponds and within the downstream channels. Perchlorate has not been detected in downstream channel sediments of either the FSDF or the B056 Landfill RFI Sites. As described in Section 4.7.4, perchlorate has been detected only one time (4.26 µg/L) at Outfall 006. Based on these data and the extensive excavation conducted within the ponds and channels, the potential for surface migration from the FSDF RFI Site is considered to be negligible.

5.3.5 Migration from Soil to Groundwater

Group 8 Reporting Area groundwater occurrence and quality are described in Appendix E, which includes an evaluation of potential migration from soil to groundwater for chemicals detected in Group 8 Reporting Area soils. A brief summary is presented below.

VOCs

VOCs, primarily TCE and its breakdown products, were detected in soil and groundwater and, within the Group 8 Reporting Area, are considered related to site activities at the FSDF RFI Site. Based on site history, monitoring well and piezometer sample data, and the detection of VOCs in soil samples from the Group 8 Reporting area, the VOCs detected in groundwater likely resulted from solvent releases, primarily at the former FSDF ponds. VOCs have been detected in both perched NSGW and Chatsworth formation groundwater at this site, likely as a result of VOC transport through soil via downward groundwater flow.

Benzene and toluene detections since 2003 in RD-50 (ESADA) and RD-07 (B056 Landfill) are considered related to the installation of FLUTe groundwater monitoring equipment in these wells.

A surficial media soil source was not identified for other VOCs (including TCE) detected in groundwater at the B009 LF, B056 Landfill, and ESADA RFI Sites. It is likely that VOC impacts at wells PZ-102 and RD-91 (B009 LF), RD-07 (B056 Landfill), and RD-50 (ESADA) resulted from incidental spills or releases from which no mass remains in the surficial media at or near these sites.

SVOCs

The potential for significant migration of SVOCs from soil to groundwater is considered minimal because only very low concentrations of PAHs (naphthalene) have been detected in groundwater (up to 0.09 µg/L in two locations). Moreover, PAHs are characterized by a high affinity for soil particles and hence low mobility to groundwater. Naphthalene is a naturally-occurring chemical; however, naphthalene in groundwater may be related to naphthalene detected in B009 LF soil. Phthalates are common laboratory contaminants and are not considered site-related. Additional characterization of PAHs in groundwater is being performed at the FSDF RFI Site.

PCBs

The potential of significant migration of PCBs from soil to groundwater is also considered minimal, since PCBs have not been detected at other areas where soil concentrations were elevated and recharge conditions present (MWH, 2006b). Similar to PAHs and dioxins, PCBs are characterized by low mobility to groundwater. However, as noted in Appendix D (Table D.3-2A), further characterization of PCBs in groundwater is being performed at the FSDF RFI Site where the potential for migration is considered highest. Additional characterization is also being performed for PCBs at the B056 Landfill RFI Site.

TPH

Petroleum hydrocarbons in groundwater were detected at FSDF and are considered site-related based on soil data, recharge conditions, and historical operations. Additional

groundwater sampling for TPH will be conducted to confirm potential impacts in the immediate area of the former ponds (Disposal Area).

At the B056 Landfill RFI Site, the potential for significant migration of TPH is considered low based on the type of hydrocarbon fraction detected in soil. Lubricant oil range hydrocarbons are large organic compounds that have low mobility, similar to PAHs, PCBs and dioxins. However, further characterization of groundwater TPH is being performed to confirm potential impacts.

Gasoline range hydrocarbons were detected in the ESADA area, at RD-50. The highest TPH detection in soil at the ESADA RFI Site was 11 mg/kg (lubricant oil range). As discussed in Section 4, TPH is considered the result of incidental spills or releases from which no mass remains in the surficial media.

Dioxins

Dioxins (as 2,3,7,8-TCDD TEQ) were detected at above background ranges at FSDF (up to 6.7 ng/kg in Channel B) and upstream of the B056 Landfill (up to 16.9 ng/kg at Building 100, CMS Area B056-3). A representative sample was collected from RS-54 at the former FSDF lower pond since historical dioxin concentrations are likely highest at this location and recharge conditions most conducive to potential dioxin impacts. Dioxins were not detected in this sample; therefore, the potential for dioxin migration to groundwater is considered negligible in Group 8. Additional characterization of dioxins in groundwater is being performed near the Building 100 discharge area.

Metals

A number of metals have been detected in NSGW and Chatsworth formation groundwater at concentrations above the GWCC, and above background ranges in site soil or historical (removed) soil. As described in detail in Appendix E, metals in groundwater may be naturally-occurring, and a weight of evidence approach has been taken to determine if metals detections above GWCCs are related to site operations. In this evaluation, consideration is given to frequency and date of the groundwater detection, presence and location of soil data above background levels, historical site operations, and hydrogeologic relationships. Within the Group 8 Reporting Area, eight metals detected in groundwater are considered potentially site related in Group 8, and are summarized as follows:

- In FSDF NSGW, cadmium, cobalt, copper, manganese, molybdenum, nickel, and selenium are considered potentially site related based on concentrations up to 50

times the GWCC. Other metals were either below the GWCC or exceeded the GWCC in early samples but were followed by numerous results below GWCCs. In FSDF CFOU groundwater manganese, molybdenum, and selenium are considered potentially site related based on concentrations up to four times the GWCC. Other metals were generally either below the GWCC or exceeded the GWCC in early samples but followed by numerous results below the GWCC.

- At B056 Landfill RFI Site, copper and selenium are considered potentially site related based on CFOU groundwater concentrations over two times the GWCC and soil concentrations above background ranges.

- At ESADA, lead was detected above the GWCC in groundwater and is elevated in soil (up to 27,000 mg/kg); therefore, this metal is considered potentially site-related.

- No metals are considered potentially site related at the B009 LF RFI Site, based on groundwater and soil data.

Perchlorate

As discussed in Section 4, perchlorate has been routinely detected above regulatory levels in both perched NSGW and CFOU groundwater at the FSDF RFI Site. These detections in groundwater are considered to be related to former use or disposal activities at the FSDF RFI Site and are consistent with soil detections in the area. Detections of perchlorate at the B056 Landfill RFI Site during one sampling event, but not detected in over 25 other samples collected from groundwater wells at the site nor detected in over 50 soil samples. The source of these non-repeatable detections is unknown.

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 F, Attachment F-7.

5.3.7 Dust Generation

SVOCs, PCBs, dioxins, and metals in soil were modeled in airborne dust generated from soil within the Group 8 Reporting Area. The exposure point concentrations for these chemical classes in dust are presented in the risk assessment spreadsheets that are provided in Appendix F, Attachment F-7.

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6.0 RISK ASSESSMENT SUMMARY

This section presents and integrates the risk assessment findings for the Group 8 Reporting Area. Human health and ecological risks for the four Group 8 RFI sites are presented in Appendix F. Summaries of the site-specific risk findings are presented in Section 4 in each of the RFI Site Reports (Appendices A, B, C, and D). The details of how the risk assessments have been performed are presented in the SRAM Work Plan, Revision 2 (MWH, 2005b), and in Appendix F 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 risks

The receptors included in the human health risk assessment (HRA) are the current worker and potential trespasser, and the future resident, worker, 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 F), 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 arithmetic mean of the data and the RME is defined as the 95% 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 noncancer Hazard Indices and cancer risks are presented as totals for all chemicals evaluated in the risk assessment.

The ERA was designed to assess exposures and potential risks to freshwater aquatic biota communities, 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 the deer mouse, the thrush, the hawk, the bobcat, and

the mule deer for terrestrial areas. Plants and soil invertebrates were also evaluated. A generalized CSM for ecological receptors is shown on Figure 6-2.

Biological conditions at the four Group 8 RFI sites are generally as they existed prior to the 2005 Topanga Fire. The majority of the former operational areas of the RFI sites are comprised of ruderal habitat, non-native grassland, coast live oak woodland, and rock outcrops. Developed land within the Group 8 Reporting Area exists only at the B009 LF RFI Site, although some erosion control ditches and roads are present throughout the area. Other vegetation types include chaparral and native scrub. Coast live oak woodland characterizes most of the northern drainages, leading to a riparian habitat in the lower reach of FSDF Channel D on BBI property. Sensitive species present at and near the RFI sites are mule deer, San Diego black tailed jackrabbit, great blue heron, southern California black walnut, Santa Susana tarplant, coast live oak, Braunton's milk vetch, and Plummer's mariposa lily.

During the September/October 2005 Topanga Fire, no vegetation within the B009 LF and ESADA RFI Site boundaries was burned (MWH, 2006b). However, much of the surrounding areas and the northern and eastern portions of the FSDF and B056 Landfill RFI Sites were burned. It is expected that the plant community will continue to grow and transition until a more stable plant community is established.

To promote 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 total Hazard Indices (HI) which sum the Hazard Quotients for each chemical evaluated in the ecological risk assessment.

Receptors with large home ranges (e.g., hawk, bobcat, and mule deer) may be exposed to RFI sites within and between Reporting Areas. The estimated risks to the hawk, the bobcat, and the 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 specifies 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 four Group 8 RFI sites separately. The reader may also want to refer to Figure 5-1, which is a diagrammatic representation of an illustrated CSM for SSFL, including the contaminant sources, direct and indirect exposure

pathways and receptors. Site-specific human health and ecological CSMs are presented in Attachments F1, F2, F3, and F4 of Appendix F.

In the following sections, estimated potential risks for each of the four Group 8 RFI sites are presented. Table 6-1 and Table 6-4 present information regarding chemicals evaluated in the risk assessment, Table 6-2 and Table 6-5 present human and ecological risk estimates, respectively, and Table 6-3 and Table 6-6 present uncertainties in the Group 8 RFI risk evaluation.

6.1 ACCEPTABLE RISKS

Acceptable risks for humans are summarized in the following statements. For comparison purposes, theoretical excess upper bound incremental lifetime cancer risks (ILCRs) of 10^{-6} or less associated with multi-media exposures are considered acceptable. The 10^{-6} risk level is the generally-accepted point of departure for selection of remedial alternatives. Potential risk estimates that are between 10^{-6} and 10^{-4} require risk management decisions. Risk estimates greater than 10^{-4} usually require remediation to reduce potential exposures. Likewise, non-cancer Hazard Index (HI) values less than 1.0 are considered acceptable, and HI values greater than 1.0 usually require remediation to reduce potential exposures (DTSC, 2006; USEPA, 1993). Also, 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:

- A number of metals (e.g., antimony, arsenic, copper, lead, and mercury) were statistically consistent with background concentrations, but were included as soil chemicals of potential concern (COPCs) because maximum detected concentrations were substantially above the maximum detected background concentration. (conservatism)

- Several metals (e.g., aluminum and vanadium at ESADA and aluminum and barium at B009) are present at concentrations considered to be naturally-occurring in soil, but since they did not pass the Wilcoxon Rank Sum test for comparison to background, they were included in the risk assessments. (conservatism)

- Aluminum exposure risks for ecological receptors at B009 LF and ESADA are based on toxicity values derived from soluble aluminum. However, the soluble and toxic forms of aluminum are only present in soil under soil pH values of less than 5.5 (USEPA, 2003), and pH ranged from 6.5 to 8.4 for the soils at B009 LF and from 7.4 to 9.6 for the soils at ESADA. Therefore, while aluminum risks are calculated and presented in the detailed risk tables (conservatism), aluminum risks were not included in the total risk estimates for ecological receptors. (uncertainty)

- Arsenic at FSDF is present at concentrations that are considered to be naturally–occurring in soil, but since the maximum detected site concentration is significantly greater than the maximum site background concentration, it was included in the risk assessments for FSDF. (conservatism)

- Where TPH-gasoline was detected, BTEX was assumed to be present and was addressed appropriately in the risk assessment. (conservatism)

- Extrapolation of TPH concentrations to individual PAHs is likely conservative when PAHs are not directly detected in soil samples. (conservatism)

- Soil vapor concentrations of benzene were assumed to be half the detection limit since it was not detected in soil vapor but assumed to be present. (conservatism)

- Terphenyls were detected in one sample at the B009 site (<1 mg/kg), but since toxicity criteria are not available, risk values were not calculated. (uncertainty)

- Bedrock sample results from the FSDF excavation were not included in the quantitative risk assessment. Chemicals were either nondetectable or were detected at concentrations that were lower than the soil concentrations evaluated in the risk assessment. (uncertainty)

- Due to the configuration of the B056 Excavation (65 feet deep, vertical bedrock walls), there are assumed to be no complete human/ecological exposure pathways. Therefore, neither sediment nor surface water data from the bottom of the excavation

were included in the HRA/ERA, and no potential exposures were evaluated. (uncertainty)

- 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 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)

- Assessment assumes that all carcinogens do not have a threshold below which carcinogenic responses occur. (conservatism)

- Dermal and inhalation exposure pathways for surface-dwelling animals were not included in this risk assessment. (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 human health risk assessment. 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)

- The USEPA uses the linearized multistage (LMS) mathematical model to extrapolate animal toxicological data for carcinogens in the human health risk assessment. 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)

- Worker risks include indoor air exposures in a hypothetical building built over maximum detected soil or groundwater concentrations. No current workers would be expected to be exposed in this manner because these buildings do not currently exist in or near the area of maximum detected concentrations. These theoretical future risks are only relevant if such a building could be built and then occupied for 20 years by a worker. (conservatism)

- The evaluation of metals concentrations in groundwater was based on data for both filtered and unfiltered samples. Additional unfiltered groundwater samples are being collected and analyzed per DTSC direction, and these new data might affect this evaluation. (uncertainty)

- Some data collected following the 2005 Topanga Fire contained potentially elevated concentrations of metals and dioxins 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, commercial, 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 B009 LF RFI Site Risk Estimates

Reasonable maximum exposure (RME) ILCR estimates (for all terrestrial surficial media plus indirect exposure to VOCs in groundwater) range from 3×10^{-9} (for child recreator) to 4×10^{-7} (for child resident). RME non-cancer HIs range from 0.001 (for adult recreator) to 0.1 (for child resident). These estimated risks are below the acceptable risk range typically used for CMS decisions.

Ecological risks have also been estimated for the B009 LF RFI Site. The terrestrial receptor HIs range from 0.01 for the bobcat to 2 for the mule deer. The chemical with the greatest contribution to ecological risks is cadmium.

6.3.2 B056 Landfill RFI Site Risk Estimates

RME ILCR estimates (for all terrestrial surficial media plus indirect exposure to VOCs in groundwater) range from 7 x 10^{-7} (for child recreator) to 2 x 10^{-6} (for child resident). RME non-cancer HIs range from 0.02 (for adult recreator) to 0.2 (for child resident). The estimated ILCR is above the low end of the acceptable risk range typically used for CMS decisions. The risk estimate was not attributable to any single chemical, but contributors included Aroclor 1254 and PAHs.

Estimated blood lead levels associated with soil exposures were less than 10 micrograms per deciliter (µg/dl) for all receptors.

Ecological risks have also been estimated for the B056 Landfill RFI Site. The terrestrial receptor HIs range from 4 for the thrush to 100 for the hawk. The chemicals with the greatest contributions to ecological risks are cadmium, molybdenum, selenium, and lead.

6.3.3 ESADA RFI Site Risk Estimates

RME ILCR estimates (for all terrestrial surficial media plus indirect exposure to VOCs in groundwater) range from 2 x 10^{-5} (for future child recreator) to 1 x 10^{-3} (for future child resident). RME non-cancer HIs range from 0.3 (for future child recreator) to 20 (for future child resident). These estimated risks are above the acceptable risk range typically used for CMS decisions. The chemicals with the greatest contribution to these potential risks were antimony and arsenic.

Blood lead levels were greater than 10 (µg/dl) for all receptors.

Ecological risks have also been estimated for the ESADA RFI Site. The terrestrial receptor HIs range from greater than 100 for the bobcat to greater than 1,000 for the deer mouse, thrush, hawk, and mule deer. The chemicals with the greatest contribution to ecological risks were antimony, arsenic, lead, and selenium.

6.3.4 FSDF RFI Site Risk Estimates

Aluminum was detected above its maximum background comparison level in one sample in the Southern Investigation Area (Chemical Use Area 3). This result was included in the risk

assessment performed for the ESADA RFI Site (Appendix C) since the sample did not reflect the majority of the FSDF site soil aluminum concentrations but was within 35 feet of ESADA area samples that contained similar aluminum concentrations.

RME ILCR estimates (for all terrestrial surficial media plus indirect exposure to VOCs in groundwater) range from 2 x 10^{-7} (for future adult recreator) to 3 x 10^{-5} (for future adult resident). RME non-cancer HIs range from 0.01 (for future adult recreator) to 4 (for child resident). These estimated risks are above the acceptable risk range typically used for CMS decisions. The chemicals with the greatest contribution to these potential risks were 1,1-DCA, TCE, benzene, PCE, and 1,1-DCE.

Blood lead levels were less than 10 (µg/dl) for all receptors.

Ecological risks have also been estimated for the FSDF RFI Site. The terrestrial receptor HIs range from 4 for the bobcat to greater than 1,000 for the thrush. The chemicals with the greatest contribution to ecological risks were lead and perchlorate.

6.4 CHEMICAL RISK-DRIVERS

Several chemicals significantly contribute to the estimated human risks, both ILCR and non-cancer HI, and ecological risks within the Group 8 Reporting Area. The identified chemical risk-drivers are used as the basis for the CMS site action recommendations. Since the estimated risks are different for the various receptors (residential, commercial, recreational and ecological) and for the various environmental matrices (soil/sediment versus groundwater – indirect exposures), the chemical risk drivers for the Group 8 Reporting Area are summarized below using these divisions.

Residential

- Soil/sediment risk drivers include VOCs (TCE, benzene, PCE), and antimony, lead, and arsenic.
- Groundwater risk drivers include VOCs (1,1-DCA, TCE, and 1,1-DCE).

Commercial/Industrial

- Soil/sediment risk drivers include antimony, lead, and arsenic.
- Groundwater risk drivers include VOCs (1,1-DCA and TCE).

Recreational

- Soil/sediment risk drivers include lead and arsenic.

Ecological

- Soil/sediment risk drivers include antimony, arsenic, cadmium, lead, molybdenum, selenium, and perchlorate.

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7.0 GROUP 8 RFI REPORT SUMMARY AND SITE ACTION RECOMMENDATIONS

This section presents a summary of RFI reporting requirements as they apply to the Group 8 RFI Report. Section 7.1 describes how this report meets the 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 8 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 8 RFI Report accomplishes these requirements by:

1) 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 four RFI sites in the Group 8 RFI Reporting Area. Section 4 summarizes the overall characterization of 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 risk-based screening levels and risk assessment findings. The RFI site characterization details are provided in Appendices A, B, C and D.

2) 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 E and other potential transport pathways in Appendix F.
3) Identifying potential receptors and estimating potential risks at each RFI site in Appendix E. Estimated risks are also summarized by RFI site in Appendices A, B, C, and D, and presented for the entire reporting area in Section 6.
4) Identifying areas requiring further work by RFI site in Appendices A, B, C, and D 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 8 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, 2004). Additional site-specific application of general procedures, recent laboratory and validation reports, and data quality assessments are provided for each Group 8 RFI site in Appendices A, B, C, and D.

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 RCRA requirements (DTSC, 1995), a CMS work plan that describes actions to be conducted during the CMS will be prepared for agency review and approval. During the CMS, site areas recommended for further consideration undergo additional 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.

In summary, site action recommendations included in the Group 8 RFI Reports identify areas for:

- Further evaluation in the CMS (CMS Areas),
- NFA, and
- 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 contaminants, based on chemical data and transport and fate evaluation. Risk assessments evaluate 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 8 Reporting Area. Samples were also collected in areas where the existing analytical data were considered to be inadequate for site characterization and/or risk assessment (including downgradient 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.

CMS or NFA Area recommendations for areas sampled within the Group 8 Reporting Area are based on an integrated evaluation of characterization and risk assessment results. 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. 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 Site Action Evaluation Process

CMS or NFA site action recommendations are based on a 4-step process, described below, that evaluates risk assessment results 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 x 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. 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 x 10^{-6} (cancer risks) or HI values are greater than 1 (noncancer 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 receptor. Risk drivers are detected chemicals with associated risks greater than 1 x 10^{-6}. Risk contributors are those chemicals that contribute to total risk but where individual chemical-associated risk is less than 1 x 10^{-6} or HI values are less than 1. Individual chemical contribution to total risk was conservatively considered at risk levels of approximately 2 x 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 during the CMS. Areas recommended for further evaluation during the CMS are comprehensive of all receptors and land use scenarios. 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, 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 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 receptor. CMS Areas are also depicted graphically to illustrate location and approximate aerial extent. Areas shown are intended to be comprehensive of all receptors and land use scenarios. 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.

It is worth noting that extent of the CMS Areas depicted graphically are conservative and likely over-estimated. As described in Step 3 above, CMS Areas are based on identifying chemical concentrations that are above their respective RBSL. This process results in CMS Areas that are larger than would need to be addressed during cleanup to achieve acceptable risks. This is because individual soil sample results rather than area-average concentrations are compared to RBSLs as 'bright-line' criteria. 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 confirm and/or 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 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 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 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 areas recommended for further evaluation in the Group RFI Reports can be confidently carried forward into the CMS because these two SSFL-wide RFI evaluations 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 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, 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), and
- Concentration gradients.

Each criterion is considered important, and a weight-of-evidence evaluation is used to make a recommendation for 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 8 REPORTING AREA SITES

Based on the evaluations presented in this document, data collected for the Group 8 Reporting Area are considered sufficiently complete to make site action recommendations as described above, and support evaluations to be performed during the CMS. Although additional data may be necessary to support some CMS evaluations, those data can be collected 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.

Group 8 site action recommendations 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 are also identified for four CMS Areas as noted. CMS Areas shown on Figure 7-1 are approximate and represent evaluations inclusive of all receptors and land use. A summary of the Group 8 CMS Area recommendations is presented in Table 7-2. As noted above, recommendations reported in this document will be reviewed upon completion of the site-wide groundwater report and large-home range receptor evaluations, and updates to this report will be prepared as needed.

Group 8 areas recommended for further evaluation in the CMS, including associated chemical drivers/contributors and areas identified for surficial soil source stabilization measures, are summarized below. Portions of Group 8 outside of these CMS Areas are recommended for NFA based on characterization and historical record review findings.

Recommendations for further evaluation of aluminum concentrations at the B009 LF and ESADA RFI Sites during the CMS were not made because these concentrations are considered naturally-occurring. In addition, as described in Section 6, estimated aluminum exposure risks for ecological receptors are based on toxicity values derived from soluble aluminum present in soil with pH values of less than 5.5 (USEPA, 2003). Group 8 site soil

pH measurements ranged from 6.5 to 9.6, indicating limited (if any) ecological exposure to the soluble, toxic form of aluminum. The limited occurrence of other metals above background levels (barium, vanadium) was considered an insignificant contributor of potential risks since these results were detected in only a very few samples or were only slightly greater than the comparison background value.

In the drainage channel north of the FSDF and B056 Landfill RFI Sites, a recommendation for further evaluation of arsenic concentrations during the CMS was not made because these concentrations are considered naturally-occurring related to shale bedrock outcrops. Also, a recommendation for further evaluation of VOCs in the soil backfill in the former pond area during the CMS was not made since these impacts are the result of transport of contaminants from shallow groundwater in this area. CMS recommendations for groundwater, including potential actions in this area, will be made after groundwater characterization activities are completed and reported in the Site-Wide Groundwater RFI Report.

A total of seven CMS Areas were identified for the Group 8 RFI Sites, including:

- **B056-1:** Building 056 Landfill and Southern Debris Area. Chemical risk drivers and contributors are cadmium, selenium, lead, molybendum, PAHs, and Aroclor 1254. This area also represents the extent of landfill materials at the site.

- **B056-2:** B056 Excavation Debris Area. Chemical risk drivers and contributors are Aroclors 1248, 1254, and 1260. Given this area's proximity to surface water in the B056 Excavation, it is recommended for stabilization measures.

- **B056-3:** B100 Discharge Area. Chemical risk drivers are dioxins. Given this area's proximity to the drainage west of the B056 Landfill, it is recommended for stabilization measures.

- **ESADA-1:** ESADA Pistol Range. Chemical risk drivers and contributors are antimony, arsenic, lead, and selenium.

- **FSDF-1:** South of Former Disposal Area. Chemical risk driver is perchlorate.

- **FSDF-2**: Former Drum Debris Area. Chemical risk driver is mercury. Given this area's location in the drainage west of FSDF, it is recommended for stabilization measures.

- **FSDF-3**: FSDF Pistol Range. Chemical risk driver is lead. Continued covering of this area by a plastic tarp is recommended as a stabilization measure.

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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 upperbound 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

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), perchloroethene (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 polycyclic 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 3-1
Group 8 Reporting Area 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	X [b]	X [b]	X								
Oils/PCBs	Hydraulic and lubricant oil storage tanks, sumps/pits, waste oils, and transformers. Includes terphenyl use		X	X [c]	X[c]	X						
Metals/Inorganic Compounds (excluding debris areas)	Corrosive activities/areas, sumps/pits, and storage tanks, including fluoride use areas					X					X	X
Perchlorate	Small rocket engine or system testing areas, igniter preparation areas, and surface impoundments/ponds									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						

Table 3-1
Group 8 Reporting Area Descriptions of Chemical Use
And Typical Target Analytical Suites for RFI Soil Characterization

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 3-11 for color-coded identification of chemical use areas in Group 8 RFI sites. Table 3-2 contains a list of individual known or potential chemical use areas in Group 8 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) Terphenyls were analyzed using a modified 8015M method. Data are reported and described with PCBs since terphenyls were used in a similar manner as PCBs.
d) 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).
e) Dioxins/SVOCs were analyzed if visible burned materials were present.
f) Asbestos was included if potentially asbestos-containing materials were observed.
g) Analysis of PCBs, terphenyls, and/or fluoride was added if related to associated site or building use.

Acronyms:

AOC = Area of Concern
CFOU = Chatsworth formation
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

Table 3-2
Group 8 Reporting Area Chemical Use Investigation Areas
Page 1 of 2

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)								
			Solvents	Petroleum	Oils / PCBs	Metals/ Inorganics (excluding debris areas)	Landfill	Perchlorate	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	VOCs, SVOCs, TPH, Metals, pH (2)	Perchlorate	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
Building 009 Leach Field (B009 LF) RFI Site (Area IV AOC) – Appendix A											
1a	Building 009 (B009) Leach Field	Sanitary Wastes (3)								X	
1b	B009 Septic Tank	Sanitary Wastes (3)									X
2a	B009	Solvents, Metals, Petroleum Fuels, Kerosene, Terphenyls	X	X	X	X					
2b	SGR Liquid Waste Hold-Up Tank & Pit	B009 Liquid Waste (3)									X
2c	OMR Waste Hold-Up Tank & Pit	B009 Liquid Waste (3)									X
3	UT-3	Diesel Fuel		X							
4a	B009 Transformer Pad (Substation 709)	PCB-containing oils			X						
4b	Transformer Pole X-32	PCB-containing oils			X						
5	Solar Concentrator Facility	Possible solvents, weak acids									X
Building 056 Landfill RFI (B056 Landfill) Site (SWMU 7.1) - Appendix B											
1	Building 056 Landfill	Landfill and drum storage (alcohols, sodium, oil/grease)	X		X	X	X				(4)
2a	Southern Debris Area	Landfill and drum storage (alcohols, sodium, oil/grease)	X		X	X	X				(4)
2b	Roadside Debris Area	Scrap metal, concrete, asphalt							X		
3a	Building 056 Excavation	None documented									X
3b	Building 056 Excavation Debris Area	Drum							X		
Empire State Atomic Development Authority (ESADA) RFI Site (SWMU 7.9) - Appendix C											
1	ESADA Former Storage Yard	Glycol ethers, denatured alcohols	X (5)			X					(4)
2	ESADA Sodium Test Area	Metals				X					
3	Former Process Development Unit (PDU) Aboveground Storage Tank (AST) Area	Possible green liquor (containing organic compounds, metals, ash)									X
4	ESADA Pistol Range	Lead shot				X					
5	Transformer Area	PCB-containing oils			X						

Table 3-2
Group 8 Reporting Area Chemical Use Investigation Areas
Page 2 of 2

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used/Stored	Chemical Use Area Types and Typical Target Analytical Suites (1)								
			Solvents	Petroleum	Oils / PCBs	Metals/ Inorganics (excluding debris areas)	Landfill	Perchlorate	Debris	Leach Field	Potential (Screening For Potential Chemical Use/Impacts)
			VOCs	TPH, VOCs, and/or SVOCs	SVOCs, TPH, PCBs, Metals (2)	Metals, Inorganics	VOCs, SVOCs, TPH, Metals, pH (2)	Perchlorate	SVOCs, TPH, Metals (2)	VOCs, SVOCs, TPH, Metals, pH (2)	VOCs, SVOCs, TPH, Metals, pH (2)
Former Sodium Disposal Facility (FSDF) RFI Site (SWMU 7.3 [Building 886]) - Appendix D											
1a	Former Lower Pond	Metals, Solvents, Kerosene, PCB/Terphenyls	X	X	X	X		X	X		
1b	Former Upper Pond	Metals, Solvents, Kerosene, PCB/Terphenyls	X	X	X	X		X	X		
1c	Western Debris Area	Drums, scrap metal	(6)	(6)	(6)	(6)		(6)	X		
1d	Former Concrete Pool	Metals				X					
2	Former Steam Lance	Kerosene		X							
3	Southern Investigation Area	Not documented (possible solvents, petroleum fuels, perchlorate, metals)									X
4	Former Drum Debris Area	Drums, scrap metal							X		
5	FSDF Pistol Range	Lead shot				X					

General Notes:
Potential chemical use areas are shown on Figure 3-2 and defined by number 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) Building 009 operations included use of kerosene, terphenyls, aluminum, sodium, and small amounts of solvents, which may have been discharged in liquid waste into the chemical use area.
(4) Drums with unknown contents were stored onsite, so screening of the area was performed.
(5) Dowanol products (glycol ethers), butyl cellosolve, and denatured ethanol were stored in drums at this location.
(6) Included drums and scrap metal, but other FSDF wastes considered possible.

Acronyms:

AST – aboveground storage tank
B009 – Building 009
B056 – Building 056
ESADA – Empire State Atomic Development Authority
FSDF – Former Sodium Disposal Facility
OMR – organic moderated reactor
PCB – polychlorinated biphenyls
PDU – Process Development Unit
SGR – sodium graphite reactor
SVOCs – semivolatile organic compounds
TPH – Total petroleum hydrocarbons
UST – underground storage tank
VOCs – Volatile Organic Compounds

Table 6-1 (1 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 8 Reporting Area

Chemical	Soil	Soil Vapor	Groundwater
Inorganic Compounds			
Aluminum	X		
Antimony	X		
Arsenic	X		
Barium	X		
Beryllium	X		
Boron	X		
Cadmium	X		X
Chromium	X		
Hexavalent chromium	X		
Cobalt	X		X
Copper	X		X
Lead	X		
Mercury	X		
Molybdenum	X		X
Nickel			X
Perchlorate	X		X
Selenium	X		
Silver	X		
Thallium	X		
Vanadium	X		
Zirconium	X		
VOCs			
1,1,1,2-Tetrachloroethane			X
1,1,1-Trichloroethane			X
1,1,2-Trichloro-1,2,2-trifluoroethane			X
1,1-Dichloroethane			X
1,1-Dichloroethene		X	X
1,2-Dichloroethane			X
2-Butanone			X
Acetone	X	X	X
Benzene	X	X	X
Chlorobenzene	X	X	X
Chloromethane			X
cis-1,2-Dichloroethene		X	X
Ethylbenzene	X	X	
m,p-Xylene	X	X	
Methylene chloride	X	X	X
o-Xylene	X	X	X
Tetrachloroethene		X	X
Toluene	X	X	X

Table 6-1 (2 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 8 Reporting Area

Chemical	Soil	Soil Vapor	Groundwater
trans-1,2-Dichloroethene		X	X
Trichloroethene	X	X	X
SVOCs			
2-Methylnaphthalene	X		
Acenaphthene	X		
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		
Chrysene	X		
Dibenz(a,h)anthracene	X		
Diethylphthalate	X		
Di-n-butylphthalate	X		
Fluoranthene	X		
Fluorene	X		
Indeno(1,2,3-cd)pyrene	X		
m-Terphenyl	X		
Naphthalene	X		
Perylene	X		
Phenanthrene	X		
p-Terphenyl	X		
Pyrene	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		
Dioxins			
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		

Table 6-1 (3 of 3)

Summary of Chemicals of Potential Concern for Human Health
Group 8 Reporting Area

Chemical	Soil	Soil Vapor	Groundwater
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		
1,2,3,4,6,7,8-HpCDF	X		
1,2,3,4,7,8,9-HpCDF	X		
OCDF	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 dibenzofuran
PCBs - polychlorinated biphenyls
COPC - chemical of potential concern
bgs - below ground surface

Table 6-2 (1 of 1)

Human Health Risk Estimates[1]
Group 8 Reporting Area

Receptor	B009 LF				B056 Landfill				ESADA				FSDF			
	HI Range	CD[2]	Risk Range	CD[2]	HI Range	CD[2]	Risk Range	CD[2]	HI Range	CD[2]	Risk Range	CD[2]	HI Range	CD[2]	Risk Range	CD[2]
Adult Worker	0.003 - 0.01		2E-08 - 2E-07		0.005 - 0.04		5E-08 - 1E-06		0.1 - 3	a,b	2E-05 - 9E-04	c	0.1 - 0.4		1E-06 - 8E-06	d,e
Future Adult Recreator	<0.001 - 0.001		6E-11 - 4E-09		<0.001 - 0.02		5E-09 - 8E-07		0.02 - 0.5	b	2E-06 - 2E-04	c	<0.001 - 0.01		5E-09 - 2E-07	
Future Child Recreator	0.004 - 0.004		5E-10 - 3E-09		0.01 - 0.06		7E-08 - 7E-07		0.3 - 0.3	b	2E-05 - 2E-05	c	0.007 - 0.03		5E-08 - 3E-07	
Future Adult Resident	0.005 - 0.01		5E-08 - 4E-07		0.008 - 0.03		6E-08 - 1E-06		0.2 - 2	a,b	2E-05 - 6E-04	c	0.5 - 1	h	3E-06 - 3E-05	d,e,f,g
Future Child Resident	0.04 - 0.1		2E-07 - 4E-07		0.07 - 0.2		4E-07 - 2E-06		2 - 20	a,b,c	2E-04 - 1E-03	c	3 - 4	h	1E-05 - 2E-05	d,e,f,g

Notes:

1. Risk estimates shown are a sum of all exposure pathways per media; the range reported is for the central tendency and reasonable maximum exposures, respectively.
2. Chemical risk drivers are those COPCs detected onsite with an HI > 1, risk > $1x10^{-6}$, or blood lead concentration > 10 µg/dl. Only major risk contributors listed if (subjectively) cumulative HI >> 1 or cancer risk >> $1x10^{-6}$.
3. Groundwater media risk estimates are for indirect exposure only and assume no domestic use of groundwater.
4. Total risk estimates do not include aluminum and barium for B009 Landfill, aluminum and vanadium for ESADA, and arsenic for FSDF because they are considered to be naturally-occurring. Aluminum, barium, and vanadium are not significant risk contributors and at naturally-occurring levels. Arsenic is above its background comparison levels in one location adjacent to, and slightly downstream of, a shale outcrop.

a = Antimony
b = Lead
c = Arsenic
d =1,1-Dichloroethane
e = Trichloroethene
f = Benzene
g = Tetrachloroethene
h = 1,1 -Dichloroethene
CD = Chemical risk driver
COPC = Chemical of potential concern
HI = Hazard Index
NA = Not applicable
LF = leach field

Table 6-3 (1 of 2)

Human Health Risk Assessment Uncertainty Analysis

Group 8 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
COPC Selection		
A number of inorganics (e.g., antimony, arsenic, copper, lead, and mercury) 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.	Moderate	Conservative
Several inorganics (e.g., aluminum and vanadium at the ESADA RFI Site, and aluminum and barium at the B009 LF RFI Site) are present at concentrations that are considered to be naturally-occurring yet because they did not pass the Wilcoxon Rank Sum test, they were included in the risk assessment.	High	Conservative
Arsenic is present at the FSDF RFI Site at concentrations that are considered to be naturally-occurring yet because it was present at concentrations significantly greater than background, it was included in the risk assessment.	High	Conservative
Chromium was selected as a soil COPC at the ESADA RFI Site; however, hexavalent chromium data were not available. The lack of hexavalent chromium data is not expected to affect the HRA results. Hexavalent chromium typically makes up only a small percentage of the total chromium detected in soil, and although chromium was demonstrated to be different from background concentrations in soil through the Wilcoxon Rank Sum test, the maximum detected chromium concentration was less than the maximum background concentration.	Low	Not Conservative
Bedrock sample results from the FSDF RFI Site excavation were not included in the quantitative risk assessment. The bedrock samples were analyzed for mercury, PCBs, perchlorate, and dioxins. Sample results were either non-detect or lower than values used to estimate risks.	Low	Not Conservative
EPC Calculations		
The maximum detected concentration of each COPC detected in groundwater was used as the EPC.	Moderate	Conservative
The mean is greater than the RME EPC for some chemicals when there are elevated DL for ND, therefore the maximum detected concentration was used as the CTE EPC.	Moderate	Conservative
The 95% UCL concentration of some chemicals is greater than the maximum concentration, therefore the maximum was used as the EPC. This is considered to be a likely overestimation of the representative EPC because samples were collected in areas with the highest likelihood to detect the highest concentrations at the site.	Moderate	Conservative
The extrapolation of soil TPH concentrations to individual petroleum constituent (i.e., BTEX or PAHs), extrapolations were conducted on a dataset containing elevated detection limits. Moreover, the TPH extrapolation methodology overpredicts VOC and SVOC concentrations when analyte-specific analysis were not performed or detection limits were elevated. Therefore, the estimated EPCs are considered conservative.	Moderate	Conservative
Risks from soil matrix COPCs (benzene) are associated vapor concentrations estimated to be 1/2 the soil vapor DL though the chemical was not detected in soil vapor.	Low	Conservative
Soil vapor exposure point concentrations for some VOCs (e.g., chlorobenzene, methylene chloride, and toluene) are estimated using soil to soil vapor partitioning extrapolations introducing some degree of uncertainty.	Moderate	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.	Moderate	Conservative
Sample 414502, a duplicate of 413580, was included in the risk assessment dataset for the FSDF RFI Site. The sample only consisted of dioxins. The impact is low because there were a high number of dioxin samples and none of the dioxin congeners were risk drivers.	Low	Uncertain

Table 6-3 (2 of 2)

Uncertainty	Magnitude of Impact	Direction of Impact
Exposure		
Worker risks include indoor air exposures in a hypothetical building built over maximum detected groundwater concentrations. No current workers would be expected to be exposed in this manner because these buildings do not currently exist in or near the area of maximum detected groundwater concentrations. These theoretical future risks are only relevant if such a building could be built and then occupied for 20 years by a worker.	High	Conservative
Constituent concentrations in soil gas were measured and indoor air exposure concentrations were modeled at locations where there currently are no buildings.	High	Conservative
Future land use of the site is currently undecided but may be commercial or recreational, which have lower risks than residential.	Moderate	Uncertain
Due to the configuration of the B056 Landfill RFI Site excavation (65 feet deep, vertical bedrock walls) there are no complete human/ecological exposure pathways. Therefore neither sediment nor surface water data from the bottom of the excavation was included in the HRA/ERA and no potential exposures evaluated.	Low	Not Conservative
Toxicity Criteria		
Assumes that all carcinogens do not have a threshold below which carcinogenic response occurs, and therefore, any dose, no matter how small, results in some potential risk.	Moderate	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.	Moderate	Conservative
High degree of uncertainty in extrapolation of dose-response data from laboratory animals to humans.	High	Conservative
Terphenyls were detected in 1 sample at the B009 LF RFI Site (<1 mg/kg) but since toxicity criteria not available, risk values were not calculated.	Low	Not Conservative

Notes:

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

Table 6-4 (1 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 8 Reporting Area

Chemical	Soil	Soil Vapor
Inorganic Compounds		
Aluminum	X	
Antimony	X	
Arsenic	X	
Barium	X	
Beryllium	X	
Boron	X	
Cadmium	X	
Chromium	X	
Hexavalent chromium	X	
Cobalt	X	
Copper	X	
Lead	X	
Mercury	X	
Molybdenum	X	
Perchlorate	X	
Selenium	X	
Silver	X	
Thallium	X	
Vanadium	X	
Zirconium	X	
VOCs		
1,1,1-Trichloroethane		X
1,1,2-Trichloro-1,2,2-trifluoroethane		X
1,1-Dichloroethane		X
1,1-Dichloroethene		X
1,2-Dichloroethane		X
2-Butanone		X
Acetone	X	X
Benzene	X	X
Chlorobenzene	X	X
Chloromethane		X
cis-1,2-Dichloroethene		X
Ethylbenzene	X	X
m,p-Xylene	X	X
Methane		X
Methylene chloride	X	X
o-Xylene	X	X
Tetrachloroethene		X
Toluene	X	X
trans-1,2-Dichloroethene		X

Table 6-4 (2 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 8 Reporting Area

Chemical	Soil	Soil Vapor
Trichloroethene		X
Xylenes (total)	X	
SVOCs		
2,4-Dinitrophenol	X	
2-Methylnaphthalene	X	
4,6-Dinitro-o-cresol	X	
Acenaphthene	X	
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	
Chrysene	X	
Dibenz(a,h)anthracene	X	
Diethylphthalate	X	
Di-n-butylphthalate	X	
Fluoranthene	X	
Fluorene	X	
Hexachlorobenzene	X	
Hexachlorobutadiene	X	
Indeno(1,2,3-cd)pyrene	X	
Naphthalene	X	
Perylene	X	
Phenanthrene	X	
Pyrene	X	
Total Petroleum Hydrocarbons		
C08-C11 (Gasoline Range)	X	
C14-C20 (Diesel Range)	X	
C20-C30 (Lubricant Oil Range)	X	
Dioxins		
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	

Table 6-4 (3 of 3)

Summary of Chemicals of Potential Ecological Concern
Group 8 Reporting Area

Chemical	Soil	Soil Vapor
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	
1,2,3,4,6,7,8-HpCDF	X	
1,2,3,4,7,8,9-HpCDF	X	
OCDF	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 concern
VOC - volatile organic compound
SVOC - semivolatile organic compound
PCB - polychlorinated biphenyl
CPEC - chemical of potential ecological concern
bgs - below ground surface

Table 6-5 (1 of 1)

Risk Estimates for Ecological Receptors
Group 8 Reporting Area

Receptor	Total HIs							
	B009 Landfill		B056 Landfill		ESADA		FSDF	
	HI Range[1]	CD	HI Range[1]	CD	HI Range[1]	CD	HI Range[1]	CD
Deer Mouse	0.7 - 0.9	None	21 - 29	a,b,c	>100 - >1000	c,d,e,f	12 - 48	d,g
without inhalation pathway	0.7 - 0.9	None	21 - 29	a,b,c	>100 - >1000	c,d,e,f	12 - 48	d,g
Thrush	1 - 1	a	2 - 4	a,c	>1000 - >1000	d,f	>100 - >1000	d
Hawk	0 - 0	None	58 - 100	c,d	>1000 - >1000	d,f	>100 - >100	d
Using Large Home Range Factor[2]	0 - 0	None	2 - 3	d	73 - >100	d	4 - 14	d
Bobcat	0.007 - 0.01	None	6 - 11	b,c	>100 - >100	c,d,e,f	<0.001 - 4	d
Using Large Home Range Factor[2]	<0.001 - <0.001	None	0.03 - 0.05	None	0.2 - 0.7	None	<0.001 - 0.01	None
Mule Deer	2 - 2	a	7 - 8	a,b,c	>100 - >1000	d,e,f	3 - 16	d,g
Using Large Home Range Factor[2]	0.03 - 0.05	None	0.2 - 0.2	None	3 - 13	d,e,f	0.08 - 0.4	None

Notes:

1. HI Range is the sum of the hazard quotients for all exposure pathways; the range reported is for the mean and 95% upper confidence limit estimates, respectively.

2. The HIs 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 HIs decrease to the values indicated above if an adjustment is made to reflect a more realistic home range for these receptors.

3. CD = chemical drivers with Hazard Quotients >1.0, or significant risk contributors.

4. Total risk estimates do not include aluminum and barium for B009 LF aluminum and vanadium for ESADA, and arsenic for FSDF because they are considered to be naturally-occurring. At the ESADA and B009 LF Sites, aluminum exposure risks are based on soluble aluminum. Since soil pH at these sites range between 6.5 and 9.6, soluble aluminum is not likely present (see Section 6). Occurrence of barium and vanadium above background are at two or less locations. Arsenic above its comparison level is associaed with a shale outcrop.

CD = Chemical risk driver
CPEC = Chemical of potential ecological concern
HI = Hazard index
NA = Not applicable

a = Cadmium
b = Molybdenum
c = Selenium
d = Lead
e = Antimony
f = Arsenic
g = Perchlorate

Table 6-6 (1 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 8 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
CPEC Selection		
A number of inorganics (e.g., antimony, arsenic, copper, lead, and mercury) 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.	Moderate	Conservative
Several chemicals were selected as CPECs because the detection limits of some of their analysis were above the ecological screening levels. These chemicals were evaluated in the ecological risk assessment even thorugh there is no evidence that they are present at the site.	High	Conservative
Several inorganics (e.g., aluminum and vanadium at the ESADA RFI Site, and aluminum and barium at the B009 LF RFI Site) are present at concentrations that are considered to be naturally-occurring yet because they did not pass the Wilcoxon Rank Sum test, they were included in the risk assessment.	High	Conservative
Arsenic is present at the FSDF RFI Site at concentrations that are considered to be naturally-occurring yet because it was present at concentrations significantly greater than background, it was included in the risk assessment.	High	Conservative
Chromium was selected as soil CPEC at ESADA; however, hexavalent chromium data were not available. The lack of hexavalent chromium data is not expected to affect the HRA results. Hexavalent chromium typically makes up only a small percentage of the total chromium detected in soil, and although chromium was demonstrated to be different from background concentrations in soil through the Wilcoxon Rank Sum test, the maximum detected chromium concentration was less than the maximum background concentration.	Low	Not Conservative
EPC Calculations		
Estimates of CPEC concentrations in media are based on samples collected from known or suspected impacted areas at RFI sites.	Moderate	Conservative
The extrapolation of soil TPH concentrations to individual petroleum constituent (i.e., BTEX or PAHs), extrapolations were conducted on a dataset containing elevated detection limits. Moreover, the TPH extrapolation methodology over predicts VOC and SVOC concentrations when analyte-specific analysis were not performed or detection limits were elevated. Therefore, estimated EPCs are considered conservative.	High	Conservative
The presence of TPH gasoline range hydrocarbons in soil caused benzene to be selected as a soil vapor and soil CPEC. Benzene was not detected in soil nor soil vapor. The selection and calculation of EPCs for benzene are based on the relationship of benzene to TPH gasoline range hydrocarbons. EPCs for benzene in soil vapor were calculated from DLs.	Moderate	Conservative
Sample 414502, a duplicate of 413580, was included in the risk assessment dataset for the FSDF RFI Site. The sample only consisted of dioxins. The impact is low because there were a high number of dioxin samples and none of the dioxin congeners were risk	Low	Uncertain
Soil vapor concentrations extrapolated from soil matrix and groundwater concentrations were used to calculate soil vapor EPC.	Moderate	Conservative
Burrow-air inhalations risks from soil matrix CPEC (acetone) is associated vapor concentrations estimated to be 1/2 the soil vapor DL though the chemical was not detected in soil vapor.	Low	Conservative

Table 6-6 (2 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 8 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact
Burrow-air inhalations risks from soil matrix CPECs (benzene, ethylbenzene, toluene, m,p-xylene and o-xylene) are estimated using groundwater to soil vapor partitioning though the chemicals were not detected in soil vapor.	Low	Conservative
Burrow-air inhalations risks from groundwater matrix COPCs (cis-1,2,-dichloroethene, trans-1,2-dichloroethene, and trichloroethene), are estimated using soil vapor concentrations related to 1/2 the DL, though the chemicals were not detected in soil or soil vapor.	Low	Conservative
Burrow-air inhalations risks from groundwater matrix COPCs (benzene and toluene), are estimated using soil vapor concentrations related to 1/2 the DL, though the chemicals were not detected in soil vapor.	Low	Conservative
Burrow-air inhalations risks from groundwater matrix COPCs (acetone, 2-butanone, chloromethane, and chlorobenzene), are estimated using groundwater to soil vapor partitioning, though the chemicals were not detected in soil or soil vapor.	Low	Conservative
Exposure		
Representative wildlife species were selected based on attributes that tended to provide conservative estimates of exposure for other members of the guild.	Moderate	Conservative
Estimates of exposure assume that wildlife do not avoid contaminated areas or foods.	Moderate	Conservative
Screening ERA estimates of exposure assume that wildlife obtain 100% of their drinking water from RFI sites.	Low	Conservative
Dermal and inhalation exposure pathways for surface-dwelling animals were not included in the exposure evaluation.	Low	Not Conservative
Due to the configuration of the B056 excavation (65 feet deep, vertical bedrock walls) there are no complete human/ecological exposure pathways. Therefore neither sediment nor surface water data from the bottom of the excavation was included in the HRA/ERA and no potential exposures evaluated.	Low	Not Conservative
Toxicity Criteria		
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.	Moderate	Not conservative
Use of acute/subchronic-to-chronic and endpoint-to-NOAEL uncertainty factors to estimate chronic NOAEL-equivalent TRVs.	Moderate	Uncertain
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.	Moderate	Not Conservative
Extrapolation of toxicity data from animals under laboratory conditions to receptors under field conditions.	Moderate	Uncertain
Lead exposures are based upon toxicity values derived from lead acetate, which is a form of lead that is significantly more bioavailable than weathered lead expected to be present	High	Conservative
Aluminum exposures are based upon toxicity values derived from soluble aluminum. However, the soluble and toxic forms of aluminum are only present in soil under soil pH values of less than 5.5 (USEPA, 2003), and pH ranged from 6.5 to 8.37 for the soils at B009 and from 7.4 to 9.6 for the soils at ESADA.	High	Conservative
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.	Moderate	Conservative

Table 6-6 (3 of 3)

Ecological Risk Assessment Uncertainty Analysis

Group 8 Reporting Area

Uncertainty	Magnitude of Impact	Direction of Impact

Notes:

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

Table 7-1
Group 8 Reporting Area Surficial Media Site Action Recommendations
Page 1 of 2

Area	Chemical Use Area Number	CMS Areas [1]	Recommended for Further Consideration in CMS Based On:			
			Residential Receptor [2]	Industrial Receptor [2]	Recreational Receptor [2]	Ecological Receptor [2]
Building 009 Leach Field (B009 LF) RFI Site (an Area IV AOC) – Appendix A [3]						
B009 Leach Field	1a	--	--	--	--	(4) (5)
B009 Septic Tank	1b	--	--	--	--	(4)
Building 009	2a	--	--	--	--	(4)
SGR Liquid Waste Hold-Up Tank and Pit	2b	--	--	--	--	(4) (5)
OMR Waste Hold-Up Tank and Pit	2c	--	--	--	--	(4)
UT-3	3	--	--	--	--	(4)
B009 Transformer Pads (Substation 709)	4a	--	--	--	--	--
Transformer Pole X-32	4b	--	--	--	--	--
Solar Concentrator Facility	5	--	--	--	--	(4) (5)
Building 056 Landfill RFI (B056 LF) Site (SWMU 7.1) - Appendix B						
B056 Landfill	1	B056-1	Aroclor 1254, PAHs	--		Cadmium, selenium, lead, molybdenum
Southern Debris Area	2a	B056-1	--	--	--	Selenium
Roadside Debris Area	2b	--	--	--	--	--
B056 Excavation	3a	--	--	--	--	--
B056 Excavation Debris Area	3b	B056-2*	--	--	--	Aroclor 1248. 1254, and 1260
B100 Discharge Area	Upgradient of 1 and 2a	B056-3*	Dioxins (6)	--	--	Dioxins (6)
Empire State Atomic Development Authority (ESADA) RFI Site (SWMU 7.9) - Appendix C						
ESADA Former Storage Yard	1	--	--	--	--	(5)
Sodium Test Area, Building 814	2	--	--	--	--	--
Former PDU Tank	3	--	--	--	--	(5)
ESADA Pistol Range	4	ESADA-1	Lead, arsenic, antimony	Lead, arsenic, antimony	Lead, arsenic, antimony	Lead, arsenic, antimony, selenium
Transformer	5	--	--	--	--	--
Former Sodium Disposal Facility (FSDF) RFI Site (SWMU 7.3 [Building 886]) - Appendix D						
Former Upper Pond (included in SWMU 7.3)	1a	--	(7)	(7)	--	--
Former Lower Pond (included in SWMU 7.3)	1b	--	(7)	(7)	--	
Former Western Debris Area (included in SWMU 7.3)	1c	--	--	--	--	--
Former Concrete Pool (included in SWMU 7.3)	1d	FSDF-1 [8]	--	--	--	Perchlorate
Former Steam Lance	2	--	--	--	--	--
Southern Investigation Area	3	--	--	--	--	--
Former Drum Debris Area	4	FSDF-2*	--	--	--	Mercury
FSDF Pistol Range	5	FSDF-3*	--	--	--	Lead
Downgradient Channels A, B, C, and D	Downgradient of above	--	(9)	(9)	(9)	(9)

Table 7-1
Group 8 Reporting Area Surficial Media Site Action Recommendations
Page 2 of 2

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., FSDF-1, FSDF-2, FSDF-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 all receptors (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) For the B009 LF RFI Site, there are no surficial media areas recommended for further evaluation in the CMS.

(4) Although cadmium was identified as a risk contributor for the thrush and mule deer, the maximum detected soil concentration is less than background (0.51 mg/kg vs. 1 mg/kg); thus, areas not recommended for further evaluation in the CMS.

(5) Recommendations for further evaluation of aluminum concentrations at the B009 LF and ESADA RFI Sites during the CMS were not made because these concentrations are considered naturally-occurring. In addition, as described in Section 6, estimated aluminum exposure risks for ecological receptors are based on toxicity values derived from soluble aluminum present in soil with pH values of less than 5.5 (USEPA, 2003). Group 8 site soil pH measurements ranged from 6.5 to 9.6, indicating limited (if any) ecological exposure to the soluble, toxic form of aluminum. The limited occurrence of other metals above background levels (barium, vanadium) was considered an insignificant contributor of potential risks since these results were detected in only a very few samples or were only slightly greater than the comparison background values.

(6) Additional assessment of dioxin distribution and source also recommended for Group 5 RFI Report.

(7) Potential risks due to TCE in soil vapor are considered to result from VOCs in groundwater since this area had been excavated to bedrock and backfilled with clean soil.

(8) CMS area is not located within the Former Concrete Pool Area, but southeast of the Former Disposal Areas.

(9) Although arsenic concentrations in drainage exceed established background, arsenic appears to be naturally occurring associated with a shale outcrop; therefore, CMS is not recommended for potential risks associated with this metal.

Acronyms:

AOC = Area of Concern
CMS = Corrective Measures Study
B009 LF = Building 009 Leach Field
B056 = Building 056
ESADA = Empire State Atomic Development Authority
FSDF = Former Sodium Disposal Facility
NFA = no further actions
PAHs – Polynuclear aromatic hydrocarbons
SVOC = Semivolatile organic compound
TCE = Trichloroethene
TPH = total petroleum hydrocarbons
PCBs = Polychlorinated biphenyls
SWMU = Solid Waste Management Unit
VOCs = Volatile Organic Compounds

TABLE 7-2
SUMMARY OF GROUP 4 REPORTING AREA SURFICIAL MEDIA CMS RECOMMENDATIONS
(Page 1 of 1)

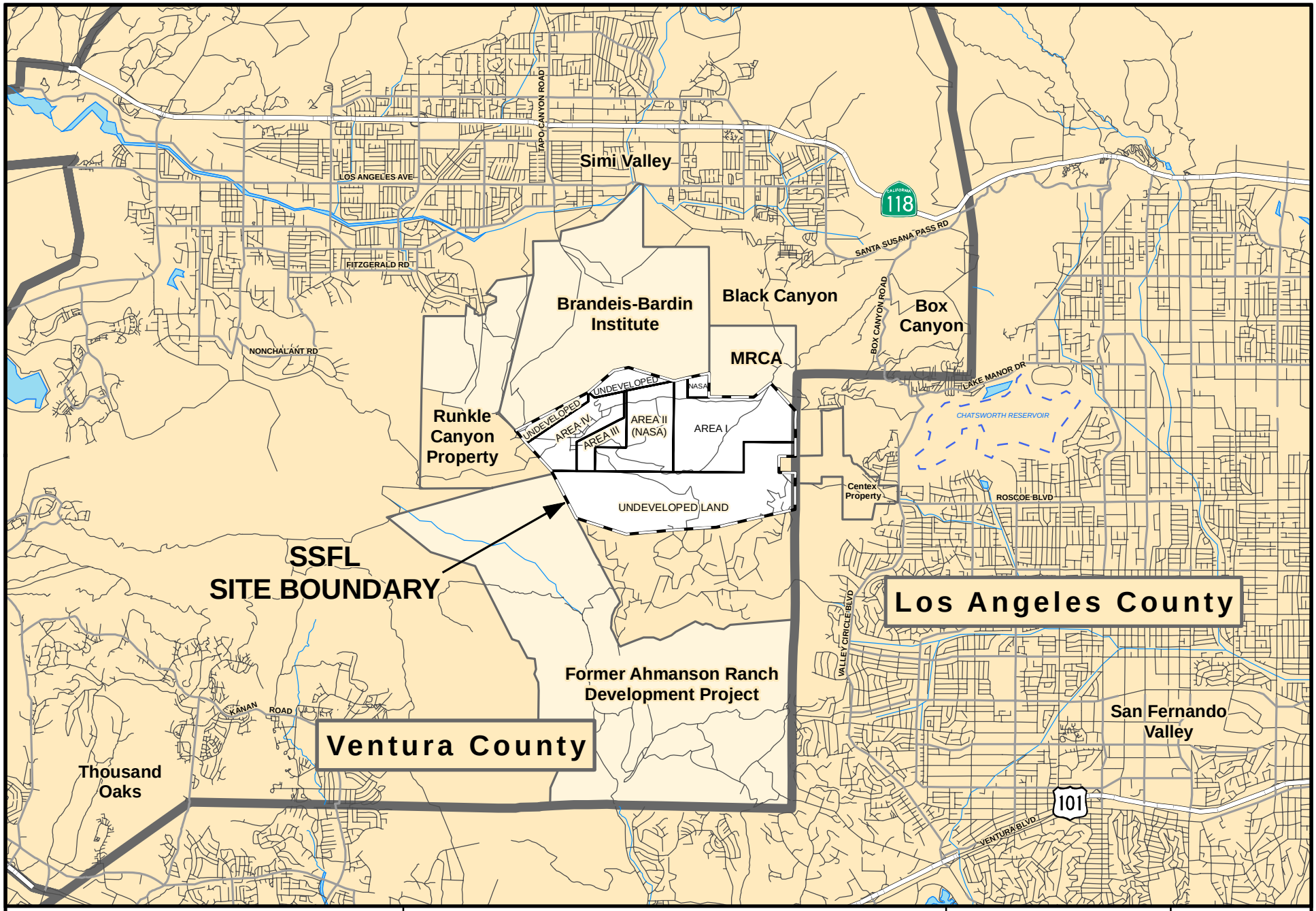
CMS Area	Description	Chemical Risk Drivers and Contributors	Rationale
B056-1	B056 Landfill and Southern Debris Area (Chemical Use Areas 1 and 2a)	Cadmium, lead, molybdenum, selenium, PAHs, Aroclor 1254	The B056 Landfill and Southern Debris Area contain fill materials with elevated chemical concentrations of metals, PAHs, and PCBs in a few localized areas. Fill materials primarily consist of inert soil, bedrock, and concrete, but scrap metal, drums, and wood also noted. Extent of fill materials delineated by soil investigation areas, historical photographs and bedrock outcrops.
B056-2*	B056 Excavation Debris Area (Chemical Use Area 3b)	Aroclors 1248, 1254, and 1260	Debris area with elevated PCBs in soil. Extent delineated by observed debris and bedrock outcrops. Given proximity to surface water in the B056 Excavation, this area is recommended for stabilization measures.
B056-3*	Building 100 Discharge Area (Upgradient from Chemical Use Area 2a)	Dioxins	Soil with elevated dioxins along north slope of Building 100 and near lined discharge ditch. Extent shown considered approximated until further evaluation of extent and source conducted as part of Group 5 RFI Report. Given proximity to the drainage west of the B056 Landfill, this area is recommended for stabilization measures.
ESADA-1	ESADA Pistol Range (Chemical Use Area 4)	Antimony, arsenic, lead, and selenium	Pistol range area with visible lead shot and elevated metals detected in soil. Highest concentrations detected in southern hill slope soils in target area. Extent delineated based on extent of visible shot and step-out sampling data.
FSDF-1	Southeast of Former Disposal Area (Chemical Use Area 1)		Elevated perchlorate detected in the southeastern portion of the FSDF RFI Site, north of H Street. Extent delineated based on step-out sampling data.
FSDF-2	Former Drum Debris Area (Chemical Use Area 4)		Elevated mercury detected in former drum debris area located in the drainage west of FSDF. Extent delineated based on step-out sampling data and rock outcrops.
FSDF-3	FSDF Pistol Range (Chemical Use Area 5)		Pistol firing range area with visible lead shot and elevated lead detected in soil. Highest concentrations detected in southern hill slope soils in target area. Extent delineated based on step-out sampling data and rock outcrops.

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.

FIGURES



1 inch equals 1.5 miles

0 1.5 3 Miles

SANTA SUSANA FIELD LABORATORY

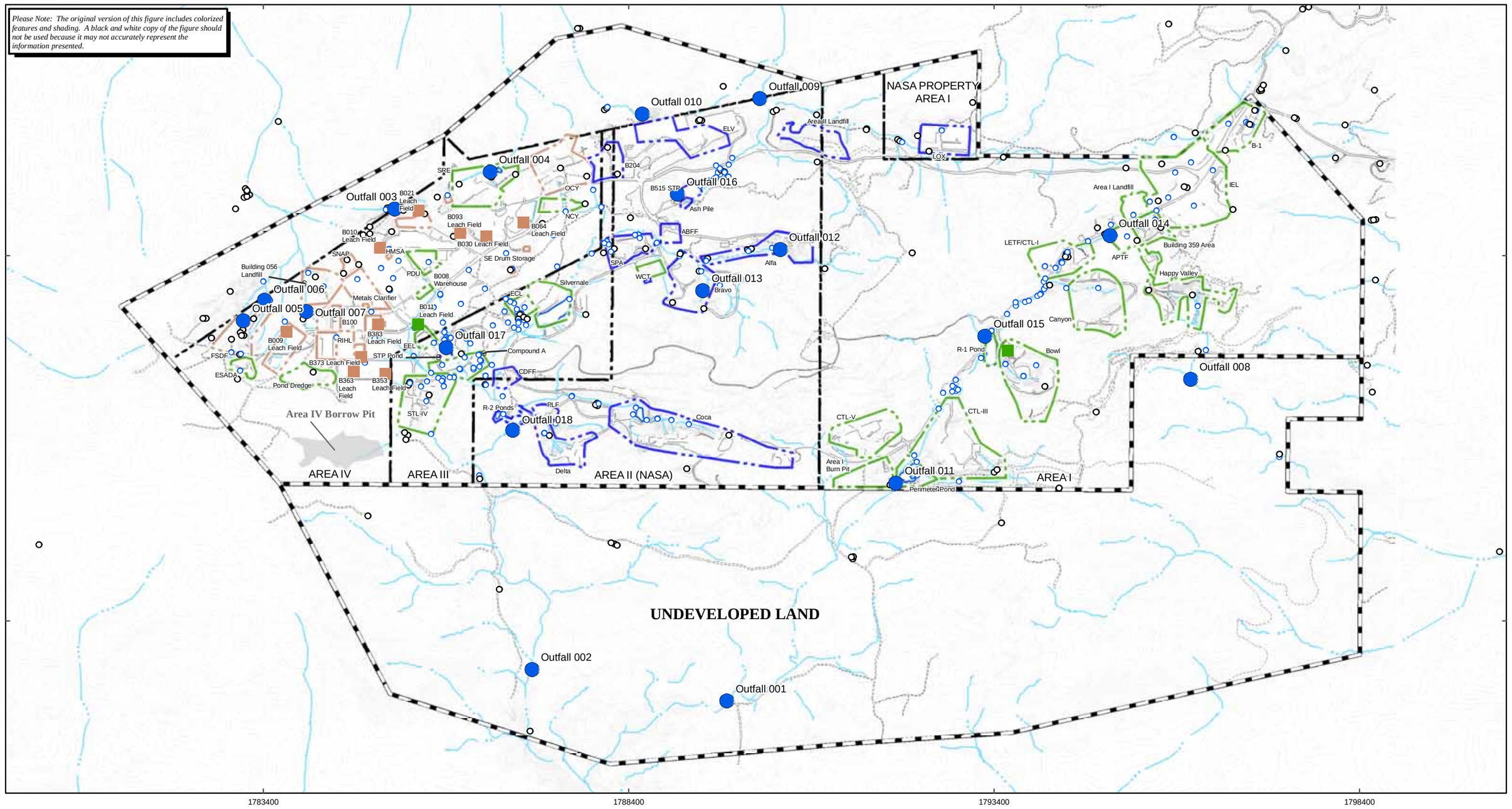
Document: RFI-Report-Group8_regional_map.mxd

Date: Sep 20, 2007

Regional Map

FIGURE 1-1

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 presented.



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MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

RFI Sites by Responsibility

- DOE
- NASA
- BOEING

Leach Fields by Responsibility

- DOE
- RD

- 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.
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: Sep 28, 2007

Document: RFI-Report-Group8_Site_Plan_SSFL_11x17.mxd

MWH

FIGURE 1-2

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 presented.

1783400 1788400 1793400 1798400

267400

262400

UNDEVELOPED LAND

NASA PROPERTY AREA I

Outfall 009

Outfall 010

Outfall 004

Outfall 003

Outfall 016

Outfall 012

Outfall 013

Outfall 014

Outfall 015

Outfall 008

Outfall 006

Outfall 005

Outfall 007

Outfall 017

Outfall 018

Outfall 011

Outfall 002

Outfall 001

Area II Landfill

ELV

LOX

B-1

IEL

Area I Landfill

SRE

B204

OCY

B515 STP

Ash Pile

B021 Leach Field

B093 Leach Field

B064 Leach Field

NCY

B010 Leach Field

B030 Leach Field

ABFF

SNAP

HMSA

SE Drum Storage

SPA

Alfa

LETF/CTL-I

APTF

Building 359 Area

Happy Valley

Building 056 Landfill

RDU

B008 Warehouse

WCT

Bravo

Silvernale

ECL

Metals Clarifier

B011 Leach Field

B100

B383 Leach Field

RIHL

EEL

Compound A

Canyon

R-1 Pond

Bowl

FSDF

STP Pond

B373 Leach Field

B009 Leach Field

ESADA

CDFF

Pond Dredge

B363 Leach Field

B353 Leach Field

PLF

R-2 Ponds

STL-IV

Coca

CTL-V

CTL-III

Area IV Borrow Pit

Delta

Area II Burn Pit

Perimeter Pond

AREA IV

AREA III

AREA II (NASA)

AREA I

UNDEVELOPED LAND

Elevation Legend

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

N

0 1,300

FEET

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

RFI SITES

AREA I
SWMU 4.1 - B-1 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, AOC - Advanced Propulstion Test Facility (APTF) Area
SWMU 4.12 - Laser Engineering Test Facility (LETF)/Component Test Lab I (CTL-I) 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 359 Sump
AOC - Happy Valley Area

AREA II
SWMU 5.1 - Area II Landfill
SWMU 5.2 - ELV Final Assembly, Building 206
SWMU 5.5 and AOC - Building 204 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 - Delta Area
SWMU 5.26 - R-2A and R-2B Ponds
AOC - Building 515 Sewage Treatment Plant
AOC - Storable Propellant Area (SPA)
AOC - Alfa/Bravo Fuel Farm
AOC - Coca/Delta Fuel Farm
AOC - Building 224 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 - Sewage Treatment Plant (STP) Pond Area

AREA IV
SWMU 7.1 - Building 56 Landfill
SWMU 7.3 - Former Sodium Disposal Facility (FSDF)
SWMU 7.4 - Old Conservation Yard (OCY)
SWMU 7.5 - Building 100 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
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 Facility
AOC - Boeing Area IV Leach Fields
AOC - DOE Area IV Leach Fields

Legend

- SSFL Property Boundary
- Administrative Boundary
- RFI Boundary
- Building
- Pond
- Drainage
- Dirt Road
- Road
- NPDES Outfall

RFI Site Location Map

SANTA SUSANA FIELD LABORATORY

Date: Sep 28, 2007

Document: RFI-Report-Group8_RFI_Location.mxd

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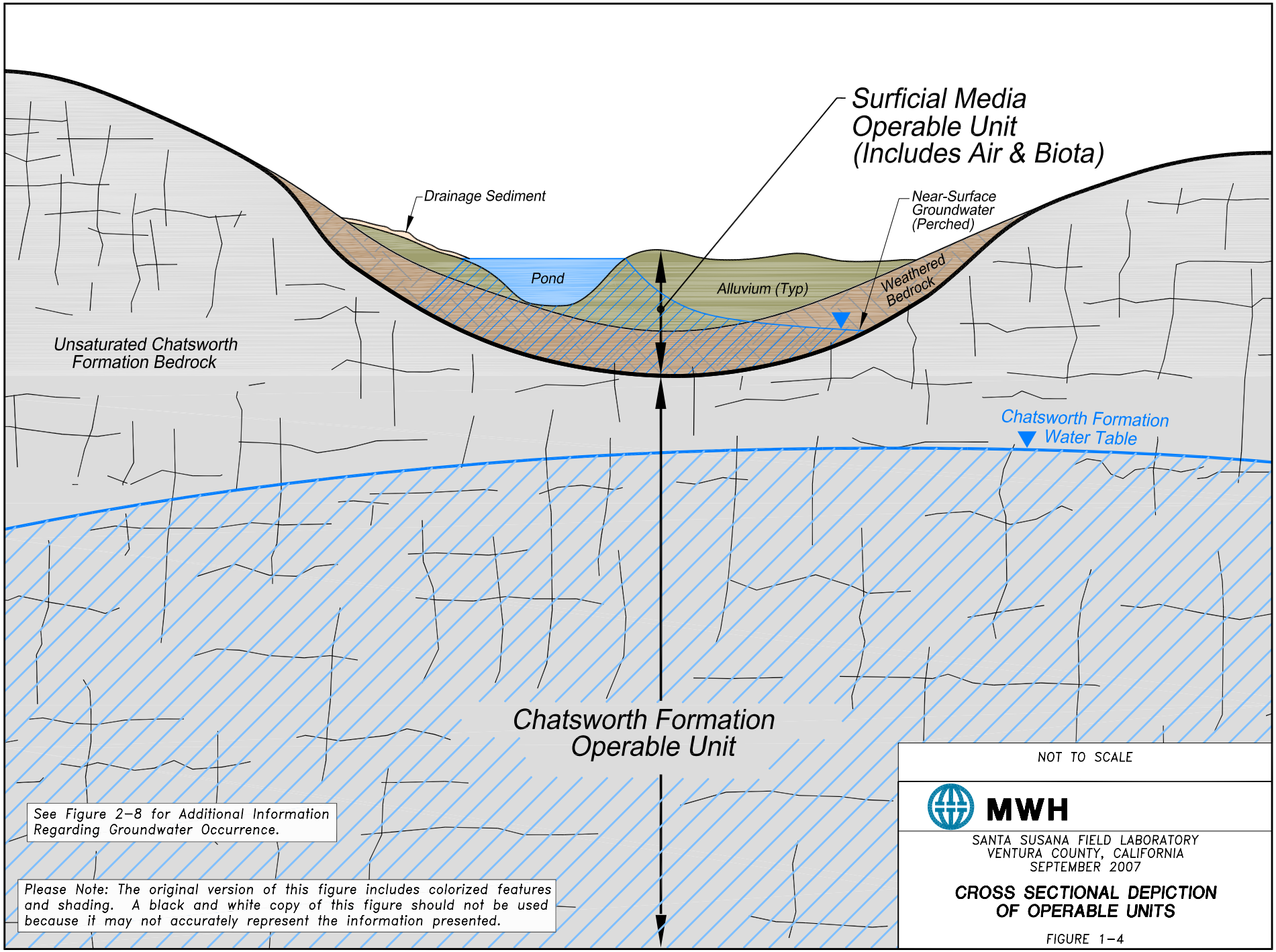
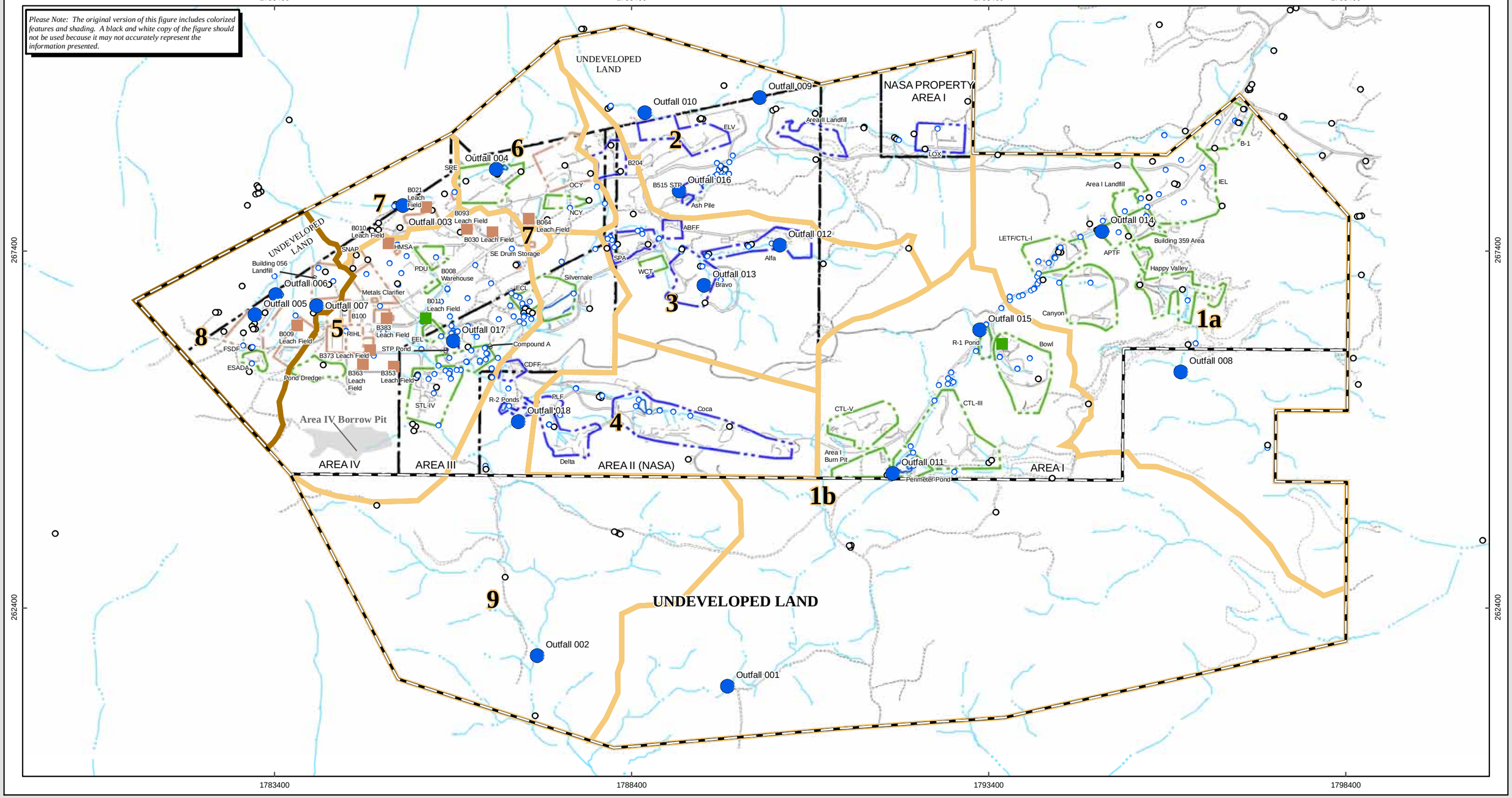
FIGURE 1-3


Surficial Media
Operable Unit
(Includes Air & Biota)
Drainage Sediment
Near-Surface
Groundwater
(Perched)
Pond
Alluvium (Typ)
Weathered
Bedrock
Unsaturated Chatsworth
Formation Bedrock
Chatsworth Formation
Water Table
Chatsworth Formation
Operable Unit
See Figure 2-8 for Additional Information
Regarding Groundwater Occurrence.
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
SEPTEMBER 2007
CROSS SECTIONAL DEPICTION
OF OPERABLE UNITS
FIGURE 1-4
FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 8 FIGS\CONCEPTUAL XSEC 9 10 07
JOB No.

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 presented.



0 1,300 FEET

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

RFI Sites by Responsibility

- BOEING
- NASA
- DOE

Leach Fields by Responsibility

- DOE
- BOEING

- Report Group 8 Boundary
- Report Group Boundary
- 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.
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: Sep 28, 2007

Document: RFI-Report-Group8_GroupAreas.mxd

MWH

FIGURE 1-5

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 presented.

Report Group 7

Report Group 8

Report Group 5

B056
Landfill

B009
Leach Field

FSDF

ESADA

Outfall 003

Outfall 006

Outfall 005

Outfall 007

Base Map Legend

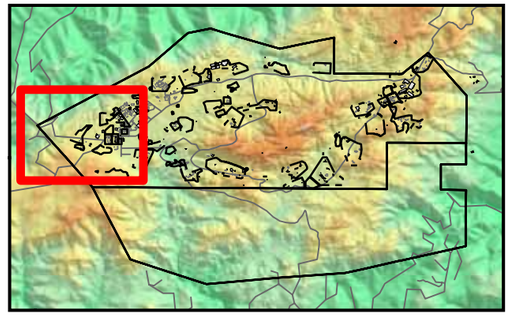
- Administrative Area Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Awning
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Dirt Road
- A/C Curbing
- Fence
- Rock Outcrop
- Elevation Contour
- Surface Water Divide
- Drainage
- Lined Drainage
- Pond
- Possible Pond
- Leach Field
- Pipe
- NPDES Outfall

Groundwater Wells

- Shallow
- Deep
- Abandoned Well

RFI Sites By Responsibility

- DOE
- BOEING



Group 8 Reporting Area

Date: Sep 28, 2007

Document: RFI-Report-Group8_Reporting_Area.mxd

1 inch equals 400 feet

0 400 800 Feet

SANTA SUSANA FIELD LABORATORY

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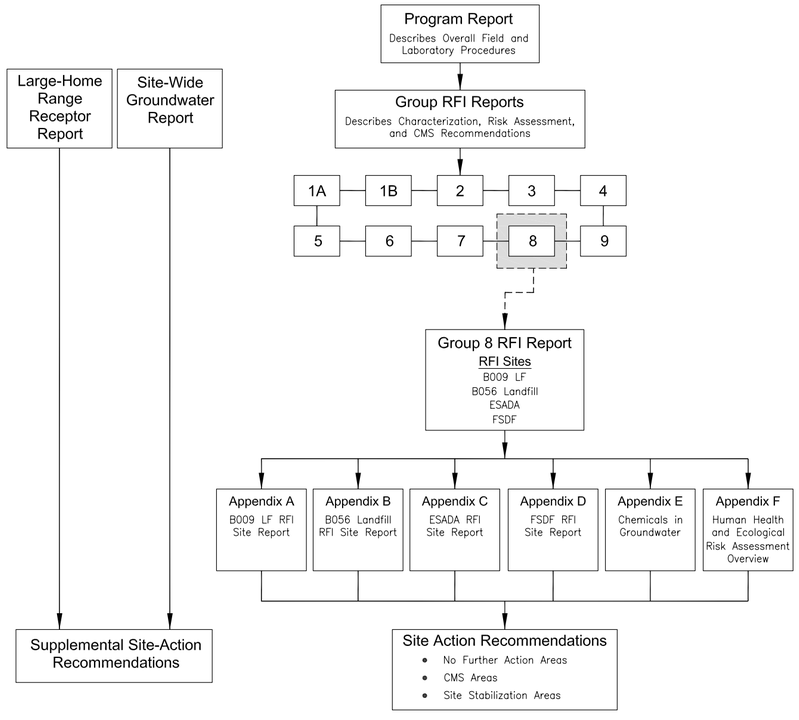
FIGURE
1-6

RFI Reporting Process



Group 8 Map of RFI Report Contents

Main Report

Volume I: Group 8 RFI Report - Group-Wide Information and Relationships Between Sites and Media

- Section 1: Purpose and Scope of Report
- Section 2: Overview of Physical Setting for Reporting Area
- Section 3: Summary of Historical Operations and Chemical Use for Each RFI Site in Reporting Area
- Section 4: Description of Sampling Results that Indicate Further Action Be Required
- Section 5: Description of How Chemicals Migrate Between Sites and Media
- Section 6: Summary of Site Risk Assessment Results and Uncertainty in Process
- Section 7: Site Action Recommendations for Areas Requiring Further Evaluation in the CMS or Measures to Control Contamination Migration While the Evaluation Occurs

Supporting Information

Volume IV: Groundwater Appendix (E)

- Description of Occurrence and Extent for Entire Report Area
- Groundwater Flow Analysis
- Description of Chemicals in Groundwater
- Analysis of Site-Related Chemicals in Groundwater

Attachment 1 - Groundwater Data for Group

Volumes II & III: Site RFI Appendices (A-D)

A - B009 LF RFI Site
B - B056 Landfill RFI Site
C - ESADA RFI Site
D - FSDF RFI Site

- Section 1: Introduction - Purpose, Scope, and Organization of Report
- Section 2: Site History, Chemical Use, Physical Settings, SWMU/AOCs at Site, Historical Operations and Types of Chemicals Used, Description of Physical Settings
- Section 3: Nature and Extent - Description of Sampling Rationale and Results, Detailed Tables and Maps
- Section 4: Risk Assessment - Summary of Human Health & Ecological Risk Assessment
- Section 5: Site Action Recommendations - Evaluation Process and Areas Identified for Further Action or No Further Action

Attachment 1: Regulatory Agency Correspondence

Attachment 2: Subsurface Information (e.g., Boring Logs)

Attachment 3: Soil Data, Including Data Quality, Validation and Laboratory Reports

Volume IV: Risk Assessment Appendix (F)

- Overview and Summary of Human Health and Ecological Risk Assessment
- Description of Supplemental Procedures

Attachment 1: B009 LF RFI Site Risk Assessment

Attachment 2: B056 Landfill RFI Site Risk Assessment

Attachment 3: ESADA RFI Site Risk Assessment

Attachment 4: FSDF RFI Site Risk Assessment

Attachment 5: Baseline Toxicity Studies for ERA

Attachment 6: Plant Health Studies for Report Area

Attachment 7*: All Site Risk Assessment Calculation Tables

Attachment 8: Data for Risk Assessment

Boeing, 2007: Historical Documents

- Facility Records, Correspondence, Reports
- Searchable Format

Information Inputs for Other Portions of Document

* Additional Content Details Provided in Appendix F

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VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

GROUP 8 MAP OF RFI REPORT CONTENTS

FIGURE 1-7

JOB No. --- FILE No. ---\INDSVR\INDUSTRIAL\CAD_MLUEBKE\BOEING_SANTA_SUSANA\GROUP_8_FIGS\FLOWCHART_9_07

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 presented.

Report Group 7

Report Group 8

B056
Landfill

FSDF

ESADA

B009
Leach Field

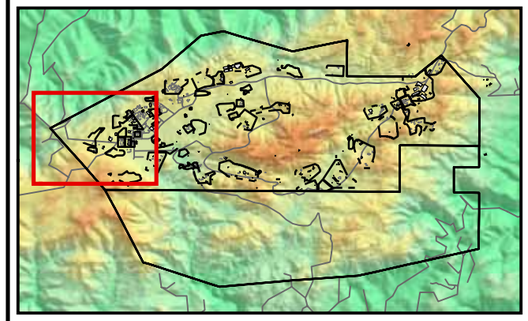
Report Group 5

1780875 1781100 1781325 1781550 1781775 1782000 1782225 1782450 1782675 1782900 1783125 1783350 1783575 1783800 1784025 1784250 1784475 1784700 1784925 1785150 1785375 1785600

267975 267750 267525 267300 267075 266850 266625 266400 266175 265950 265725 265500 265275 265050 264825 264600

Elevation Legend

< 950 ft	1550 - 1625 ft
950 - 1025 ft	1625 - 1700 ft
1025 - 1100 ft	1700 - 1775 ft
1100 - 1175 ft	1775 - 1850 ft
1175 - 1250 ft	1850 - 1925 ft
1250 - 1325 ft	1925 - 2000 ft
1325 - 1400 ft	2000 - 2075 ft
1400 - 1475 ft	2075 - 2150 ft
1475 - 1550 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
- Elevation Contour
- Drainage
- Lined Drainage
- Pond
- Possible Pond

Groundwater Wells

- Shallow
- Deep
- Abandoned Well

Topographic Relief Map
Group 8 Reporting Area

Date: Sep 28, 2007

Document: RFI-Report-Group8_TopoRelief.mxd

1 inch equals 400 feet

0 400 800 Feet

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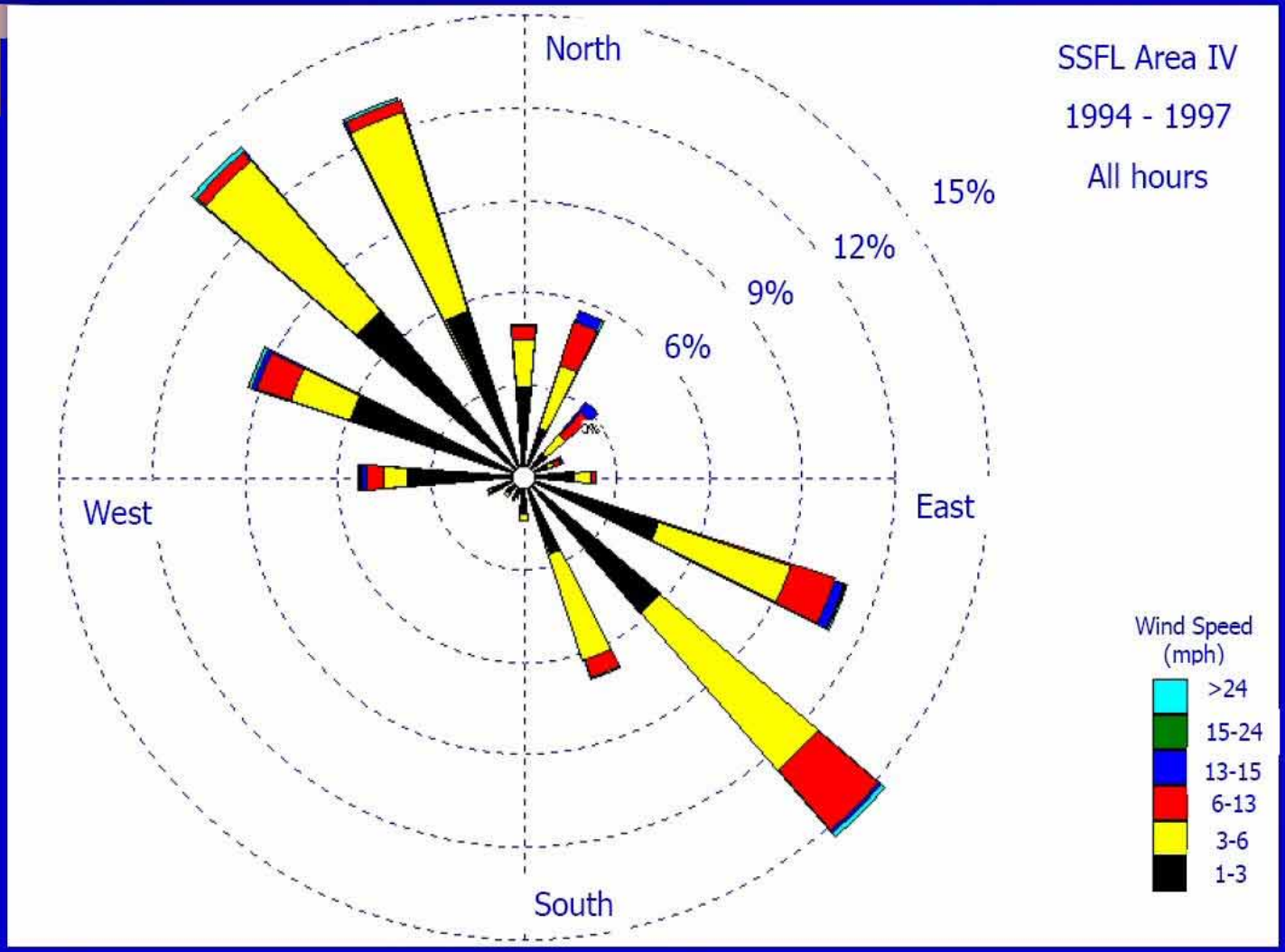
FIGURE
2-1

Wind Roses

Winds equally out of the Northwest and Southeast



STI

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

9

Source: STI (2003)

Figure 2-2

FIGURE 2-3A
ANNUAL PRECIPITATION AT SSFL, 1960-2006

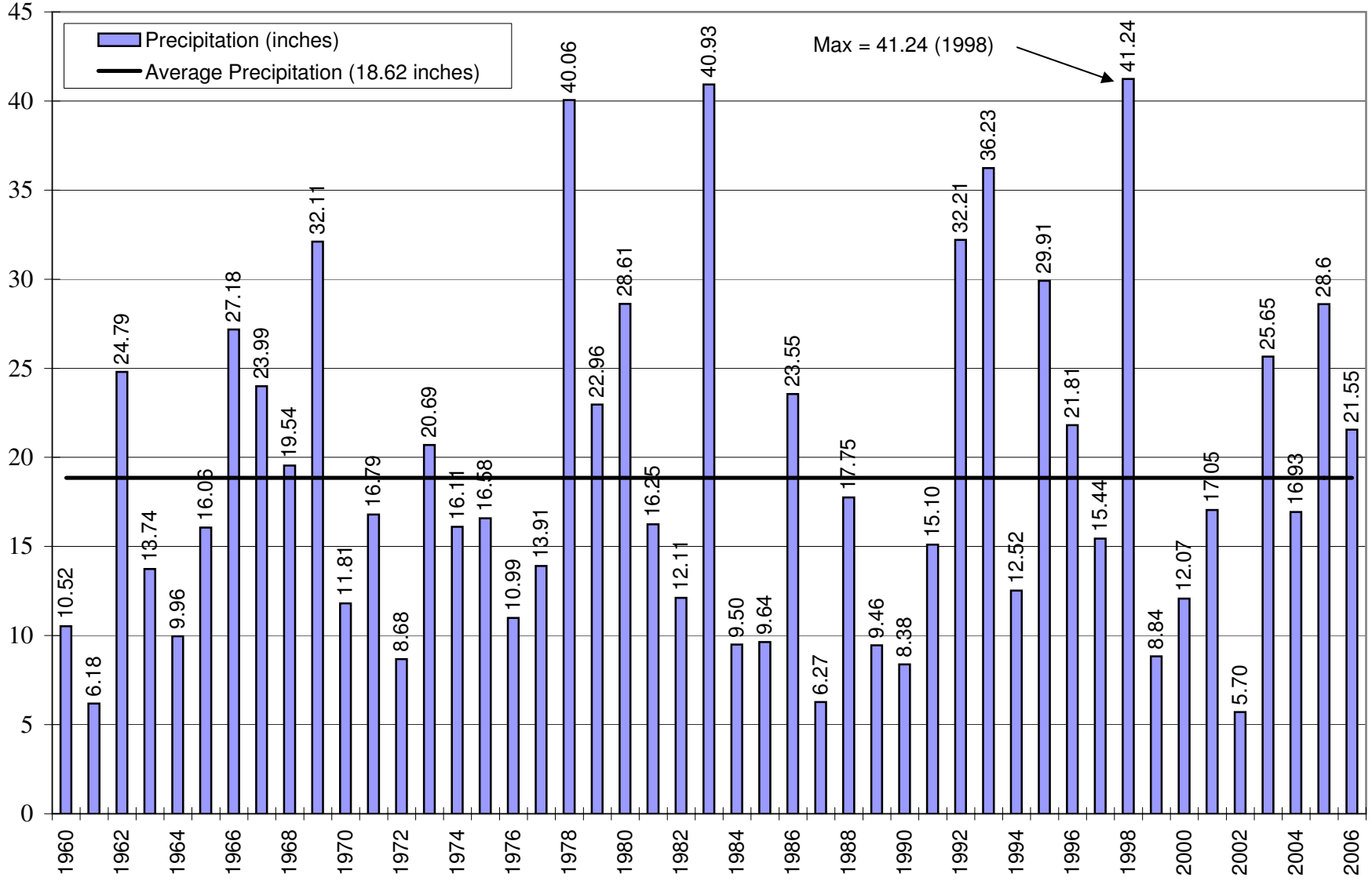
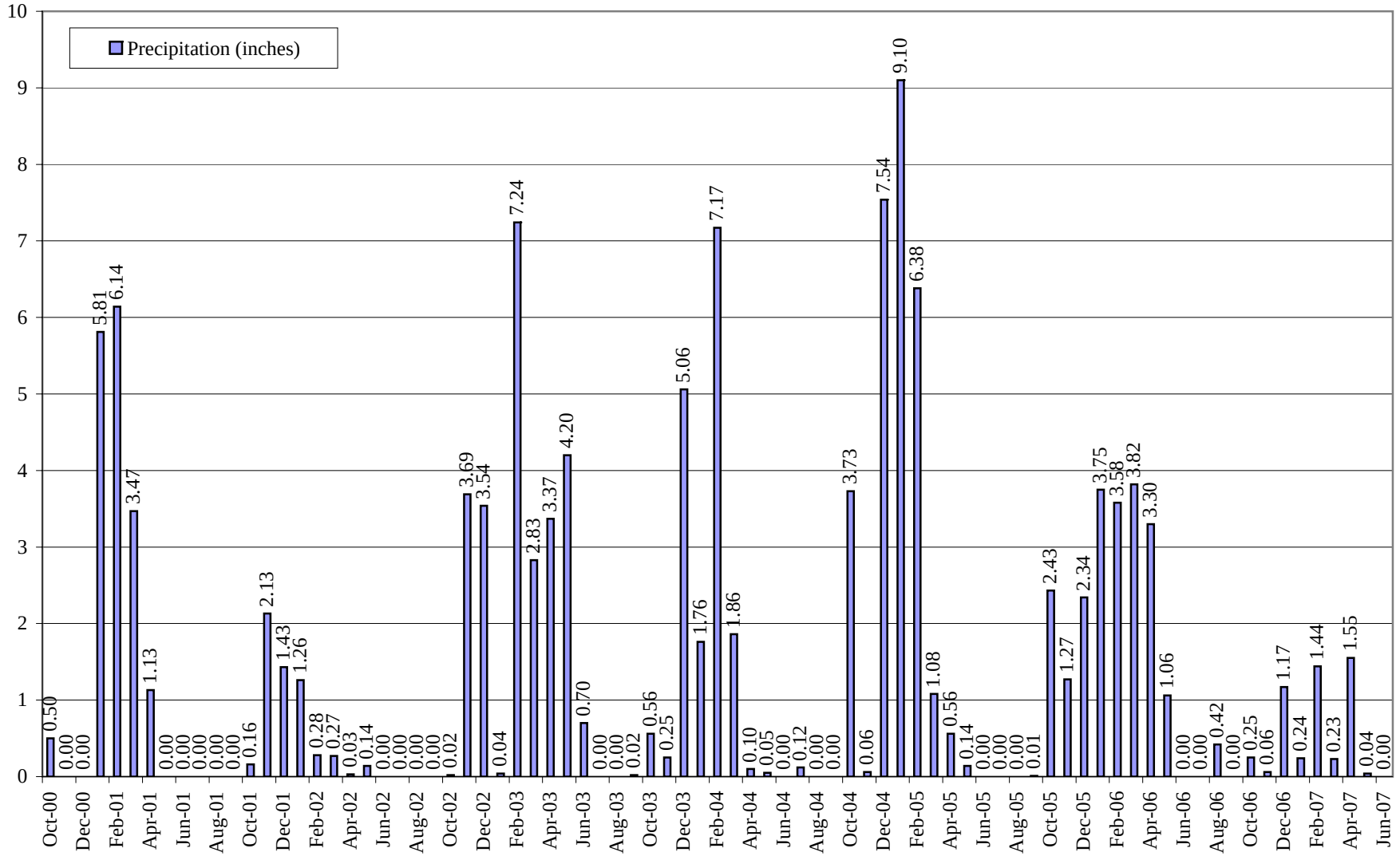
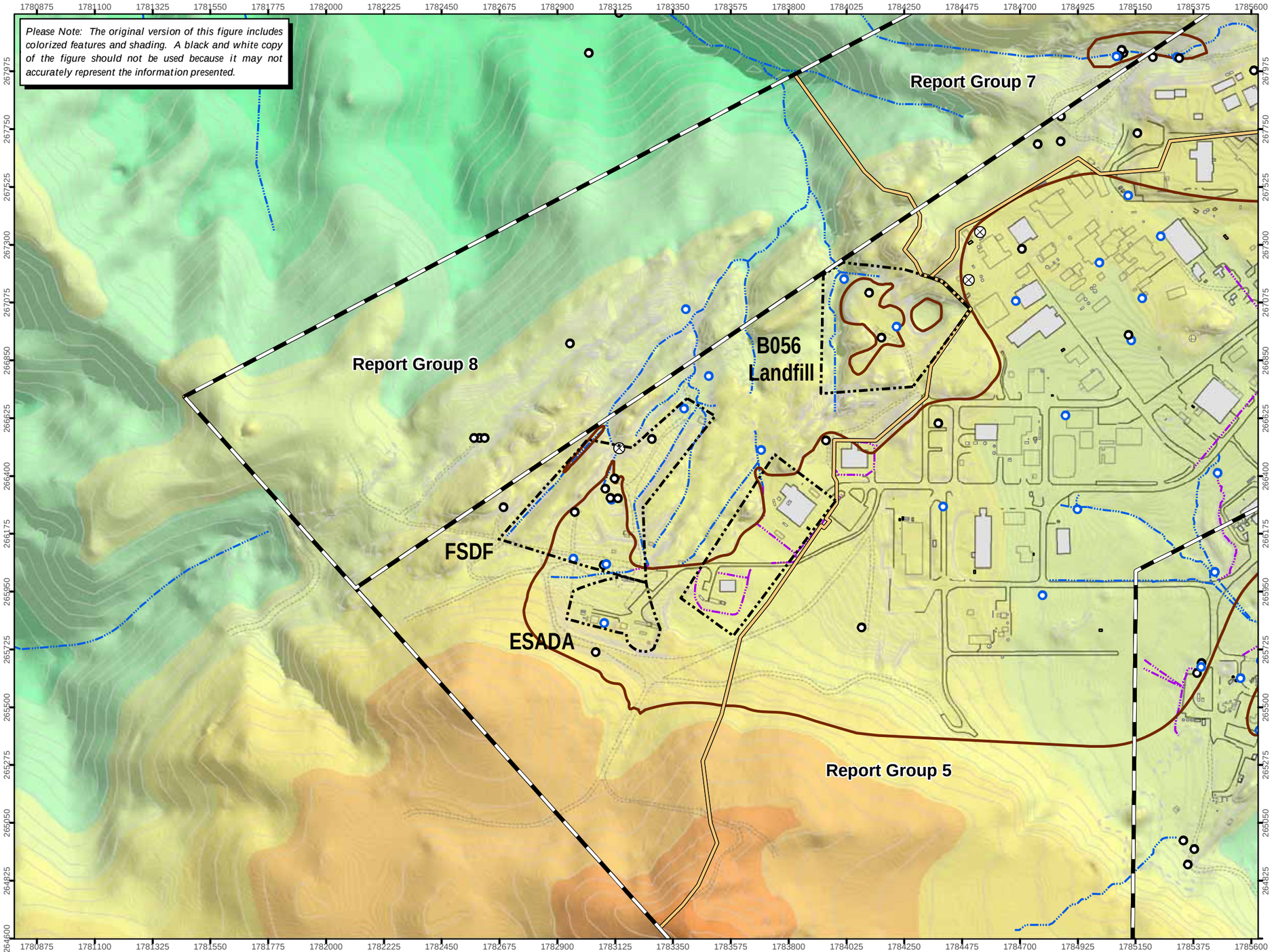


FIGURE 2-3B
MONTHLY PRECIPITATION AT SSFL, OCTOBER 2000 - JUNE 2007



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 presented.



Elevation Legend

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

Groundwater Wells

- Shallow
- Deep
- Abandoned Well

Approximate Extent of Alluvium Thickness >5 Feet

Note: Alluvium thickness within the areas shown on this figure is typically >5 feet, although locally variable with thinner deposits near rock outcrops. For the purposes of this figure, alluvium includes areas backfilled with native soil.

Generalized Extent of Alluvium and Fill Group 8 Reporting Area

Date: Sep 29, 2007

Document: RFI-Report-Group8_Alluvium.mxd

1 inch equals 400 feet

0 400 800 Feet

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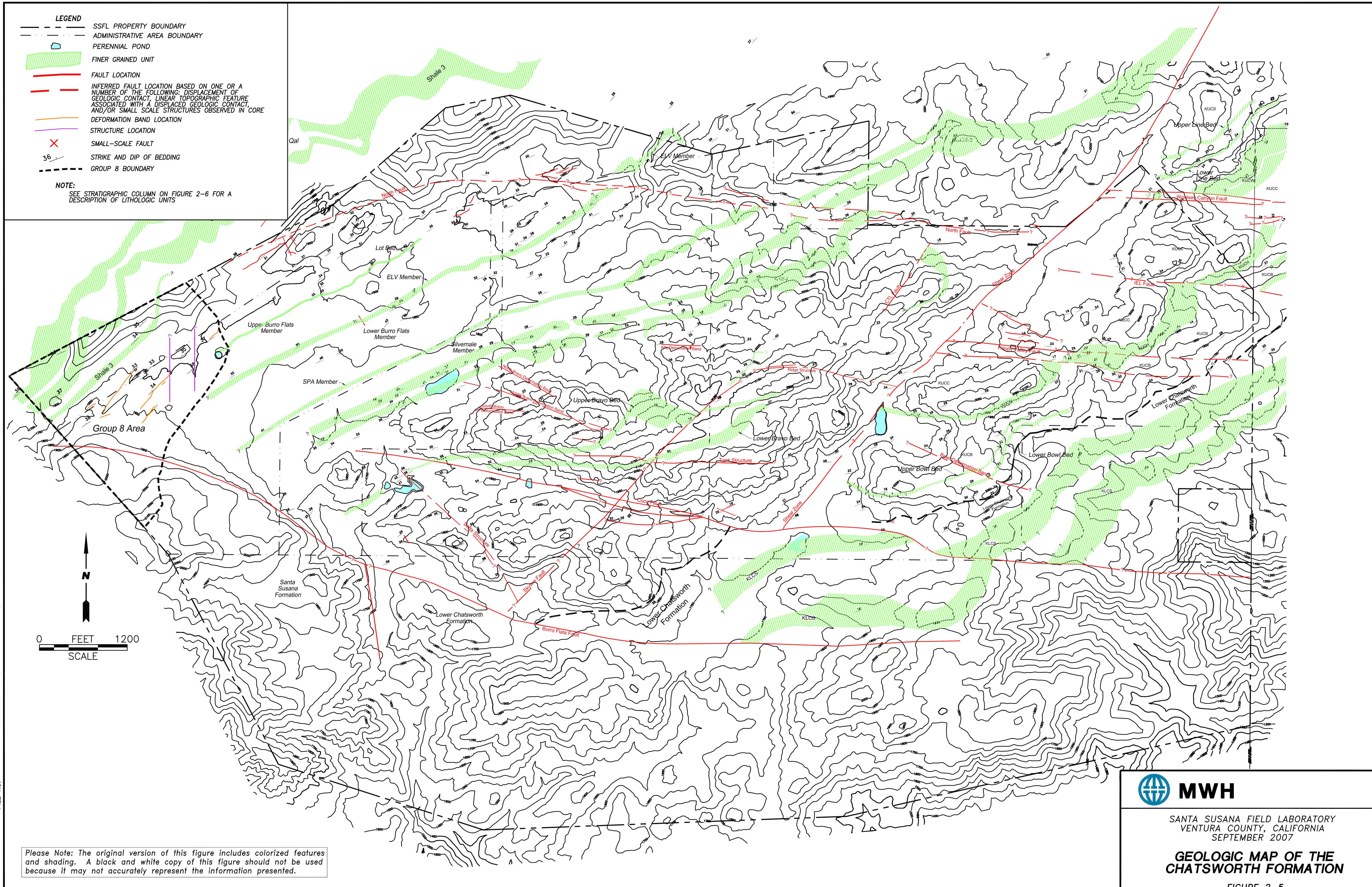
FIGURE 2-4



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
SEPTEMBER 2007

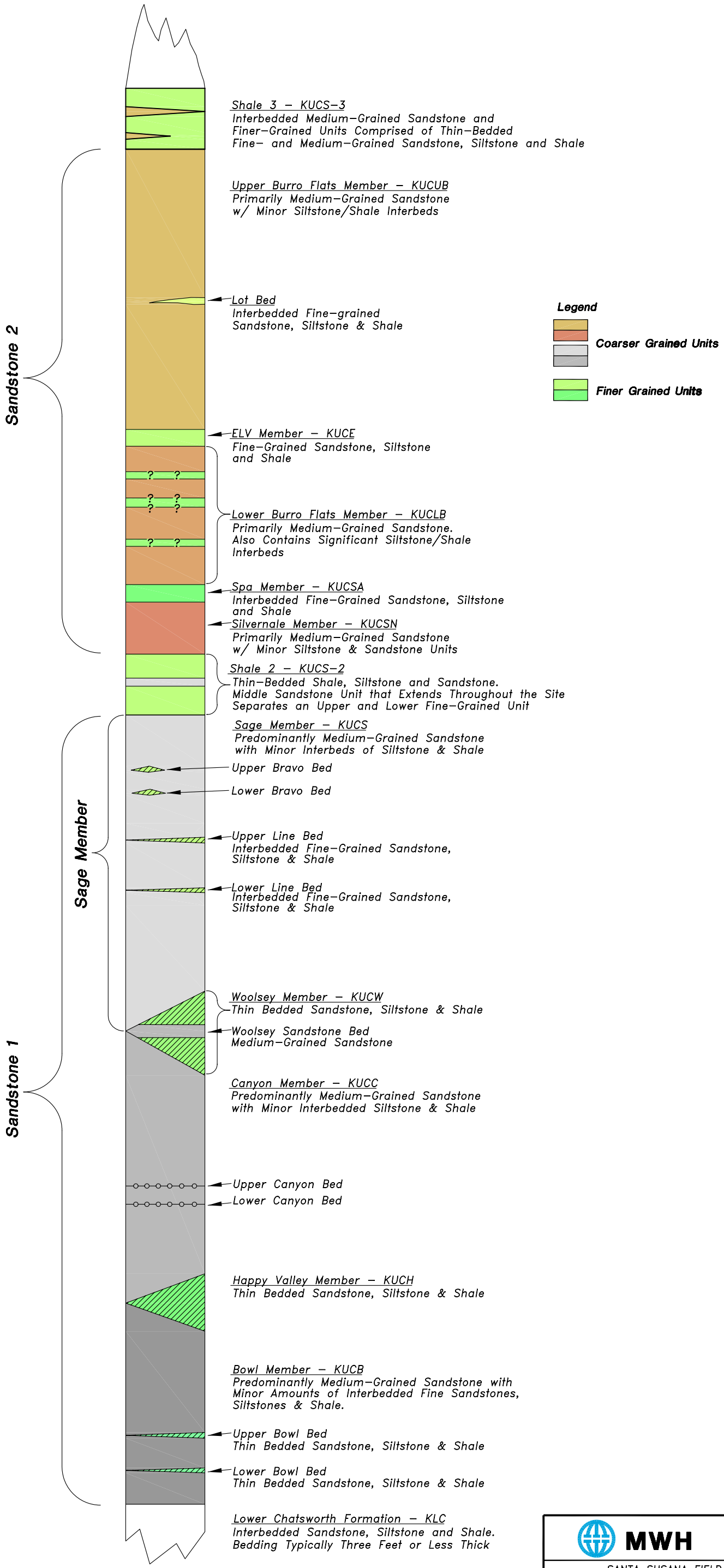
GEOLOGIC MAP OF THE CHATSWORTH FORMATION

FIGURE 2-5

INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 8 FIGS\GEOLOGY SSFL 9 9 07

FILE No.

JOB No.



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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SEPTEMBER 2007

STRATIGRAPHIC COLUMN OF THE CHATSWORTH FORMATION

FIGURE 2–6

JOB No. -- FILE No. INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 8 FIGS\STRAT COLUMN 6 1 04

ARROYO SIMI

MEIER CANYON

CHATSWORTH RESERVOIR

DAYTON CANYON

GROUP 8 AREA

BELL CREEK

LOS ANGELES RIVER

SSFL

Airport

Pass

Chatsworth Peak

Well

Oakwood Cemetery

Runkle Reservoir

Meier Canyon

Chatsworth Lake Manor

Chatsworth Reservoir
(Normally Dry)

Dayton

Bell Canyon

Las Virgenes

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Legend

▲ NPDES Outfalls

0 FEET 5280
SCALE

N

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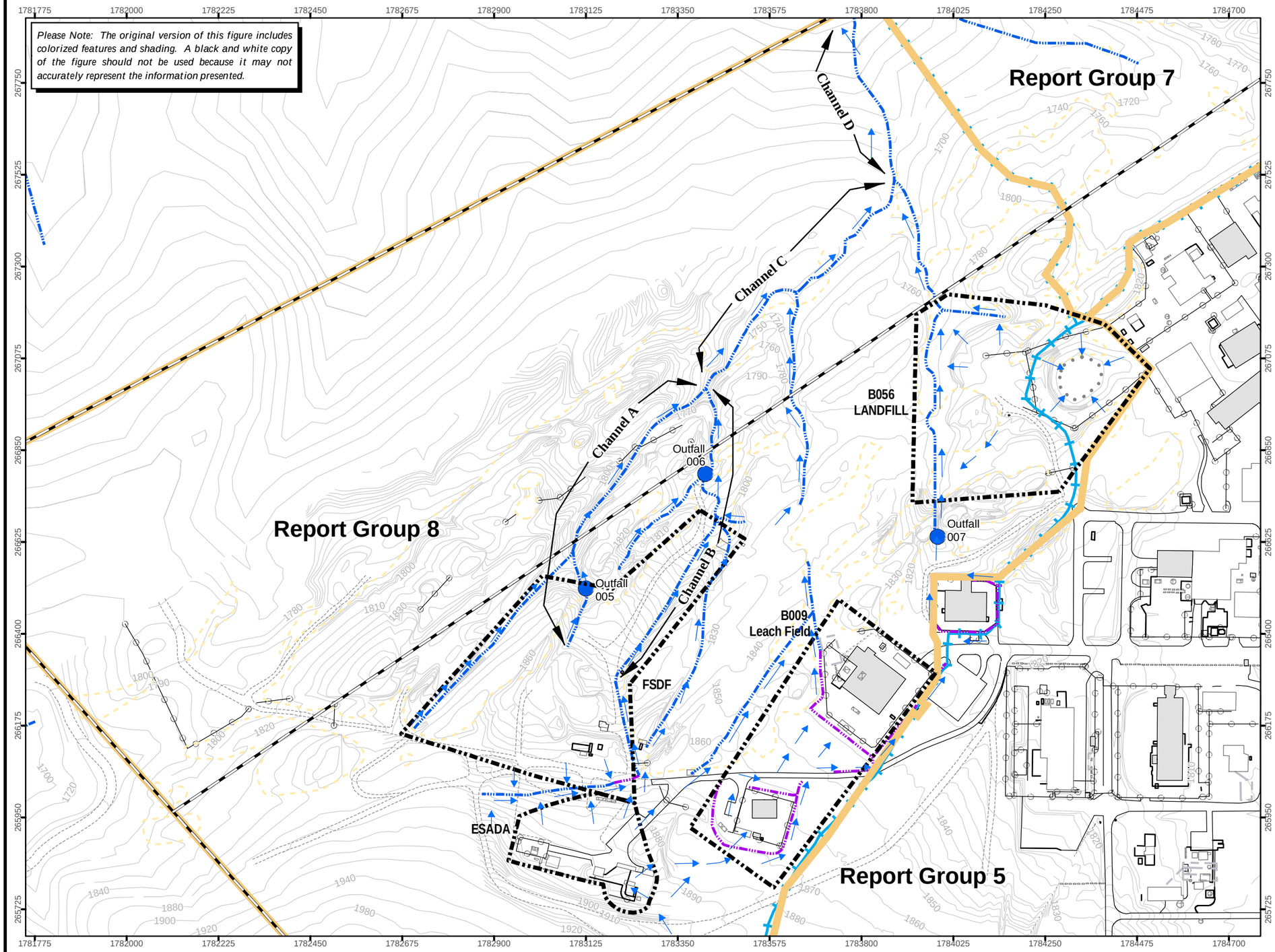
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

DRAINAGES LEADING FROM SSFL

FIGURE 2-7A

JOB No. ==== FILE No. CAD MLUEBKE\BOEING\SANTA SUSANA\GROUPB FIGS\OUTFALLS 9 11 07

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 presented.



Base Map Legend

- 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
- Dirt Road
- A/C Curbing
- Fence
- Rock Outcrop
- Elevation Contour
- Surface Water Divide
- Drainage
- Lined Drainage
- Pond
- Possible Pond
- Leach Field
- Pipe
- NPDES Outfall

Legend

- Surface Flow

Surface Water Drainages Group 8 Reporting Area

Date: Sep 28, 2007

Document: RFI-Report-Group8_Surface_Flow.mxd

1 inch equals 250 feet

0 250 500 Feet

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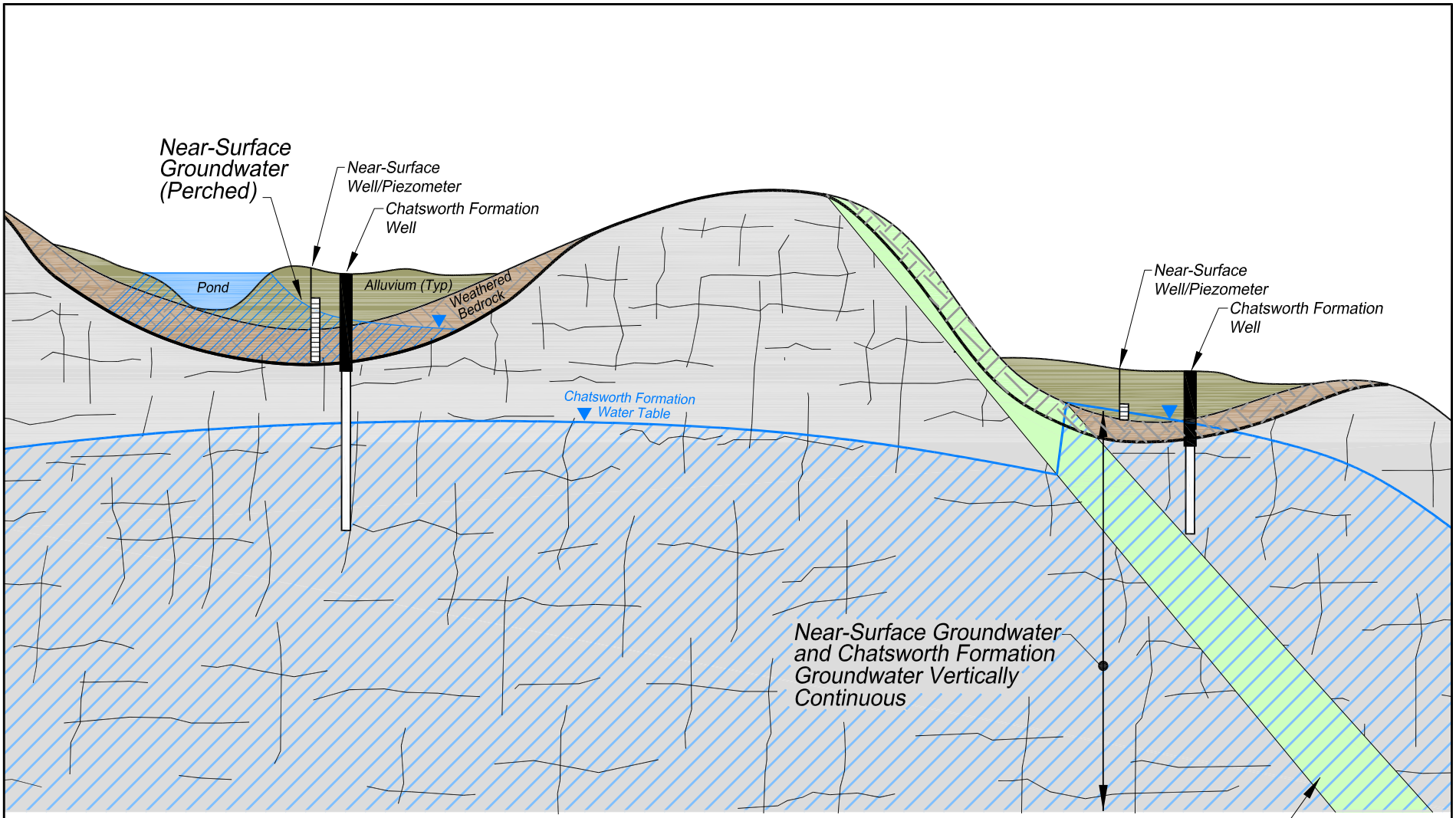
FIGURE 2-7B



NOT TO SCALE

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.

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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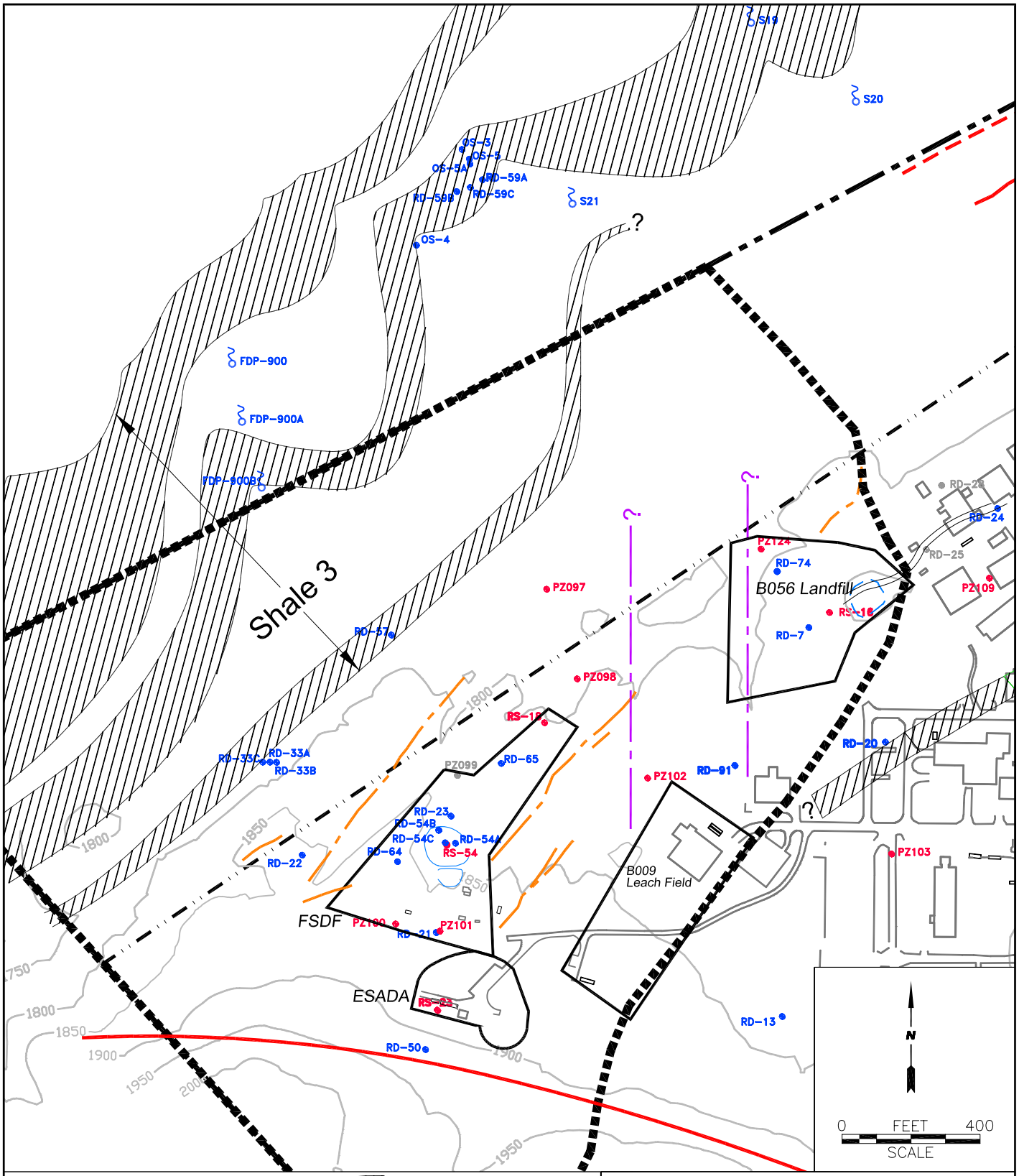
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

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

FIGURE 2–8

FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 8 FIGS\CONCEPTUAL XSEC 9 7 07

JOB No.



FILE: C:\ADM\LUEBKE\BOEING santa susana\group 8 figs\NEAR SURFACE GW 07 30 07

JOB No.

LEGEND

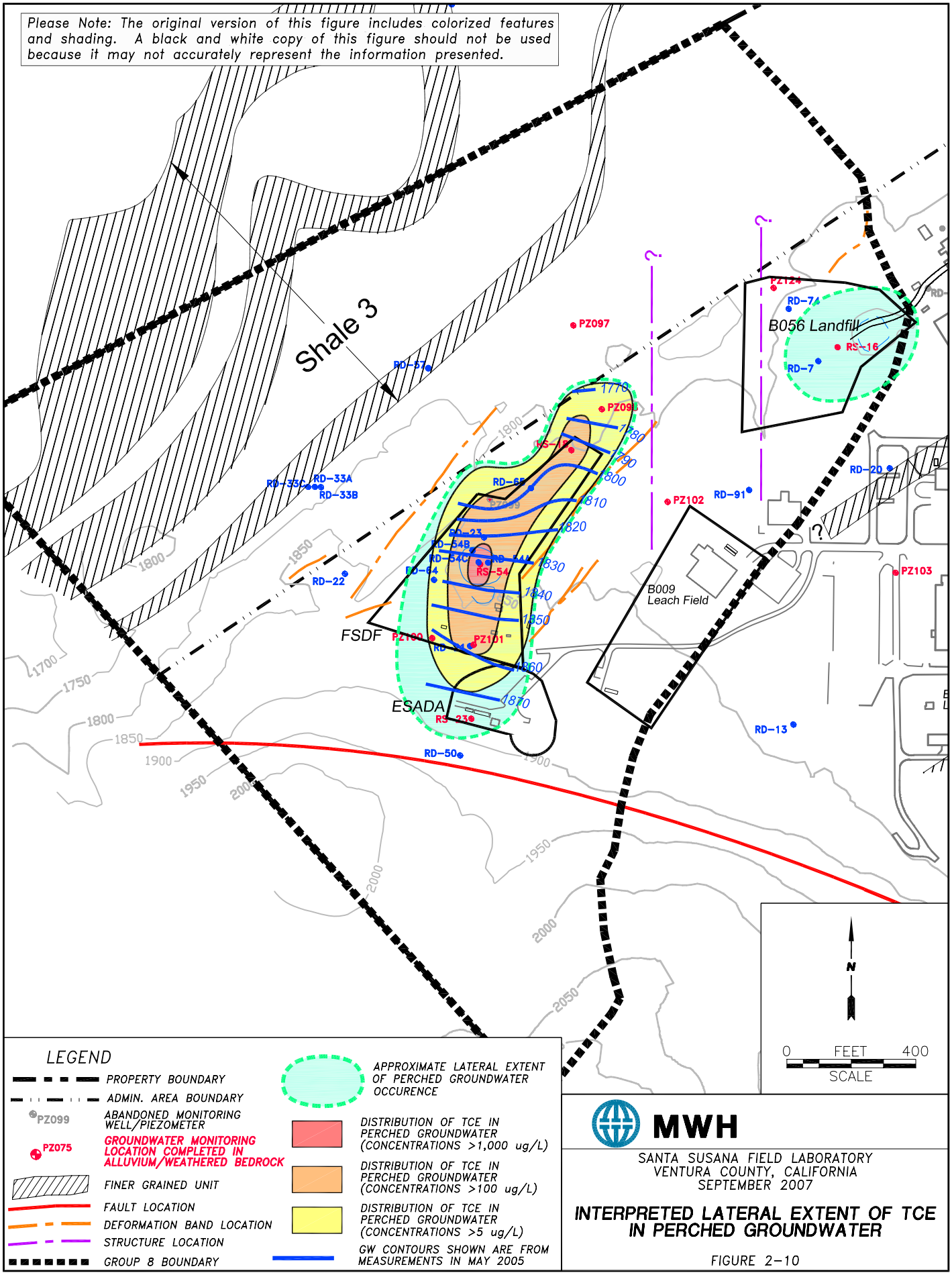
- PROPERTY BOUNDARY
- ADMIN. AREA BOUNDARY
- S21 SPRING/SEEP LOCATION
- PZ075 GROUNDWATER MONITORING LOCATION COMPLETED IN ALLUVIUM/WEATHERED BEDROCK
- RD-29 GROUNDWATER MONITORING LOCATION COMPLETED IN UNWEATHERED BEDROCK
- PZ099 ABANDONED WELL OR PIEZOMETER (2006)
- FINER GRAINED UNIT
- FAULT LOCATION
- DEFORMATION BAND LOCATION
- STRUCTURE LOCATION
- GROUP 8 BOUNDARY

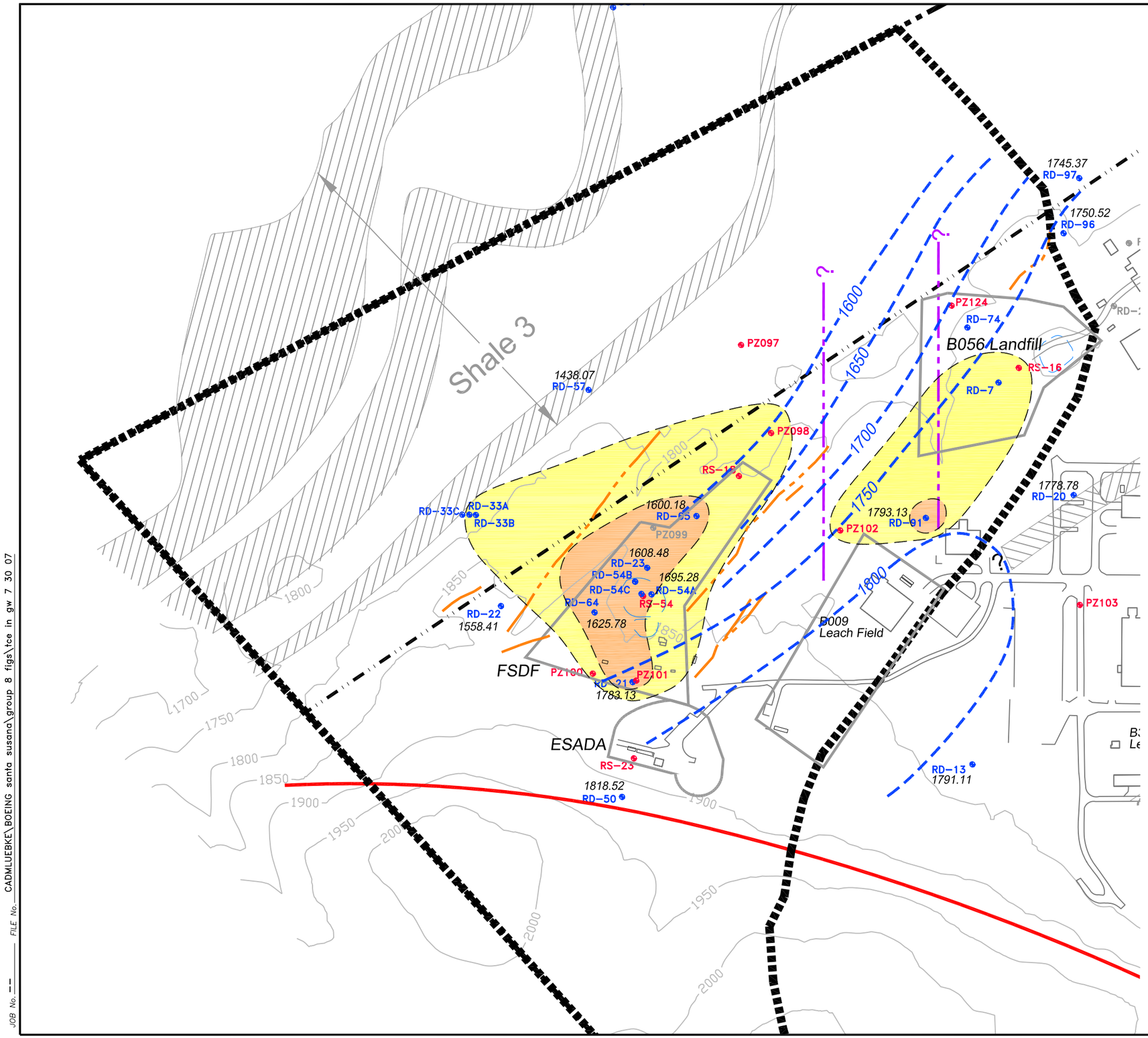
MWH

SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

GROUNDWATER MONITORING LOCATIONS WITHIN GROUP 8

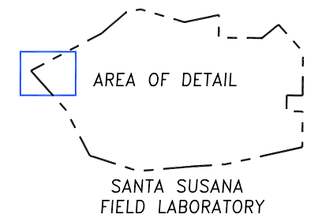
FIGURE 2-9

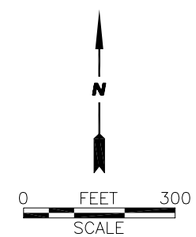

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of this figure should not be used because it may not accurately represent the information presented.
Shale 3
B056 Landfill
B009
Leach Field
FSDF
ESADA
PZ097
PZ098
PZ099
PZ100
PZ101
PZ102
PZ103
PZ124
RD-7
RD-7A
RS-16
RD-13
RD-20
RD-22
RD-23
RD-33A
RD-33B
RD-33C
RD-50
RD-54
RD-54B
RD-54C
RD-65
RD-91
RS-23
RS-54
1700
1750
1800
1850
1900
1950
2000
2050
N
0 FEET 400
SCALE
LEGEND
PROPERTY BOUNDARY
ADMIN. AREA BOUNDARY
ABANDONED MONITORING WELL/PIEZOMETER
PZ099
GROUNDWATER MONITORING LOCATION COMPLETED IN ALLUVIUM/WEATHERED BEDROCK
PZ075
FINER GRAINED UNIT
FAULT LOCATION
DEFORMATION BAND LOCATION
STRUCTURE LOCATION
GROUP 8 BOUNDARY
APPROXIMATE LATERAL EXTENT OF PERCHED GROUNDWATER OCCURENCE
DISTRIBUTION OF TCE IN PERCHED GROUNDWATER (CONCENTRATIONS >1,000 ug/L)
DISTRIBUTION OF TCE IN PERCHED GROUNDWATER (CONCENTRATIONS >100 ug/L)
DISTRIBUTION OF TCE IN PERCHED GROUNDWATER (CONCENTRATIONS >5 ug/L)
GW CONTOURS SHOWN ARE FROM MEASUREMENTS IN MAY 2005
MWH
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007
INTERPRETED LATERAL EXTENT OF TCE IN PERCHED GROUNDWATER
FIGURE 2-10
FILE: C:\ADM\LUEBKE\BOEING santa susana\group 8 figs\NEAR SURFACE GW 7 30 07 TCE
JOB No.



LEGEND

- PROPERTY BOUNDARY
- ADMINISTRATIVE AREA BOUNDARY
- PZ075 — GROUNDWATER MONITORING LOCATION COMPLETED IN ALLUVIUM/WEATHERED BEDROCK
- RD-29 — GROUNDWATER MONITORING LOCATION COMPLETED IN UNWEATHERED BEDROCK
- CHATSWORTH FORMATION WATER TABLE SURFACE (2Q 2007)
- 1818.52 — CHATSWORTH FORMATION WATER TABLE ELEVATION (2Q 2007)
- FINER GRAINED UNIT
- INTERPRETED FINER GRAINED UNIT
- FAULT LOCATION
- DEFORMATION BAND LOCATION
- STRUCTURE LOCATION
- GROUP 8 BOUNDARY
- DISTRIBUTION OF TCE IN CHATSWORTH GROUNDWATER (CONCENTRATIONS >100 ug/L)
- DISTRIBUTION OF TCE IN CHATSWORTH GROUNDWATER (CONCENTRATIONS >5 ug/L)





MWH

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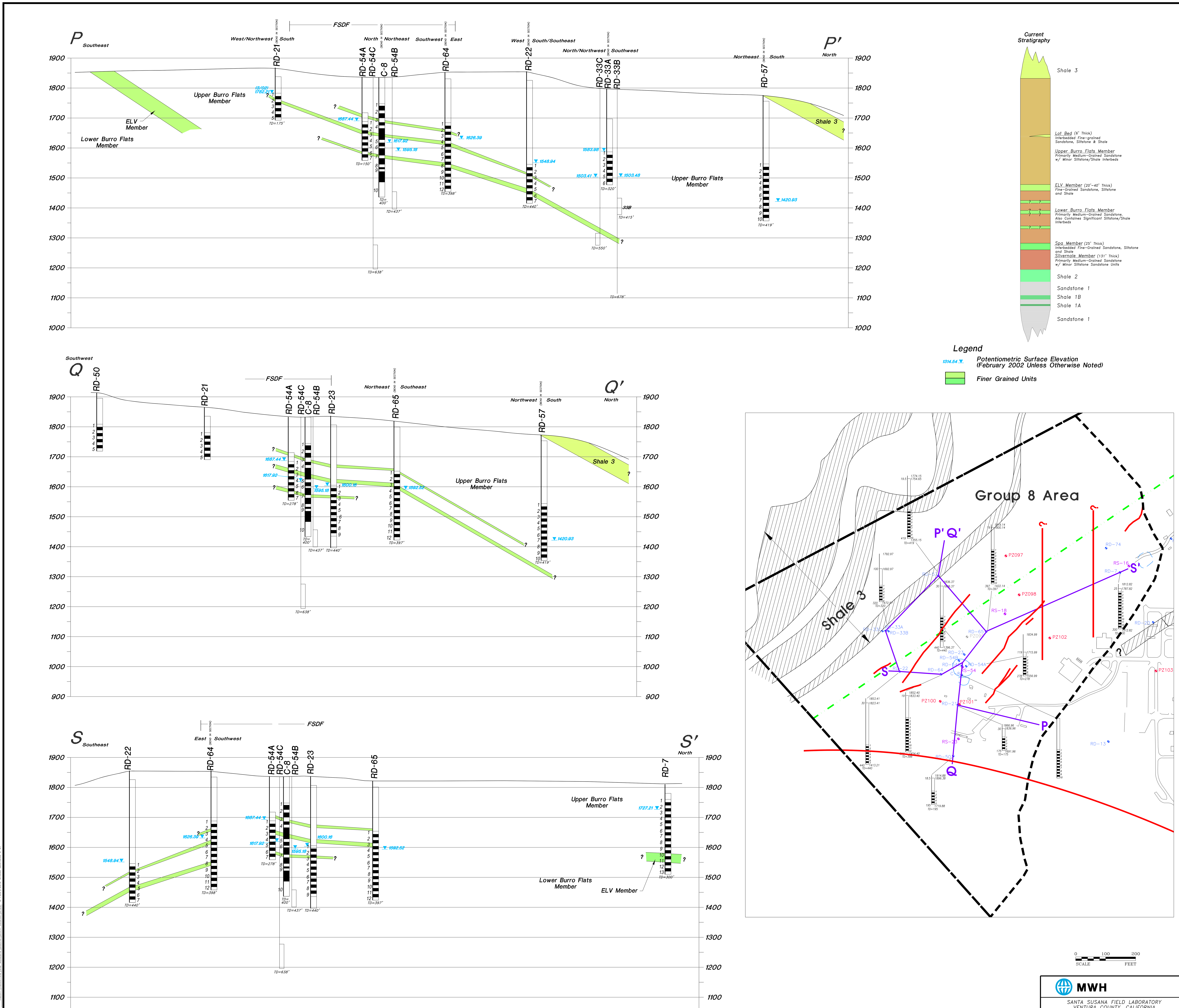
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

INTERPRETED LATERAL EXTENT OF TCE IN CHATSWORTH FORMATION GROUNDWATER

FIGURE 2-11

JOB No. -- FILE No. CADMLUEBKE\BOEING santa susana\group 8 figs\tce in gw 7 30 07



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.

MWH

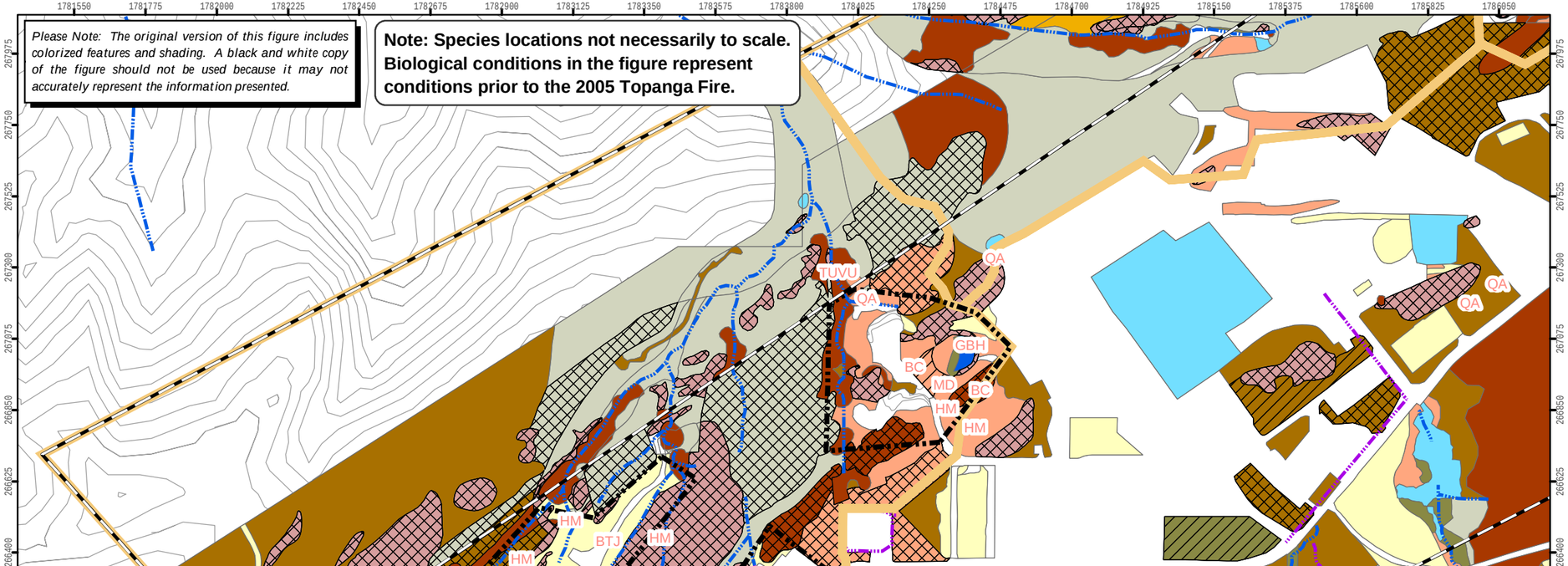
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2007

HYDROGEOLOGIC CROSS SECTIONS AND DEPTHS TO CHATSWORTH FORMATION GROUNDWATER

FIGURE 2-12

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 presented.

Note: Species locations not necessarily to scale. Biological conditions in the figure represent conditions prior to the 2005 Topanga Fire.



Base Map Legend

- Administrative Area Boundary
- RFI Site Boundary
- Report Group Boundary

- VEGETATION WITH ROCK OUTCROPS OVERLAY
- DISTURBED VEGETATION OVERLAY
- BACCHARIS SCRUB
- CHAPARRAL/COAST LIVE OAK WOODLAND
- VENTURAN COASTAL SAGE SCRUB/CHAPARRAL
- CHAPARRAL
- COAST LIVE OAK RIPARIAN FOREST
- COAST LIVE OAK WOODLAND
- FRESHWATER MARSH
- MULEFAT SCRUB
- NATIVE GRASSLAND
- NONNATIVE GRASSLAND
- VENTURAN COASTAL SAGE SCRUB
- DEVELOPED
- OPEN WATER
- RUDERAL HABITAT
- ROCK OUTCROP
- SOUTHERN WILLOW SCRUB
- SOUTHERN WILLOW SCRUB/MULEFAT SCRUB

Sensitive Wildlife

BC	BOBCAT
BTJ	S.D. BLACK-TAILED JACKRABBIT
COHA	COOPER'S HAWK
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

BW	SOUTHERN CAL. BLACK WALNUT
HM	SANTA SUSANA MOUNTAIN TARPLANT
QA	VALLEY OAK
QL	COAST LIVE OAK

Biological Conditions Group 8 Reporting Area

Date: Sep 29, 2007

Document: RFI-Report-Group8_Biological.mxd

1 inch equals 400 feet

0 400 800 Feet

SANTA SUSANA FIELD LABORATORY

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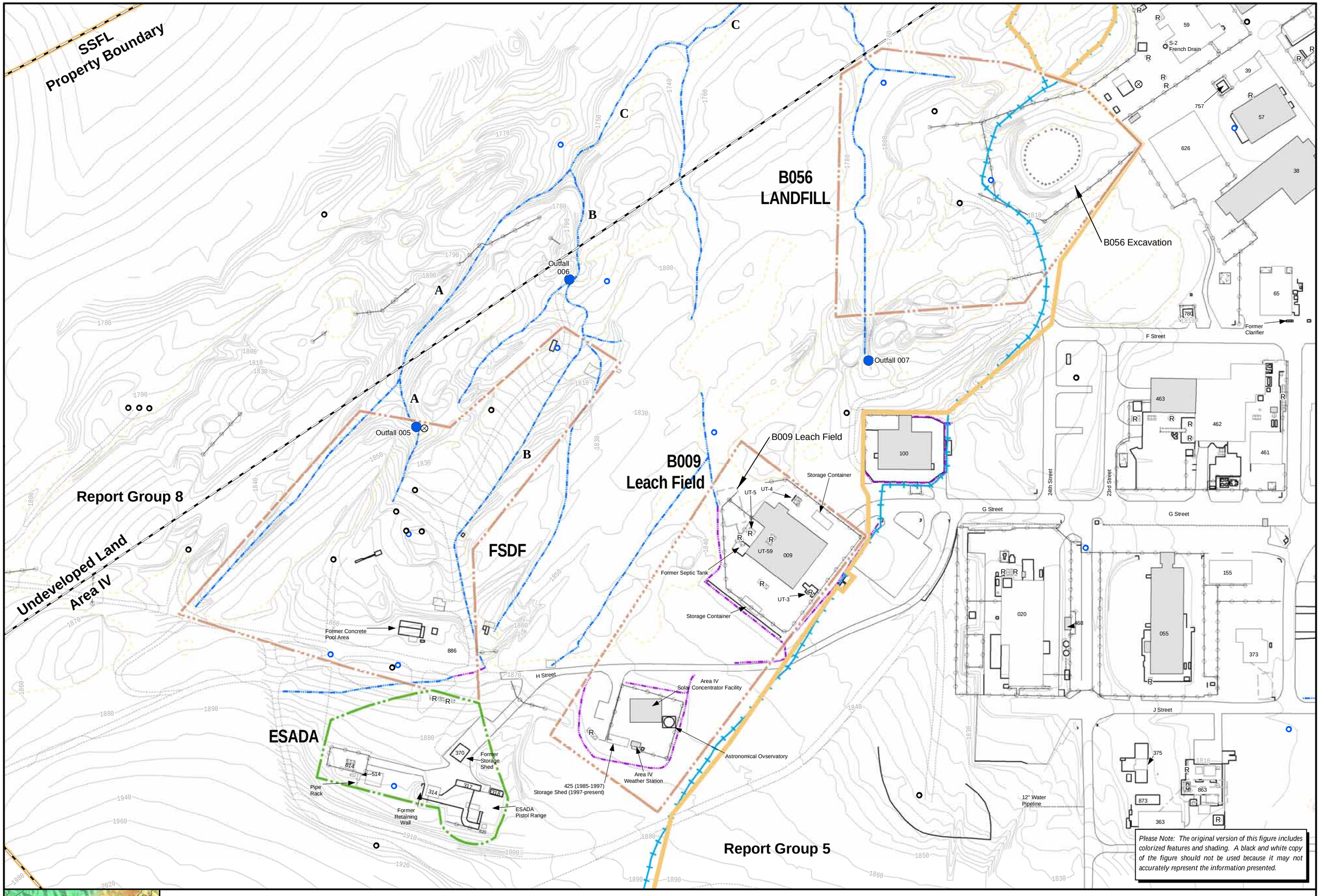
FIGURE 2-13



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 presented.

Administrative Area Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond

Groundwater Wells
- **Near Surface**
- **Chatsworth**
- **Abandoned Well**

NPDES Outfall

RFI Sites by Responsibility
- **DOE**
- **BOEING**

Site Plan
Group 8 Reporting Area
SANTA SUSANA FIELD LABORATORY

1 inch equals 125 feet

0 125 250 Feet

Date: Sep 28, 2007

Document: RFI-Report-Group8_Site_Plan.mxd

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 presented.

SSFL Property Boundary

Sediments witihin channels and banks were removed throughout Channels **A**, **B**, and **C**. Widths of removal varied throughout Channels.

Report Group 8

Report Group 5

B056 LANDFILL

B009 Leach Field

FSDF

ESADA

Undeveloped Land

Outfall 005

Outfall 006

Outfall 007

B056 Excavation (bedrock excavation with partial fill)

Potential Soil Borrow Area

RD-28, RD-24, RD-25, RD-74, RD-07, RD-20, RD-91, RD-13, RD-57, RD-33A, RD-33B, RD-33C, RD-65, RD-23, RD-54B, RD-54C, RD-22, RD-64, RD-54, RD-50, RS-16, RS-18, RS-23, PZ-124, PZ-097, PZ-098, PZ-099, PZ-100, PZ-101, PZ-102, PZ-103, PZ-105, PZ-109, RD-21

F Street, G Street, H Street, J Street, 24th Street, 23rd Street

1782450 1782675 1782900 1783125 1783350 1783575 1783800 1784025 1784250 1784475 1784700

267300 267075 266850 266625 266400 266175 265950 265725

Base Map Legend

- 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
- Dirt Road
- A/C Curbing
- Fence
- Rock Outcrop
- Elevation Contour
- Surface Water Divide
- Drainage
- Lined Drainage
- Pond
- Possible Pond
- Leach Field
- Pipe
- NPDES Outfall

Groundwater Wells

- Near Surface
- Chatsworth
- Abandoned Well

Approximate Areas of Soil Disturbance

- Excavation
- Excavation-Backfill
- Grading
- Landfill
- Other Soil Disturbance Area

Note: Disturbed soils around buildings and/or structures are approximate and are assumed to extend 2 feet around edges of the pad.

Buildings, Improvements, and Soil Disturbances within Group 8 Reporting Area

Date: Sep 28, 2007

Document: RFI-Report-Group8_Disturbance.mxd

1 inch equals 200 feet

0 200 400 Feet

SANTA SUSANA FIELD LABORATORY

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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 presented.

SSFL Property Boundary

Report Group 8

Undeveloped Land Area IV

B056 LANDFILL

B009 Leach Field

FSDF

ESADA

Report Group 5

Outfall 005

Outfall 006

Outfall 007

B056 Excavation

Former Concrete Pool Area

Former Septic Tank

Storage Container

Former Storage Shed

Pipe Rack

Former Retaining Wall

ESADA Pistol Range

425 (1985-1997) Storage Shed (1997-present)

Area IV Solar Concentrator Facility

Area IV Weather Station

Astronomical Ovservatory

12" Water Pipeline

S-2 French Drain

F Street

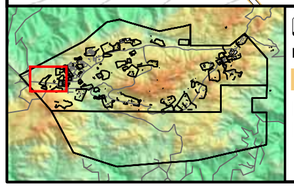
G Street

H Street

J Street

23rd Street

24th Street



Administrative Area Boundary
RFI Site Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leach Field
Drainage
Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond

Groundwater Wells
Near Surface
Chatsworth
Abandoned Well
NPDES Outfall

Chemical Use Area (* Chemical Use Area present at Report Group 8 Area)

Multiple Use *	Oils / PCBs *	Hydrazine	Leach Field *
Solvent	Metals / Inorganics *	Debris *	Potential *
Petroleum *	Perchlorate	Landfill *	

Potential Chemical Use Areas
Group 8 Reporting Area
SANTA SUSANA FIELD LABORATORY

1 inch equals 125 feet

0 125 250 Feet

Date: Sep 29, 2007

Document: RFI_Report-Group8_Chem_use.mxd

FIGURE 3-3