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BOEING

VIA FEDERAL EXPRESS

September 29, 2006

James M. Pappas, P.E.
Chief, Northern California Permitting and Corrective Action Branch
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, California 95826-3200

Re: Submittal of RFI Report for Group 6 Reporting Area, Santa Susana Field Laboratory

Dear Mr. Pappas:

The Boeing Company (Boeing), on behalf of Boeing and the United States Department of Energy, is pleased to submit the Group 6 RCRA Facility Investigation (RFI) Report for the northeastern portion of Area IV at the Santa Susana Field Laboratory (SSFL). This is the first of 10 Group RFI Reports that will be prepared to encompass all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) under investigation. This report provides the characterization data, risk assessment results, and site action recommendations for the Group 6 Reporting Area, consisting of four RFI sites: the Old Conservation Yard (SWMU 7.4), the New Conservation Yard (SWMU 7.8), the Sodium Reactor Experiment (Area IV AOCs), and the Building 064 Leach Field (Area IV AOC).

The Group 6 RFI Report has been designed to meet RFI reporting requirements in the Post Closure permit issued to Boeing. This information includes the nature and extent of chemicals in all media within the reporting area, evaluation of potential contaminant migration, and identification of areas recommended for further work. This report has also been prepared to address DTSC comments dated February 4, 2004 regarding the draft RFI Site Report for the Old Conservation Yard site, and input received regarding the overall RFI reporting process at several meetings held on this topic. For example, DTSC has requested that the report describe and integrate characterization data and risk estimates both laterally (i.e., between RFI sites) as well as vertically (i.e., between surficial media and groundwater). Additionally, the Group 6 RFI Report (presenting results) and the RFI Program Report (presenting overall approach and methodologies) together constitute a 'stand-alone' RFI report as requested by DTSC.

This report presents recommendations for further work in the next phase of the RCRA Corrective Action process, the Corrective Measures Study (CMS). Recommendations are for surficial media (soil, soil vapor, sediment, etc.) but are based upon the characterization data and risk estimates from all the media evaluated in the Group 6 Reporting Area. Because the SSFL groundwater investigation is ongoing, specific CMS recommendations for groundwater will be presented in a future site-wide groundwater RFI report.

BOEING

Boeing and DOE recognize that this is a significant milestone for the SSFL, and we look forward to discussing this report with your team. If you have any questions, please call me at (818) 466-8795.

Sincerely,

Art Lenox
Environmental Remediation

cc:
Mr. Gerard Abrams, DTSC (w/o attachment)
Ms. Laura Rainey, DTSC
Mr. Peter Bailey, DTSC
Mr. Mike Lopez, Department of Energy

SHEA-104332

GROUP 6 – NORTHEASTERN PORTION OF AREA IV
RCRA FACILITY INVESTIGATION REPORT
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

VOLUME I – TEXT, TABLES, AND FIGURES

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AND

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September 2006

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	Atomics International
AOC	Area of Concern
AST	aboveground storage tank
BBI	Brandeis-Bardin Institute
bgs	below ground surface
Boeing	The Boeing Company
BMP	Best Management Practice
BTEX	benzene, toluene, ethylbenzene and xylenes
B040	Building 040
B064 LF	Building 064 Leach Field
CFOU	Chatsworth Formation Operable Unit
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CSM	conceptual site model
COPC	contaminant of potential concern
CPEC	contaminant of potential environmental concern
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
EIR	Environmental Impact Report
EPC	exposure point concentration
ETEC	Energy Technology Engineering Center
°F	degrees Fahrenheit
feet MSL	feet above mean sea level
GRC	Groundwater Resources Consultants, Inc.
GWCC	groundwater comparison concentration
HI	hazard index
HQ	hazard quotient
HRA	human health risk assessment
HSA	Historical Site Assessment
H&A	Haley & Aldrich
ICF	ICF Kaiser Engineers
ILCR	incremental lifetime cancer risk
LMS	linearized multistage
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MW	Montgomery Watson
MWH	Montgomery Watson Harza
NASA	National Aeronautics and Space Administration
NCY	New Conservation Yard
NDMA	N-nitrosodimethylamine
NFA	no further action

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

ng/kg	nanograms per kilogram
NPDES	National Pollutant Discharge Elimination System
NSGW	near-surface groundwater
OCY	Old Conservation Yard
Ogden	Ogden Environmental and Energy Services Company, Inc.
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/L	picograms per liter
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RME	reasonable maximum exposure
RMHF	Radioactive Materials Handling Facility
Rocketdyne	Rocketdyne Division
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
Sapere	Sapere Consulting, Inc.
SMMC	Santa Monica Mountains Conversancy
SRAM	Standardized Risk Assessment Methodology Work Plan
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
STI	Sonoma Technology Inc.
Surficial OU	Surficial Media Operable Unit
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
TCE	trichloroethene
TEQ	toxicity equivalency quotient
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
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
VCEHD	Ventura County Environmental Health Department
VOC	volatile organic compound
WDP	Waste Discharge Permit

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 6 Reporting Area, located in the northeastern 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 purpose of the RFI is 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 6 RFI Report is the first of 10 Group RFI reports that will present results and recommendations for large, interrelated portions of the SSFL. The Group 6 Reporting Area includes four RFI sites: the Old Conservation Yard (OCY), the New Conservation Yard (NCY), the Sodium Reactor Experiment (SRE), and the Building 64 Leach Field (B064 LF). Known and potential chemical use areas were 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 6 Reporting Area is sufficiently complete to estimate current and future risks to potential human and ecological receptors, and support CMS evaluations. Characterization and risk assessment results were used to identify areas within Group 6 where additional work is needed. Therefore, site action recommendations have been made that include: (a) further evaluation in the CMS ("CMS Areas"); (b) no further action ("NFA Areas"); and (c) interim source area stabilization measures to control contaminant migration ("Stabilization Areas").

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 1×10^{-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 6, this evaluation identified 27 CMS Areas which are recommended for further evaluation. Primary chemicals contributing to or driving the estimated risks are indicated in Table ES-1 and on Figure ES-1.

The extent of CMS Areas shown on Figure ES-1 is approximate and comprehensive for all potential receptors (residential, commercial, recreational and ecological).

Within the Group 6 CMS Areas, stabilization measures are recommended for 13 locations to control potential contaminant migration via the surface water pathway. Stabilization Areas are recommended based on evaluation of chemical concentrations, gradients, depth, topographic conditions, containment features (e.g., asphalt cover, dam), and proximity to drainages. CMS Areas with stabilization recommendations are shown in italic font in Table ES-1. Erosion control measures are already in place at most areas recommended for stabilization within the Group 6 Reporting Area.

Recommendations in this report are for surficial media (soil, soil vapor, sediment, etc.) but are based upon the characterization data and risk estimates from all the media evaluated. Because the SSFL 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., mule, 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 6 RFI Report will be reviewed once these additional evaluations are completed and, if needed, updates to this report 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.

TABLE ES-1

SURFICIAL MEDIA RFI RESULTS AND SITE ACTION RECOMMENDATIONS

RFI SITE / CHEMICAL USE	**RISK ESTIMATES** (values provided are maximum risks calculated for entire site)				**GROUPED CHEMICAL USE AREAS**	**CHEMICAL GROUPS DETECTED / MATRIX (soil/sediment unless noted)**	**AREAS RECOMMENDED FOR CMS AND SOURCE AREA STABILIZATION CMS AREA NUMBER / CHEMICAL DRIVERS**
	Human Risks (Surficial Media Plus Indirect Groundwater)			**Ecological Risks (HI)**			
	Residential Risks	Worker Risks	Recreator Risks				
New Conservation Yard (NCY) (SWMU 7.8) The NCY RFI site was used for: • Storage of salvageable materials • A low-background alpha/beta counting laboratory and document incineration	Human risk: 7 x 10^{-5} Human HI: 0.99	Human risk: 4 x 10^{-5} Human HI: 0.15	Human risk: 2 x 10^{-5} Human HI: 0.03	Deer Mouse: >1000 Thrush: 770 Hawk: 71 Bobcat: 200 Mule Deer: >1000	**New Conservation Yard**	VOCs, metals	**NCY 1-1** • Metals
					Ash Pile	PAHs, PCBs, dioxins, metals	***NCY 2-1, NCY 2-2, NCY 2-3*** • PAHs, dioxins, metals
Old Conservation Yard (OCY) (SWMU 7.4) The OCY RFI site was used for: • Storage (four areas) for salvageable materials • Storage and pumping of diesel fuel oil. In addition, other portions of the site included: • Debris areas containing construction debris or storage of burned telephone poles • Transformers	Human risk: 2 x 10^{-2} Human HI: 5.3	Human risk: 1 x 10^{-2} Human HI: 0.28	Human risk: 5 x 10^{-3} Human HI: 1.4	Deer Mouse: >1000 Thrush: 781 Hawk: 169 Bobcat: >1000 Mule Deer: >1000	**Storage Areas:** • Former Rocketdyne Conservation Yard • Former AI Conservation Yard • Former North Slope Storage Area	VOCs (soil vapor and soil / sediment), PAHs, TPH, PCBs, metals	**OCY 1-1, OCY 1-2, *OCY 1-3, OCY 1-4*** • PAHs, PCBs • Address uncertainty for 2,4-dinitrophenol
					Fueling Areas: • Former Fueling Area at Building 320	VOCs, TPH	**OCY 3-1** • VOCs • Address uncertainty for 2,4-dinitrophenol
					Debris Areas (Southeast OCY): • Former Telephone Pole Storage Area • Northern and Southern Debris Areas	PAHs, TPH, PCBs, dioxins, metals	***OCY 5-1, OCY 6-1, OCY 6-2*, OCY 6-3** • PAHs, PCBs, dioxins, metals • Address uncertainty for 2,4-dinitrophenol
					Debris Area (North Slope): • North Slope Debris Area "A" • North Slope Debris Area "B"	PAHs, TPH, PCBs, metals	***OCY 6-4*, OCY 6-5** • PCBs, metals
					Transformer Areas: • Transformer Area in southeast • Transformer Area 737	PCBs	**OCY 7-1, OCY 7-2** • PCBs
					Downslope Drainage Areas: • Former SRE Pond Discharge Pipeline • Topographic Low Spot, Downslope Area	VOCs, PAHs, TPH, PCBs, dioxins, metals	***OCY 4-1, OCY 8-1 , OCY 8-2*** PAHs, PCBs, dioxins, metals
Sodium Reactor Experiment (SRE) (Area IV AOC) The SRE RFI site was used for: • Nuclear power reactor and supporting operations • Southern California Edison (SCE) power plant operations • Hot oil / Sodium component cleaning • Storage of fuel oil In addition, other portions of the site included: • Sanitary leach field • Downslope drainage and pond areas • Transformers • Diesel and gasoline fuel USTs	Human risk: 4 x 10^{-4} Human HI: 8.1	Human risk: 2 x 10^{-4} Human HI: 1.2	Human risk: 1 x 10^{-5} Human HI: 2.1	Deer Mouse: 74 Thrush: 671 Hawk: 150 Bobcat: 4.9 Mule Deer: 16	**SCE Steam Power Plant**	VOCs (soil vapor), TPH, mercury	***SRE 3-1*** • Mercury
					Building 003 Leach Field	PAHs, TPH, metals	**SRE 7-1** • PAHs, metals
					Transformer Areas: • Transformer Area 963 • Transformer Area South of Building 003	PCBs	**SRE 9-1, SRE 10-1** • PCBs
					Oil Stain at Building 003	VOCs (soil vapor and soil / sediment), TPH, PCBs	**SRE 11-1** • VOCs, PAHs
					Downslope Drainage and Pond Areas: • SRE Pond Influent Channels (lined) • SRE Pond • Drainage Downslope of SRE Pond	VOCs, PAHs, TPH, PCBs, dioxins, metals	**SRE 14-1, *SRE 14-2*** VOCs, PAHs, PCBs, dioxins, metals Sediment contained in the lined channel is also recommended for removal as part of facility maintenance activities.
Building 064 Leach Field (B064 LF) (Area IV AOC) Sanitary leach field	None				**B064 Leach Field**	Metals	None

<u>ACRONYMS:</u>

AOC Area of Concern
CMS Corrective Measures Study
HI Hazard Index
PAH polynuclear aromatic hydrocarbon
PCB polychlorinated biphenyls
RFI RCRA Facility Investigation
SVOC semivolatile organic compound
SWMU Solid Waste Management Unit
TPH total petroleum hydrocarbons
UST underground storage tank
VOC volatile organic compound

Italic fonts indicate CMS Area also recommended for soil source stabilization action.

Notes: (1) Chemical use areas have been grouped by location and related chemical use; (2) residential risk estimates presented above do not include direct groundwater exposures; direct groundwater risk estimates are 3 x 10^{-6} and HIs range up to 8.2; (3) metals and dioxins are listed if detected above background comparison concentrations.

MWH

SECTION 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 6 Reporting Area located in the northeastern 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 6 Reporting Area includes the New Conservation Yard (NCY), Old Conservation Yard (OCY), the Sodium Reactor Experiment (SRE), and the Building 064 Leach Field (B064 LF) RFI Sites.

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 6 Reporting Area, described further in Section 1.3, is primarily located in the northeastern portion of Area IV although portions of the reporting area extend into Area III and the northern undeveloped land.

Prior to development, the land at the SSFL was used for ranching. During 1948, North American Aviation (a predecessor company to Boeing) began using (by lease) what is now known as the northeastern portion of the SSFL. The majority of the SSFL was acquired as part 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 Division (Rocketdyne) of North American Aviation and of the Rockwell Corporation. The vast majority of rocket engine testing and ancillary support operations occurred from the 1950s through the early 1970s, and 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 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 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 was used in small rocket motor testing and various research and development programs. Solid propellants, including perchlorate compounds, were primarily used, stored, or 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, liquid metal heat exchanger components, nuclear energy research, and related technologies. Nuclear energy research, testing, and support facilities were located within the 90-acre portion of

Area IV that was leased to DOE and designated as the Energy Technology and Engineering Center (ETEC). Operations were conducted by Atomics International (AI), a division of North American Aviation, and Rocketdyne on behalf of DOE, primarily from the 1950s through the early 1980s.

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 Santa Monica Mountains Conservancy (SMMC). 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 indicates that this property contains religious, teaching, and camping facilities. The SMMC property is zoned as open space.

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 is under development 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

Five 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 also being conducted at the SSFL, including permitting for air and surface water discharges, 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 occur within 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, beginning in 1984. Surface water discharges are regularly monitored at 18 NPDES locations, shown on Figure 1-2.
- Fuel storage tanks at the site are now included in the RCRA Program under oversight by DTSC. Historically, underground storage tanks (USTs) were regulated by the Ventura County Environmental Health Division (VCEHD). Aboveground storage tanks (ASTs) were regulated by the RWQCB.
- 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 include 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 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 description 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 include the RCRA Facility Assessment (RFA), the 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 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 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. It should be noted that for ease of presentation on this figure, and as reported in previous documents (MWH, 2004), Boeing and DOE leach fields each have been grouped together and listed as one RFI site.

The RFI includes characterization of all 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 [MW], 2000b; Montgomery Watson Harza [MWH], 2001; MWH, 2003e, 2003f, 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 within CMS Areas.

The CMS phase of the RCRA Corrective Action Program is an evaluation of remedial alternatives for areas identified for further evaluation during the RFI. The CMS may also include further evaluation of uncertainties identified in the RFI related to risk assessment 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. 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.

1.2.2 Operable Units at the SSFL

Since the early 1980s, SSFL site characterization has proceeded along two parallel paths: one for groundwater and the other for soil and related surficial media. In 1999, DTSC formalized this approach by identifying two Operable Units (OUs) (DTSC, 1999). As defined by United States Environmental Protection Agency (USEPA), an OU is a discrete entity that may comprise various attributes, including characteristics of the impacted media, geographical location, vertical and areal 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. Two OUs have been identified at the SSFL through discussion with DTSC based on an understanding of where chemicals are present today, where they may migrate in the future, and how either human or ecological receptors may be exposed to those chemicals (DTSC, 1999). The OUs at the SSFL are:

- The Surficial Media OU (Surficial OU), comprised of saturated and unsaturated soil, sediment, surface water, 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 these two OUs is the boundary between weathered and unweathered bedrock. 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).

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 Chatsworth formation media (bedrock or groundwater) are also considered as part of the RFI site risk assessments.

As stated above, a goal of the RFI Program is to characterize chemical impacts in all 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 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 evaluation for either the Surficial OU or 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) 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 10 Group Reporting Areas as shown on Figure 1-5. 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 will be 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. Group 7 includes two areas shown on Figure 1-5 that will be reported together.

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.

Two aspects of the Surficial Media RFI will be addressed after all Group RFI Reports are prepared. 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 resulting from the on-going CFOU investigation must be 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 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., mule deer and hawk). Assessment of potential risks to these receptors will be performed once sufficiently large areas of the site 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. In both of these cases, additional Surficial Media recommendations will be in addition to those presented in the Group Reports.

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 by subsequent site-wide RFI evaluations.

1.3 SCOPE AND OBJECTIVES OF THE GROUP 6 RFI REPORT

The Group 6 RFI Report presents RFI findings and CMS recommendations for the northeastern portion of Area IV. The scope and objectives of the Group 6 Report are described below, as well as the content and format of this report.

1.3.1 Scope

The Group 6 Reporting Area consists of approximately 88 acres located in the northeastern portion of Area IV and extends into the northern undeveloped land (Figure 1-6). Approximately 49 of the 88 acres of the reporting area occur within Area IV, 38 acres occur in the northern undeveloped land, and slightly more than 1-acre occurs in Area III. Adjacent areas to Group 6 Reporting Area include BBI property to the north, maintenance operations in Area II to the east, DOE-operational areas in support of nuclear energy research to the west, and the Silvernale Reservoir to the south. The Group 6 Reporting Area is adjacent to five other Group Reporting Areas, as shown on Figure 1-6. Reporting Groups 2 and 3, consisting primarily of NASA RFI sites, are to the east. Reporting Groups 5 and 7, consisting of DOE and Boeing RFI sites, are located to the west and south. Reporting Group 9, including Silvernale Reservoir, is located to the south of Group 6, and is shown on Figure 1-5.

Four RFI sites are included in the Group 6 Reporting Area:

OCY RFI Site	SWMU 7.4: Old Conservation Yard
NCY RFI Site	SWMU 7.8: New Conservation Yard
SRE RFI Site	Area IV AOC: SRE Complex Area Area IV AOC: Building 003 Leach Field
B064 LF RFI Site	Area IV AOC: Building 064 Leach Field

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 Appendix A and in Section 4, RFI sampling extended outside of these boundaries, as necessary, to determine the nature and extent of potential contamination and assess migration pathways. Overall, approximately 21 of the 88 acres of the Group 6 area are contained within the outlines of the RFI site boundaries shown on Figure 1-6.

1.3.2 Objectives

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

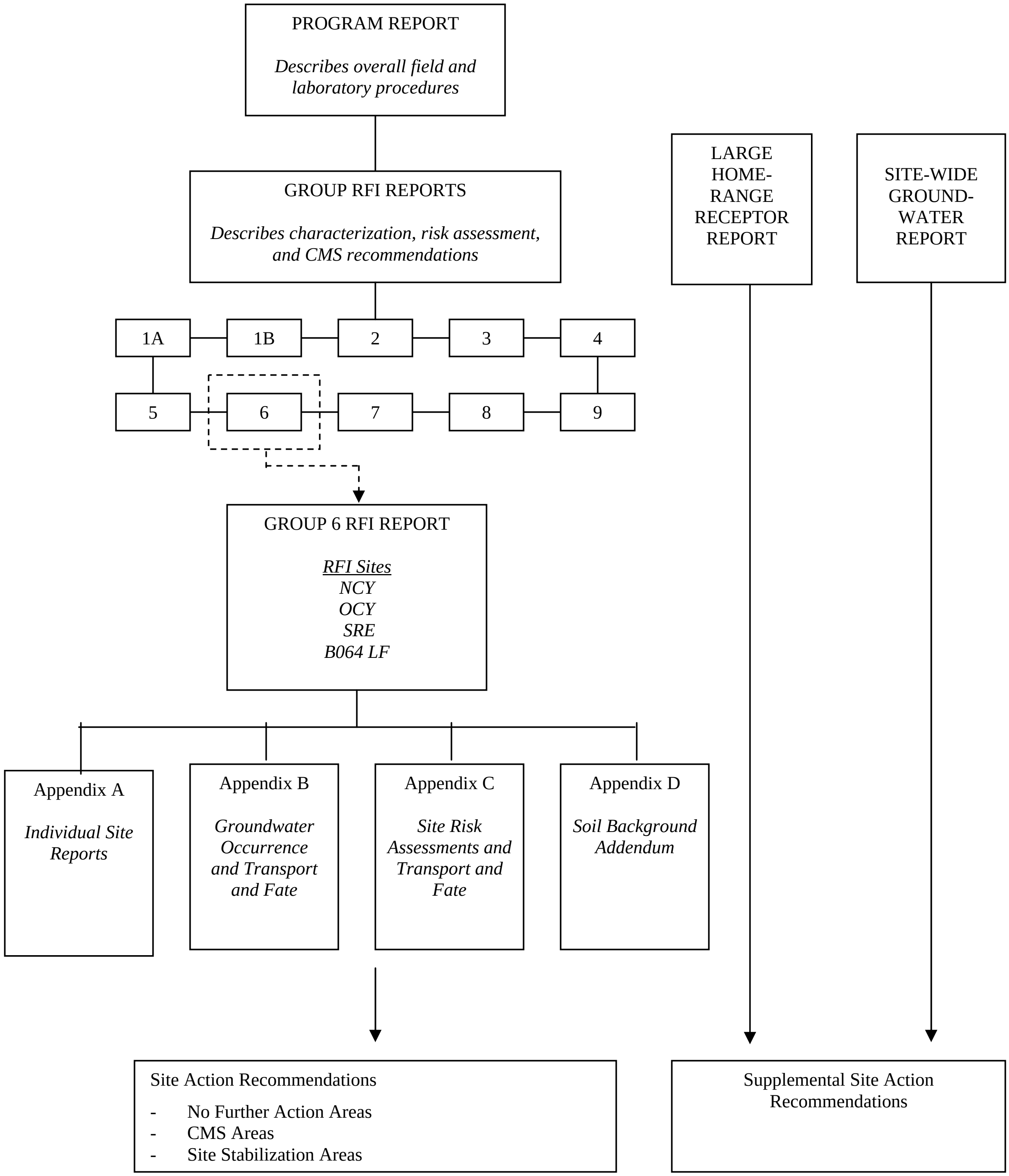
- To present characterization results in the Group 6 Reporting Area and identify the nature and extent of chemical contamination in environmental media.
- To present human health and ecological risk assessment results based on chemicals present in the Group 6 Reporting Area.
- To present risk-based recommendations 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 defined sufficiently for CMS planning, although supplemental areas or volumes 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 Content and Format

To present the necessary information regarding characterization findings, risk assessment results, and site action recommendations, the Group 6 Report is divided into nine sections and four appendices. A diagram for the Group 6 RFI report structure is shown below, and presented in relationship to the overall RFI reporting approach for the SSFL.

RFI REPORTING PROCESS



This volume (i.e., Volume I) of the Group 6 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. The following describes the content of this document:

Volume I:

Section 1 – Introduction. This section provides SSFL background and operations, description of environmental programs, RFI strategy and reporting, and the scope and objectives of this Group 6 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. 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 3 – Group 6 Site History and Chemical Use. This section summarizes the history of the Group 6 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 presented.

Section 4 – Nature and Extent of Chemicals in Group 6. 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 described in Appendix A, as presented 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 6 Reporting Area based on RFI site and Group 6 risk assessments.

Section 7 – Group 6 RFI Report Summary and Site Action Recommendations. This section describes reporting requirements, and presents the criteria and process applied to make site action recommendations. Specific areas within the RFI sites are identified as recommended areas for further evaluation in the CMS, including those also recommended for source stabilization measures.

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 used in the document that may be unfamiliar to the reader.

Volumes II and III:

Appendix A – RFI Site Reports. This appendix presents detailed site history, characterization findings, risk assessment results, and site action recommendations for the four RFI sites evaluated in the Group 6 RFI Report. Site operational histories are described, and sampling results are presented in tables for each potential chemical use area and depicted on maps. Groundwater conditions and risk assessment findings for each site are included. The overall format of these appendices generally follows that presented in this volume of the Group Report. Each RFI site report is a section within Appendix A (Appendix A1, A2, etc.).

Volume IV:

Appendix B – Groundwater Characterization. This appendix presents information regarding groundwater conditions in the Group 6 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 chemicals in groundwater that are site-related to support characterization and risk assessment.

Appendix C – 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, risk calculations, result tables, and all transport and fate modeling.

Appendix D – Soil Background Report Addendum. This appendix presents the *Soil Background Report Addendum*. This addendum report provides the results and interpretation of soil and ash samples collected from background sample locations and analyzed for fire-related chemicals after the September/October 2005 Topanga Fire.

SECTION 2.0
PHYSICAL SETTING OF THE REPORTING AREA

This section describes the physical setting within the Group 6 Reporting Area. The RFI Program Report provides an overview of the physical setting at the SSFL (MWH, 2004).

2.1 TOPOGRAPHY

The area of land encompassed within the Group 6 Reporting Area occupies approximately 88 acres, with about 440 feet of topographic relief. A shaded relief map showing the site topography is provided on Figure 2-1. Just north of the SRE RFI Site, Group 6 surface elevation reaches a maximum of approximately 1,980 feet above mean sea level (feet MSL). The lowest surface elevation is approximately 1,540 feet MSL and occurs in a natural surface water drainage at the northern SSFL boundary. Within the former operational areas of southern Group 6, surface elevation is mostly between about 1,825 and 1,845 feet MSL. The SRE Pond is a topographic depression in the northeastern portion of that site; the pond elevation is typically about 1,815 feet MSL. The southernmost portion of Group 6 is a broad, relatively flat portion of the SSFL with local relief associated with rock outcrops. This area is referred to as Burro Flats.

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), a landward wind pattern occurs due to proximity of the adjacent 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 6 Reporting Area. A wind rose diagram from January to December 2001 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 both in the 1960s and 1990s.

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 3-year period from October 2000 through September 2003 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 the Transverse Ranges of southern California, a geomorphic province resulting from north-south compression associated with the San Andreas Fault. As a result, geologic structures such as faults and folds trend in an approximate east-west direction. Soils and bedrock within Group 6 are described in this section.

2.3.1 Soil

Group 6 soils consist primarily of weathered products of Chatsworth formation bedrock (alluvium), colluvium, and fill soils. Figure 2-4 shows the approximate extent of alluvium, including fill soil areas, within the Group 6 Reporting Area. Alluvium occurs mainly within topographic lows and along stream drainages, although a thin alluvial veneer (5 to 10 feet thick) covers a broad expanse of the Burro Flats area. Fill materials have been used in some of the developed operational areas of the SRE and OCY Sites.

Soils are comprised mostly of silty sand, sandy silt and lean clay. Finer-grained soils exist in the western portion of the NCY RFI Site also contain ash resulting from site operations. The SRE Pond contains freshwater sediment eroded from the surrounding areas, and consists of sandy silt, silty sand, and organic silt. The topographic low spot within the OCY RFI Site contains sediment eroded from areas within the site, and includes discharge from the SRE Pond to the west. These sediments are typically lean clays and sandy silts. Sediment in the drainages typically consists of sandy silt and silty fine-to-medium sands.

Based on soil boring logs (Appendix A), soil and fill thickness ranges up to approximately 8 feet at the OCY RFI Site, 27 feet at the SRE RFI Site, 13 feet at the NCY RFI Site, and less than 1 foot at the B064 LF RFI Site. Soils are generally comprised of lean clay, sandy silt, and silty sand.

2.3.2 Bedrock

The Group 6 Reporting Area is situated on the Upper Burro Flats Member of the Upper Chatsworth formation (MWH, 2002). Figure 2-5 shows the geologic units represented within the SSFL, and Figure 2-6 presents a stratigraphic column of these units. The Upper Chatsworth formation is a series of interbedded sandstone and shale units that generally strike N70°E and dip between 20° and 30°NW. The Upper Burro Flats Member is comprised of fine- to medium-grained sandstone. The ELV Member occurs between the Upper and Lower Burro Flats Members, and is comprised of thinly interbedded fine-grained sandstone, siltstone, and shale. The Lot Bed is a distinct shale unit that has been mapped west of the former OCY RFI Site AST earthen berms.

The bedrock underlying the SSFL has a controlling influence on groundwater flow and contaminant transport and fate. For this reason, various bedrock physical property measurements have been made. Bedrock properties have been estimated based on laboratory measurements performed on bedrock samples and from borehole geophysical logs collected from wells within the Group 6 Reporting Area. These properties are briefly discussed in Section 5 and presented in tables included with Appendices B and C.

2.4 SURFACE WATER

The SSFL sits atop the Simi Hills, and surface water runoff drains both to the north into the Arroyo Simi in Simi Valley and to the east and south into Bell Creek, which leads to the Los Angeles River (Figure 2-7A). Details of Group 6 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 6 Reporting Area first presents overall drainage patterns, followed by more detailed site descriptions.

Overall Surface Water Flow for Group 6

Group 6 consists of three watersheds (also known as 'drainage basins'), with two located in the north and one in the south. One northern watershed consists solely of undeveloped land. The other northern watershed is comprised of the SRE RFI Site and the northernmost portion of the OCY RFI Site. The northern drainage basins lead to Meier Canyon and the Arroyo Simi (shown on Figure 2-7A). Outfall 004 at the SRE RFI Site is the established NPDES monitoring location in this area of the SSFL (Figures 2-7A and 2-7B).

The southern portion of the Group 6 Reporting Area is part of a larger SSFL drainage basin in which surface water flow leads first to Silvernale Reservoir (SWMU 6.8) and secondly to the R-2 Ponds (SWMU 5.26), before exiting the SSFL to the south through undeveloped land to Bell Creek. NPDES monitoring points for this drainage basin at the SSFL include Outfall 018 at the R-2 Ponds and Outfall 002 in the undeveloped land (Figure 2-7A).

Surface Water Flow at the Group 6 RFI Sites

As shown on Figure 2-7A, surface water flow over the majority of the SRE RFI Site is to the east toward the SRE Pond, before it flows north through the undeveloped land to Simi Valley (Figure 2-7B).

The SRE Pond is an approximately 250,000-gallon capacity surface water body that historically contained storm water or waste water runoff from SRE RFI Site activities. The pond is typically dry, except during or immediately following the wet winter months. Historically, SRE Pond water was pumped via an aboveground pipe and discharged in the southern portion of the OCY RFI Site (Figure 2-7B). The SRE pipeline was likely inactive by the early to mid-1990s (Trippeda, 2006b). The SRE Pond also includes a valve-controlled discharge pipe that can be used to discharge water to the northern drainage (Rockwell, 1977).

Surface water flow at the OCY RFI Site is generally to the south, although a small portion of the northernmost part of the site drains to the north through the undeveloped land (Figure 2-7B). Generally, surface water channels are not well defined in the OCY RFI Site, so most drainage occurs by sheet flow, exiting the site to the south in both the east and the west. In the west, surface water flow generally leads to a wide, topographically low area. This ‘low spot’ is not a well defined channel, but does contain a 5-foot wide, asphalt-lined drainage swale that begins at the SRE discharge pipeline and extends south to the paved road. This ‘low spot’ is commonly wet during the winter months. Surface water drainage in both the east and west is conveyed south under the road via storm water culverts.

Surface water flow at the NCY RFI Site occurs by sheet flow from both the western and eastern portions of the site, within a defined drainage that occurs in the center and south of the site. This drainage is asphalt-lined from its origin at OCY until it turns and trends east-west south of the NCY RFI Site (Figure 2-7B). This drainage joins the eastern tributary leading from the OCY RFI Site described above. This drainage ultimately leads to the Silvernale Reservoir.

Surface water flow at the Building 064 LF RFI Site occurs mostly via sheet flow that enters a concrete-lined channel and flows east to the road (Figure 2-7B). At the road, the concrete channel transitions to an unlined swale and flows northward to a culvert that conveys flow east under the road to the NCY RFI Site. Surface water discharges from a pipe near the northwest corner of the NCY RFI Site flows east-northeast, joins flow in the asphalt-lined swale from the OCY low spot, and continues south through the NCY RFI Site (Figure 2-7B).

2.5 GROUNDWATER

Both near-surface and CFOU groundwater are present in the Group 6 Reporting Area and are monitored by wells and/or piezometers. As described in Appendix B and various groundwater reports (MWH, 2003a and b), NSGW is present in localized areas across the SSFL, but the CFOU groundwater is a regional unit, present throughout this area (Figure 1-1). Groundwater is regularly sampled at the SSFL and data published in annual and quarterly groundwater reports (Haley & Aldrich [H&A], 2006a and b).

Details of the groundwater system and monitoring network in the Group 6 Reporting Area are presented in Appendix B. The general relationship of the NSGW and CFOU groundwater units in the Group 6 Reporting Area is shown on Figure 2-8.

As described in Appendix B, the over 400 monitoring wells, piezometers, and springs within and near the SSFL have been divided into the 10 RFI Group Reporting Areas. Well associations 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 within or near a RFI site were associated with that RFI site, and wells near Group Reporting Area boundaries were included for evaluation of chemical impacts and/or transport and fate evaluations. Similarly, springs or seeps have been associated with RFI sites and Reporting Areas based on presence within or proximity to the reporting areas. Wells, springs, and seeps are evaluated both on- and offsite for inclusion in the Group Reporting Areas.

NSGW and CFOU groundwater occurrence and quality for the Group 6 Reporting Area, including springs and seeps, are described in the following sections.

2.5.1 Near-Surface Groundwater

Within the Group 6 Reporting Area, NSGW is monitored by the following wells/ piezometers:

- RS-25 – west of the SRE RFI Site
- PZ-114 – southeast of the OCY RFI Site
- PZ-115 – at the NCY RFI Site
- PZ-113 – south of the NCY RFI Site
- PZ-056 – east of the NCY RFI Site.

Figure 2-9 shows the locations of these wells and piezometers and the extent of NSGW in the area. NSGW typically only occurs within the southeast corner of the Group 6 Reporting Area. In this piezometer, NSGW occurs periodically within weathered bedrock at depths ranging from 14 to 24 feet bgs. NSGW has been measured at other Group 6 locations. NSGW in R5-25 periodically occurs in this well at depths ranging from approximately 10 feet bgs to greater than 13.5 feet bgs. In PZ-114, NSGW occurs periodically within weathered bedrock at depths ranging from 34 to 48 feet bgs. NSGW has only occurred in PZ-113 during three monitoring events since it was installed in 2001

(Appendix B); PZ-115 has been dry since that time (MWH, 2003b). NSGW flow is generally to the south, following surface topography.

2.5.2 Chatsworth Formation Groundwater

Within the Group 6 Reporting Area, CFOU groundwater is monitored by the following wells:

- RD-14 and WS-07 – within the OCY RFI Site
- RD-15 and RD-92 – to the east and south of the NCY RFI Site, respectively
- RD-18, RD-85, and RD-86 – within the SRE RFI Site
- RD-92 – to the east of the B064 LF RFI Site

Figure 2-10 shows the locations of these wells and CFOU groundwater elevations (potentiometric surfaces). Also shown on this figure are the estimated extents of TCE plumes present in both NSGW and CFOU groundwater near the Group 6 Reporting Area.

In the southern portion of the Group 6 Reporting Area, including most of the OCY, NCY, and B064 LF RFI Sites, depths to CFOU groundwater generally range from 35 to 60 feet bgs. At the OCY RFI Site, CFOU groundwater occurs at depths typically ranging from 50 to 60 feet bgs. At the NCY RFI Site, depths to CFOU groundwater vary, ranging from 25 to 78 feet bgs in RD-15 and occurring at approximately 60 feet bgs in RD-92. CFOU groundwater at the B064 LF RFI Site is also monitored in RD-92. Water level variations described above generally depend on rainfall, with the shallowest depths to CFOU groundwater coinciding with El Nino events (e.g., 1993 and 1998 – see Figure 2-3A).

In the northern portion of the Group 6 Reporting Area, at the SRE RFI Site, CFOU groundwater levels range from approximately 27 feet bgs at the eastern end of the site (RD-85), to about 58 feet bgs near the SRE Pond (RD-86). South of the SRE Pond, CFOU depths to groundwater range from approximately 63 to 95 feet bgs (RD-18).

CFOU groundwater flow is generally northward within the northern portion of the Group 6 Reporting Area (Figure 2-10). In the central and southern portions of the area, gradients are fairly flat.

Figure 2-11 depicts hydrogeologic cross-sections for the Group 6 Reporting Area. As shown on both cross-sections, water levels decrease to the north and do not appear greatly influenced by geologic formation changes (i.e., rock type differences).

2.5.3 Springs and Seeps

Springs and seeps have not been identified in the Group 6 Reporting Area, although three occur to the north and east (Appendix B). Based on current understanding of groundwater flow directions, described above, these springs are unlikely to be sourced from impacted Group 6 groundwater, and thus are not considered further in this report. The three springs and seeps reported to the north and east will be considered and addressed in the Group 2 and Group 3 Reporting Area Reports (Figure 2-9) (MWH, 2003d).

2.6 BIOLOGY

Biological conditions within the Group 6 Reporting Area are shown on Figure 2-12. This map depicts conditions before the 2005 Topanga Fire. Both pre- and post-fire vegetation conditions are described below. Sensitive species within the Group 6 Reporting Area include the mule deer, two-striped garter snake, bobcat, coast live oak, valley oak, *quercus lobata*, and Santa Susana Mountain tar plant (MWH, 2005a).

<u>Pre-Fire Conditions</u>

Most of the southern portion of the OCY RFI Site is considered disturbed, non-native grassland. The remaining southern areas of the site are a mixture of Venturan coastal sage scrub, coast live oak woodland, mulefat scrub, and rock outcrops. The northern portion of the OCY RFI Site is primarily ruderal habitat, non-native grassland, mulefat scrub, and sandstone outcrop with small areas of Venturan coastal sage scrub and chaparral (contiguous with extensive areas of coastal sage and chaparral offsite to the north). A small portion of the OCY RFI Site is considered to be developed lands (i.e., a dirt road).

The topographically flat, eastern areas of the SRE RFI Site are characterized by sage scrub, ruderal habitat, and rocky outcrops, which occur throughout the site. The SRE Pond and adjacent areas contain coast live oak woodland, southern willow scrub, and mule fat scrub, while fresh water marsh plants are found in the wet portion of the pond. A small portion of the SRE RFI Site is developed, including a dirt road and an area covered by a plastic tarp.

At the NCY RFI Site, coast live oak woodland and non-native grassland occur in the gently sloping areas leading to the central drainage. The drainage contains mulefat scrub in places, and Venturan coastal sage scrub and chaparral are found to the northeast and southeast of the site, respectively.

The Building 064 LF RFI Site consists of ruderal habitat, non-native grassland, and rock outcrops. Developed land includes a paved road near the site.

<u>Post-Fire Conditions</u>

During the September/October 2005 Topanga Fire, much of the vegetation at the SSFL (including the Group 6 Reporting Area) was burned and significant ash deposited, especially in drainages. Both native and non-native plant species identified above were destroyed by the fire. In areas with limited vegetation (e.g., bedrock or grasses), effects of the fire were minimal. Areas with more vegetation (e.g., trees and chaparral) were impacted significantly by burning and deposition of ash.

When observed in July 2006, the plant community in the Group 6 Reporting Area was in a transitional state where early post-fire plant species were growing (Appendix C). It is expected that the plant community will continue to grow and transition until a succession plant community is established. This succession community may or may not be the same as was present at the time of the fire, due to the aggressiveness of some non-native species, i.e., grasslands.

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SECTION 3.0
GROUP 6 SITE HISTORY AND CHEMICAL USE

This section presents a summary of historical operations, current site conditions and significant alterations, and describes known or potential chemical use within the Group 6 Reporting Area based on detailed information included for each RFI site in Appendix A. A Group 6 RFI map, including surface features, buildings and monitoring wells, is shown on Figure 3-1. Changes to RFI site conditions are shown on Figure 3-2.

The following sections provide summaries of site history information for each of the Group 6 RFI sites. The sites are presented in this section in the order they are described in Appendix A, and the reader is referred to that appendix for more details regarding site operations and sources of information. Potential chemical use areas at each of these RFI Sites have been identified and used to target the sampling conducted following DTSC-approved work plans (Ogden, 1996 and 2000a and b; GRC, 1995a and b; MW, 2000b; MWH, 2001). The potential chemical use areas are described briefly in this section, and grouped into eight general types:

- Solvents
- Petroleum fuels
- Oil-related materials
- Metal wastes (not related to debris areas)
- Debris areas
- Perchlorate and other energetic chemicals
- Hydrazine fuels
- Other screening areas

Table 3-1 summarizes the types of facility operations associated with each of these categories, and provides typical target chemicals analyzed during the RFI at these locations. Areas of known 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 site operational histories for each of the four RFI sites included in the Group 6 Reporting Area. Facility correspondence, demolition and decommissioning reports, investigation reports, waste disposal records, maps, drawings, photographs, and personnel interviews as cited in the references to this document were reviewed and evaluated to compile the site history information presented below.

Primary sources of information include the RFA (SAIC, 1994), the Current Conditions Report (ICF, 1993), the RFI Work Plan Addendum (Ogden, 1996), the Historical Site Assessment (HSA) of Area IV (Sapere, 2005), the Final Decontamination and Radiological Survey of the Old Conservation Yard (Rockwell, 1990), the Final Report Decontamination and Decommissioning of Fuel Storage Facility 4064 (Boeing, 1999c), the Sodium Reactor Experiment Decommissioning Final Report (Rockwell, 1983), review historical aerial photos (USEPA, 1997), and interviews with site personnel. More detailed site historical and reference information is presented in the RFI site reports included in Appendix A.

3.1.1 New Conservation Yard (NCY)

The NCY RFI Site is comprised of approximately 2 acres and has been inactive since 1997. With the exception of a few features described below, all site structures have been removed. The NCY RFI Site includes SWMU 7.8 identified by the RFA (SAIC, 1994).

At the eastern end of the NCY RFI Site is a former, fenced-in salvage yard, referred to as the 'New Con Yard' in this document. It was used between approximately 1977 and the 1990s (USEPA, 1997) for temporary storage for salvageable materials, especially metal parts and equipment (SAIC, 1994). The storage area was also used for temporary storage of equipment after 1983 through the 1990s GRC, 1989; USEPA, 1997). This portion of the site was originally identified as SWMU 7.8 in the RFA (SAIC, 1994).

The NCY RFI Site was expanded to the west to include the area surrounding former Building 040 when an ash pile was observed outside this building during site inspections. Building 040 was constructed in 1960 and was used to house sealed check sources and a laboratory for counting air samples and wipe samples (Sapere, 2005). An incinerator was reportedly located at or near the northeast corner of Building 040 and is believed to have been used to burn documents and photographs according to standard practices at the time (Lenox, 2000a). Adjacent to Building 040 was a fire truck parking spot and canopy (Sapere, 2005).

All structures at the NCY RFI Site have been removed, with the exception of an asphalt-lined ditch that leads from the road south of the OCY RFI Site to the natural drainage in the center of the NCY RFI Site (Figure 3-2). Current conditions at the NCY RFI Site also include erosion control measures at the Building 040 Ash Pile, and in associated down-slope areas and along the drainage to control potential contaminant migration (MWH, 2006). These areas are further described in Appendix A.

3.1.2 Old Conservation Yard (OCY)

The OCY RFI Site is comprised of approximately 10 acres and has been inactive since 2000. With a few exceptions as described below, all site structures have been removed. The OCY RFI Site includes SWMU 7.4 identified by the RFA (SAIC, 1994).

The OCY RFI Site was used primarily for staging and storage of salvageable materials, including metal parts and equipment, from Area IV and DOE operations between 1952 and 1977 (GRC, 1989; Rockwell, 1990). Salvage materials were typically stored in drums. SWMU 7.4 was defined in the RFA as the OCY Container Storage Area (SAIC, 1994). The OCY Container Storage Area is labeled on facility maps and in this document as the Rocketdyne Conservation Yard. The OCY RFI Site also includes two other storage areas. Drum storage occurred throughout the site during the 1960s and 1970s (GRC, 1989).

In 1977, salvageable material storage was transferred to the New Con Yard, located at the NCY RFI Site (described above), and the OCY was used for material storage by Plant Services (Rockwell, 1990; Sapere, 2005). Between 1986 and the late 1990s, the Rocketdyne Conservation Yard area was used by the SSFL transportation department as a storage area for shipping trailers/containers (Rockwell, 1990).

Two large diesel fuel oil ASTs (AST-731 and AST-732) were constructed in the west and northern portion of the OCY RFI Site (ICF, 1993; Ogden, 1996). These were 1.5 million-gallon capacity tanks surrounded by approximately 10-foot high earthen berms. There was also a pump house (Building 320), a 20,000-gallon fuel oil UST (UT-28), and a manifold pump area. A concrete ditch and clarifier provided overflow containment during filling operations. Building 320 was the only operational building at the OCY RFI Site. (A metallic container unit, labeled Building 313, was used for storage and moved to various locations within the site.)

There were several pipelines at the OCY RFI Site. Fuel pipelines connected the fuel farm to an AST in Area IV that will be reported on in the Group 5 Reporting Area. As described in Section 2, an effluent pipeline leading from the SRE Pond discharged into a drainage to the south of the OCY AST fuel farm into the OCY 'low spot'. Records for the SRE RFI site (see Section 3.1.3) indicate that this pipeline was installed in 1959 (Rockwell, 1977. The pipeline was removed in 1999/2000. At the time of removal, the aboveground pipeline was observed to be in good condition (Appendix A).

Five areas were used for debris collection and disposal at the OCY RFI Site. Two areas in the eastern portion of the site were used for the disposal of construction debris, with burial of burned materials. A third area was used for the storage of telephone poles just north of the Rocketdyne Conservation Yard. Two areas were identified north of the Northern Storage Area and AST locations, down slope of the facility.

Due to elevated cesium 137 levels measured in 1988 surveys of the OCY storage areas, a limited excavation action was performed in 1990 to remove approximately 4inches of soil in a 400 square foot area in the southwestern portion of the Rocketdyne Conservation Yard (Rockwell, 1990). There is no record of this excavation being backfilled. The area had been repaved by the mid 1990s. Following this removal action, the Old Conservation Yard was released for unrestricted use in 1995 (DHS, 1995).

All structures, surface debris, and pipelines have been removed, with the exception of the surface coating materials at the AI Yard (Figure 3-2). In 2002, the AST earthen berm soils were spread over portions of the OCY RFI Site. The approximate area where berm soils were spread is shown on Figure 3-2. Based on field observations of fill depth, approximately 1 foot of soil was added to the previous grade and the area contoured to gently slope southward (Trippeda, 2002). Current conditions at the OCY RFI Site also include erosion control measures at debris areas to control potential contaminant migration (MWH, 2006). These areas are further described in Appendix A.

3.1.3 Sodium Reactor Experiment (SRE)

The SRE RFI Site is comprised of approximately 9 acres and has been inactive since 1998. With the exception of a few features described below, all site structures have been removed. The SRE watershed was identified in the RFA as SWMU 7.13 (SAIC, 1994). The SRE Complex operational area was added as an Area IV AOC for characterization during the RFI by Boeing in 1998 (DTSC, 1998). The Building 003 Leach Field is also identified as an Area IV AOC (SAIC, 1994).

The SRE was a liquid-metal-cooled nuclear power reactor built in 1957 (contained within Building 143) and operated between 1957 and 1964; it used sodium as the primary coolant (Rockwell, 1983).

The SRE Pond was constructed down gradient of Building 143 to contain waste water runoff from SRE operations. The SRE Pond containment was an earthen dam within a natural drainage leading offsite. In 1958, a 1.5-foot diameter valve-controlled outlet pipe was added, and later, in 1959, the SRE Pond was redesigned to include a pump to transfer discharge from the SRE drainage to an interior SSFL drainage leading to the Silvernale Reservoir (Rockwell, 1977). The SRE Pond water was pumped and transferred via aboveground piping to a discharge point south of the OCY RFI Site fuel farm (Figure 3-1).

Two major events occurred at the SRE. In 1959, the SRE reactor was shut down to repair the core due to a cooling failure and resultant damage of the fuel assemblies (Sapere, 2005). In 1964, liquid waste was released from below-ground storage tanks (installed near the edge of the hillside north of Building 143) to the SRE Pond (Sapere, 2005; Rockwell, 1977). The facility ceased operation in 1967 (Rockwell, 1983). Between 1974 and 1999, the facility was surveyed for radiological impacts, and decontamination and demolition activities for the SRE Complex were completed in 1983 (Sapere, 2005; Rockwell 1976 and 1983). Cleanup activities during this period included removal of contaminated soil and silt from the SRE Pond (Rockwell, 1983). During demolition activities at the Former Steam Power Plant, pipe cutting activities released a small amount of mercury to the ground surface and attempts were made to clean it up (Lenox, 2000b). As noted in the decommissioning report, mercury was contained in the annular space of the double-walled piping used in the heat exchanger of the Power Plant (Rockwell, 1983).

Decommissioning activities not only removed contaminated building structures, but included excavation of soil and bedrock, most notably north and east of Building 143 and in the SRE Pond (Rockwell, 1983). Building excavations during decommissioning activities were backfilled with clean soils and concrete rubble removed during the excavation activities, or purchased from an offsite, nearby land development operation (Rockwell, 1983). There is no record whether the pond excavation area was backfilled. DOE released the SRE for unrestricted use in 1985 (DOE, 1985). Non-contaminated portions of buildings remained onsite following decommissioning activities and were utilized for other activities as described below.

The SRE facility consisted of a group of over 15 buildings and structures related to the support and operation of the reactor. During SRE operations, these buildings and support activities included: a Toluene Process/Tetralin Heat Exchanger area (north of Building 143), a former Southern California Edison Steam Power Plant including a cooling tower (east of Building 143), a 'box shop' (for equipment preparation) in Building 163, a sanitary leach field leading from Building 003, sodium cleaning areas south of the pond, three removed fuel-oil USTs, and four transformer locations (one associated with the Steam Power Plant). Site personnel report that solvents were discharged to the ground north of the 'box shop' at Building 163 (Lenox, 2000b). Some of these buildings were used for non-SRE activities after facility de-activation and before demolition. For example, Building 163 was later used as a 90-day accumulation area for hazardous waste materials generated at SSFL.

All of the SRE-related buildings have been removed, including tanks, transformers, and asphalt cover (Figure 3-2). Final site demolition activities occurred in 2000/2001, and included the removal of building structures including the deep basements of Buildings 003 and 143, removal of the Building 003 Leach Field and septic tank (Boeing, 2001b), and excavation of the two small areas (approximately 390 cubic yards) north and west of Building 143 to remove cesium 137 above background levels (Boeing, 2001a). The Building 003 and 143 deep excavations were backfilled with clean borrow soils from a DTSC-approved source onsite (Venable, 2006; DTSC, 2000). A few ancillary above-ground concrete support structures still exist, such as the concrete-line drainage ditches that lead to the SRE Pond, and concrete foundations near Building 724 and the former Cooling Tower. A few below-ground building foundation structures were also left in bedrock near Building 143 (Venable, 2006). The western portion of the site which contained the majority of the building structures has been regraded. Current conditions at the SRE RFI Site also include erosion control measures installed at the mercury-impacted soils and along the drainage below the SRE Pond to control potential contaminant migration (MWH, 2006). These areas are further described in Appendix A.

3.1.4 Building 064 Leach Field

The B064 LF RFI Site is comprised of approximately 1-acre and has been inactive since 1997. All site structures have been removed except as described below. The B064 LF RFI Site was identified as an Area IV AOC in the RFA (SAIC, 1994).

Building 064 was built in 1958 and expanded in 1963. It was used for the storage of packaged source material (natural and depleted uranium, and thorium) and nuclear material (enriched uranium and uranium 233). Small quantities of chemicals may have been used to support site operations, but are not documented in facility records. The Building 064 Side Yard was an approximately 4,500 square foot area east of the building used for equipment and container storage. Following a 1988 radiological survey of the Building 064 site, approximately 585 cubic yards of contaminated soil were removed from the Side Yard to remove elevated cesium 137 (Boeing, 1999c). The Building 064 site was released for unrestricted use by DOE in 2005 (DOE, 2005).

The former leach field was located approximately 20 feet east of Building 064, below the Side Yard area. Like the other onsite leach fields in SSFL, it was used for disposal of sanitary waste between 1958 and 1961 (Boeing, 1999a; SAIC, 1994; MWH, 2004). Use of the leach field was discontinued following the installation of the current sanitary sewer system. In general, leach field construction typically consisted of 4-inch diameter terra cotta clay piping surrounded by large gravel and buried at depths ranging from 2 to 6 feet bgs. The leach fields received flow from a septic tank, typically located outside of the building near the sanitary locations. Specific construction details for the Building 064 leach field are not available in facility records. The leach field was removed during 1997 (Boeing, 1999c). Based on photographs taken during the excavation, removal of the septic tank required excavation to approximately 6 feet bgs, and removal of the leach lines generally extended down to shallow bedrock, approximately 3 feet bgs (Sapere, 2005). The excavation was narrow, extending between a rock outcrop and an asphalt-covered road. Soil sidewall materials were used as backfill, resulting in a very thin soil cover with patches of exposed bedrock after the excavation was complete. A concrete-lined drainage ditch was installed on the north side of the excavation leading to the main roadway (Trippeda, 2006a).

All of the Building 064 facility structures have been removed, including asphalt cover, and concrete footings (Figure 3-2). The site does contain a concrete-lined ditch for surface water runoff control.

3.1.5 Non-RFI Site Report Area

As described in Section 1, the RFI site boundaries depicted on maps in this Group 6 RFI Report are shown as representative outlines that generally encompass the operational portions of the sites. These outlines did not limit characterization in any way, and potential chemical use was evaluated within the entire Group 6 Reporting Area. Potential use areas have been identified north of the OCY RFI Site outside of the original RFI Site boundary as described in Section 3.3. Inspection of historical aerial photographs of the remainder of Group 6 RFI area and various site reconnaissance inspections did not indicate other chemical use areas within the Group 6 Reporting Area.

3.2 CURRENT SITE CONDITIONS AND SIGNIFICANT ALTERATIONS

The focus of this Group 6 RFI is to characterize current conditions of the Group 6 Reporting Area with respect to chemical contamination. Current conditions at most of the Group 6 RFI sites are different from the operating conditions. This section summarizes how current conditions differ from operating conditions. For the great majority of characterization activities, sampling was done and little (if any) subsequent site condition changes occurred with the exception of building removals. In some cases, as described below, conditions changed after RFI samples were collected. Changed conditions affecting RFI sample information are described and detailed in the RFI Site Reports provided in Appendix A.

All buildings and most support structures that were present in the Group 6 Reporting Area have been removed. There were buildings at all four Group 6 RFI sites. During building demolition and removal, concrete building foundations were generally removed which disturbed the soil immediately beneath and adjacent to the foundation. Following building foundation removal, the sidewalls of the resulting depression were collapsed, and soil in the immediate vicinity to the building was used to create a level surface to prevent surface water ponding. For the purposes of the RFI, it can be assumed that there was minor soil disturbance at the location of every removed building.

Demolition activities also included the removal of other structures and improvements. ASTs and USTs were removed. UST excavation areas were generally limited to the soils immediately adjacent to the tank, and if soil contamination did not exist, then the removed soils were replaced into the excavation as backfill. Piping and electrical lines were removed. In some cases, paved lots and drives were removed. Most of these activities likely involved some limited soil grading near the structures as a finishing step.

Significant soil grading activities were performed at three of the four Group 6 RFI sites. This grading has influenced RFI sampling approaches, or the interpretation of previous results. Areas affected occur at the SRE, B064 LF, and OCY RFI Sites, and are described further below.

The removal of the SRE building complex resulted in backfilling deep basement excavations (to depths of up to at least 26 feet) and excavation of silt/soil from the SRE Pond (Rockwell, 1983), and grading of surficial soil following final site demolition activities in 2000/2001. Some early RFI samples were collected when buildings were present, and later RFI samples were collected after the buildings had been removed. Post-building demolition samples collected in areas of obvious soil disturbance targeted undisturbed soils at slightly deeper soil horizons (i.e., the upper few inches of soils were removed prior to sampling). Pre-demolition samples were not adjusted for revised soil depths, because the amount of soil disturbance near each building foundation area was limited, typically within a few feet of the building perimeter and to depths of 1 to 2 feet based on standard demolition practices for the SSFL. Several USTs within the SRE RFI Site were removed, with the excavated soils used as backfill and the surface graded.

At the B064 LF RFI Site, the leach field was completely removed and surrounding soils used to recontour the area (Trippeda, 2006a). Soil vapor sampling was done prior to leach field removal, but it was outside of the backfill area so sampling depth was not adjusted. Soil samples have been collected at the site following leach field removal activities.

The OCY RFI Site has been affected by multiple site soil disturbance activities. As described above, in 1989 a 400-square-foot area was excavated to an approximate depth of 4-inches to remove radiological impacts in the southwestern corner of the Rocketdyne Conservation Yard (Rockwell, 1990; Appendix A). The area was repaved, and although generally flat, was slightly lower than the rest of the yard. Samples collected in this area of the OCY RFI Site were not adjusted for any change in topography resulting from this excavation activity. One UST also existed within the OCY site and was removed in 1987, with the excavated soils used as backfill. In 2002, soils contained in the earthen AST berms were spread across portions of the site not recommended for further evaluation (see Section 7),and the soils graded to promote surface water flow to the natural drainages in the southern portion of the site (Figure 3-2). This activity at the OCY RFI Site has resulted in an increase of grade of approximately 1-foot in the area where the soils were spread. This occurred after most of the RFI sampling had been completed, although some additional samples were collected afterwards. Thus, the depth of any soil samples collected in this area prior to spreading the earthen berms are approximately 1-foot deeper than originally reported, and are noted as such on the OCY RFI Site Report tables (Appendix A).

Surface water drainage has not been altered significantly in the Group 6 Reporting Area. Current conditions, even with the demolition and grading that has occurred, generally reflects the historical drainage patterns. The one exception to this is that pumping of SRE Pond water for discharge into the OCY RFI Site drainage no longer occurs. Current storm water discharge from the SRE Pond is limited to minor seepage through the dam, since most runoff is contained within this man-made structure.

3.3 CHEMICAL USE

As described above, potential chemical use areas have been categorized into eight groups (Table 3-1). These include: solvents, petroleum fuels, oil-related materials, metal wastes (exclusive of debris areas), debris areas, perchlorate and other energetic compounds, hydrazine fuels, and other screening areas. These groups are listed in Table 3-1, which also summarizes the types of facility operations and provides a typical RFI sampling analytical suite for evaluation of chemical impacts. This summary is generalized, however, and is not meant to define all sampling requirements at each Group 6 RFI site. It is meant to provide the reader with a context to review sampling results provided in Section 4. Site-specific sampling rationale and detailed result descriptions are provided in Appendix A.

The RFI sampling program targeted documented or suspected chemical use areas at the RFI sites and included screening sampling at other areas where chemical use may have occurred. Figure 3-3 depicts all potential chemical use areas for the Group 6 Reporting Area. Figures 3-4 through 3-9 show individual chemical use areas for the Group 6 RFI sites. Table 3-2 provides a list of each site's potential chemical use category and identifies types of chemicals likely used. The following sections present a summary of the potential chemical use areas in the Group 6 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 maintain weed growth or forestall rodent infestations. Construction materials include asphalt, concrete, or small quantities of explosives that may be used at building sites where bedrock modifications are needed. Pesticides, herbicides, rodenticides, and explosives used for routine facility operations would have been applied according to label instructions. Energetic chemicals used as surface or subsurface explosives for construction or demolition purposes would have been used during short events and the chemicals typically consumed upon detonation. As described in Section 4 and Appendix B, groundwater monitoring is conducted for many of these chemicals but they have not been targeted for Surficial Media investigation for this type of routine use.

3.3.1 Solvents

Solvent use in the Group 6 Reporting Area was very limited, although some cleaning or rinsing operations likely occurred at the SRE and OCY RFI Sites. Potential solvent use areas in the Group 6 RFI sites are shown on Figure 3-4 and include:

- OCY: Several areas were used for drum storage, which could have included solvents.
- SRE: A toluene process unit was used to support reactor testing and operations at the site between 1959 and 1964. Solvents may have also been used to clean equipment at various onsite locations, including the Southern California Edison Steam Power Plant.

3.3.2 Petroleum Fuels

Petroleum fuel use within the Group 6 Reporting Area was primarily associated with diesel fuel oil storage ASTs and USTs at the OCY and SRE RFI Sites along with other supporting structures. Waste products from fueling operations are associated with collection sumps, clarifiers, and drainage ditches or channels. Potential petroleum fuels use areas in the Group 6 RFI sites are shown on Figure 3-5 and include:

- OCY: Two 1.5-million gallon ASTs stored fuel oil for Area IV operations. A fueling area, including a waste clarifier UST, and associated pipelines, was used for fuel transfer operations. During fueling operations in 1982, approximately 400 gallons of diesel fuel were spilled east of the fueling area. Several areas at the site were used for drum storage, which could have included petroleum fuels.
- SRE: Two diesel fuel and one gasoline USTs were used to support site operations.

The volatile organic compounds (VOCs) benzene, toluene, ethylbenzene and xylenes (BTEX) are components in gasoline-range petroleum hydrocarbon fuels. The gasoline UST at the SRE RFI Site was screened for associated impacts related to these VOCs.

3.3.3 Oil-Related Materials

Hydraulic and/or lubricant oils were used in various areas within the Group 6 Reporting Area. General uses included equipment lubrication and use in transformers. Waste oil from site operations might also have been associated with collection sumps, clarifiers, and drainage ditches or channels. Waste oils can potentially contain various semi-volatile organic compounds (SVOCs) or metals if used for machining. Electrical transformers present prior to 1980 may have used oils containing polychlorinated biphenyl compounds (PCBs). Potential oil-related use areas in the Group 6 RFI sites are shown on Figure 3-6 and include:

- OCY: Five transformer areas occur at the site and were evaluated for potential PCB impacts. Several areas were used for drum storage, which could have included oil products. The ground surface coatings at some of the storage areas likely contained oil-based materials.

- SRE: A tetralin heat exchanger was used to support reactor testing and operations at the site between 1959 and 1964. Tetralin can include PCB-containing oils. A ‘hot oil’ process was used for cleaning metallic sodium from components at a location south of the SRE Pond. Hydraulic or lubricating oils were also likely used at various onsite locations, including the Southern California Edison Steam Power Plant. Three transformer areas occur at the site and were evaluated for potential PCB impacts. A small hydraulic oil spill from a backhoe occurred in 2000 near Building 003.

3.3.4 Metals Wastes

Metals wastes can be associated with site operational activities (testing, laboratory work, etc.) or caused by the degradation of scrap metal debris. Because these two types of occurrences are different, potential metal use areas at the Group 6 RFI sites have been divided into two categories, operational metal wastes, and debris areas. This section focuses on operational wastes, and the following section focuses on debris areas.

Operation activities resulting in metal wastes at the Group 6 RFI sites included metal-cooled heat exchanger and cooling tower processes at the SRE RFI Site as described below. Other, more typical metal wastes generated by photographic processing, corrosive activities involving acids (dewaxing and cleaning of metallic parts, etc.), high-energy propellant testing, or various machine shop and laboratory operations were not present at the Group 6 RFI sites. Potential metal waste areas associated with operations in the Group 6 RFI sites are shown on Figure 3-7 and include:

- SRE: A ‘hot oil’ process was used for cleaning metallic sodium from components, possibly generating metal-containing wastes at a location south of the SRE Pond. Mercury was used in double-walled piping in a heat exchanger associated with the Southern California Edison Steam Power Plant. During demolition activities, a small amount of mercury was released to surface soils at this location. Although not documented in facility records, hexavalent chromium might have been used as a biocide at the Steam Power Plant Cooling Tower location, or possibly as an algicide at the Industrial Dry Well.

3.3.5 Debris Areas

Debris areas are locations where various amounts of solid waste have been identified at the SSFL Group 6 RFI sites, with debris typically including paint chips, scrap metal, construction debris (asphalt, concrete, etc.), small equipment pieces, or burned materials. These areas are typically targeted for a wider range of sample analysis than the areas described in the preceding section that typically generate only metal wastes (Tables 3-1 and 3-2). Also included in this category are incinerators used for burning documents or photographs, and areas where wastes were burned. Debris areas in the Group 6 RFI sites are shown on Figure 3-8 and include:

- NCY: Ash generated from document incineration accumulated on the ground surface outside the northeast corner of Building 040.
- OCY: Five debris areas occur at this site. These include a burned telephone pole storage area, two areas of predominantly construction debris storage (with some charred material at depth), and two northern slope debris areas containing scrap metal, containers, and drums.

3.3.6 Perchlorate, Energetic Chemicals, and Hydrazine

As shown on Table 3-2, perchlorate, energetic chemical, and hydrazine use was not reported or documented for site operations described above within the Group 6 Reporting Area. An operations documentary film made for the SRE indicates that explosives were used to support (1) building construction where reactor facilities were constructed within bedrock, and (2) demolition activities at that site (SRE video, DOE Public Meeting, September 2004).

3.3.7 Screening Areas

Areas with known use for chemical storage are included in this category if the types of chemicals stored at the locations were not well documented. Several areas at the Group 6 RFI sites were, or may have been, used for chemical storage, handling, or disposal. Screening areas include various storage areas, and former sanitary leach fields, and containment structures or retention ponds designed to contain site-related wastes. Since chemical use in the screening locations could vary based on site history information, or upon up-gradient chemical use areas, analytical suites for RFI assessment of screening areas also varied. The Group 6 RFI screening areas are shown on Figure 3-9 and include:

- NCY: Salvageable equipment was stored in the yard, primarily consisting of metal scrap (SAIC, 1994).

- OCY: Four storage areas occur at the site, and the topographic low spot and pipeline discharge area in the south received water pumped from the SRE Pond, which might have contained various SRE RFI Site-related wastes (potentially solvents, petroleum fuels, oil-related materials, and metals wastes).

- SRE RFI Site: The primary area designed to receive downstream waste from SRE operations was the SRE Pond. An industrial dry well was also onsite near the leach field location, and may have received waste liquids from site operations. A former sanitary leach field was associated with Building 003. Portions of the entire SRE site may have been used for storage throughout site operations, and the site was used for hazardous waste accumulation.

- Building 064 Leach Field RFI Site: A former sanitary leach field.

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SECTION 4.0

NATURE AND EXTENT OF CHEMICALS IN GROUP 6

This section provides an overview of nature and extent findings for all media for the Group 6 RFI Reporting Area. The characterization overview provides a description of group-wide chemical concentrations for all media. Section 5, Transport and Fate, is based upon these findings. A discussion of characterization completeness within chemical use areas and recommendations for further evaluation in the CMS is provided in Appendix A.

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 Appendix A. 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 themselves become information used in defining if further sampling is needed, and if the nature and extent of impacts have been defined.

Characterization results for Group 6 RFI Sites are presented by the six major chemical groups included in the RFI laboratory analytical program:

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

The chemical groups listed above represent the targeted RFI sampling suites for the types of known or potential chemical use identified in the Group 6 Reporting Area as described in Section 3.Figures 4-1 through 4-6 present results for the six chemical groups listed above. The purpose of the figures is to present a summary of characterization findings in the context of site information which includes:

- Group 6 RFI sample locations.
- Locations where samples were analyzed for a respective chemical group (e.g., VOCs). As described in following sections, color coded symbols differentiate chemical concentrations relative to risk-based screening levels (RBSLs), background, or toxicity equivalent quotients (TEQs), and generally reflect chemical gradient or distribution. Sampling targeted chemical use areas, and sample locations not analyzed for the chemical depicted on that figure are shown in gray.
- Chemical concentrations represented by various colors based on comparison to RBSLs (VOCs, SVOCs, PCBs, TPH, and dioxins) and DTSC-approved background levels (metals and dioxins only). RBSLs are chemical-specific back-calculated concentrations that represent 'acceptable' risk levels, based on risk assessment parameters and methodologies detailed in the SRAM. A description of RBSL derivation is provided in Appendix C. For presentation purposes, the most conservative RBSL was used for comparison.
- Summary information for groundwater, screened against regulatory levels or site criteria, such as Groundwater Comparison Concentrations (GWCCs).
- Relationship of samples to areas recommended for further evaluation in the CMS. "CMS Areas" are those portions of the RFI site recommended for further consideration and evaluation in the next phase of the RCRA Corrective Action process. These recommendations are based solely on characterization data and risk assessment results as described in the RFI Site Reports in Appendix A. The CMS recommendations and the criteria used in those decisions are presented in Section 7.

The following sections present a description of RFI sampling results by chemical group. Additional chemicals are monitored in groundwater as required by DTSC as part of the groundwater program. These results are described in Appendix B, and are non detect (perchlorate, N-nitrosodimethylamine [NDMA], herbicides, pesticides), or consist of general minerals or other inorganic compounds (e.g., sulfate, calcium carbonate, magnesium, etc.).

4.1 VOLATILE ORGANIC COMPOUNDS

4.1.1 Soil/Sediment

A total of 66 soil vapor samples and 41 soil samples were analyzed for soil VOCs. Locations were based on site use (known or suspected chemical use area) and screening and sample results (stepouts). Group 6 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 respective RBSLs in that sample.

VOCs in Group 6 generally were detected at low concentrations. Most analyzed samples did not contain detectable VOC concentrations, and with one exception, VOCs exceeding 300 micrograms per kilogram (µg/kg) were detected in samples collected in 1990 at the SRE Pond. As described below, subsequent samples in the SRE Pond contained much lower concentrations (ranging up to 36 µg/kg acetone). The only recent sample with results above 300 µg/kg was collected in the drainage below the pond. In this sample, acetone was detected at 5,200 µg/kg, which was the Group 6 maximum VOC concentration. Overall, the limited VOC detections within Group 6 Reporting Area are consistent with limited use and potential storage of solvents, as described in Section 3.

VOC soil and sediment results for the RFI sites within the Group 6 Reporting Area are summarized as follows:

- <u>SRE RFI Site</u>:
  - ➢ General areas at the site. Freon 113 was detected at low levels (2 to 3.9 micrograms per liter [µg/L]) in four soil vapor locations across the site. Uniform concentrations detected do not suggest a concentration gradient indicative of a localized source.
  - ➢ Oil-stained area east of Building 003 (CMS Area SRE 11-1). VOCs were detected in soil samples, including methylene chloride up to 7 µg/kg.
  - ➢ SRE Pond (CMS Area SRE 14-1). Methylene chloride was detected in 1990 at concentrations up to 4,200 µg/kg, but at a maximum of 13 µg/kg in 2001. Methylene chloride was detected at 13 µg/kg in the drainage (CMS Area SRE 14-2), but was not detected downstream. Acetone was detected in the drainage immediately below the SRE Pond at 5,200 µg/kg, and decreased to non detect downstream. TCE was detected up to 1,000 µg/kg in 1990 samples, but was not detected in 1998 samples, including one collocated with the previous maximum detection.
- <u>OCY RFI Site</u>:
  - ➢ Former fuel spill excavation (CMS Area OCY 3-1). VOCs, primarily methylene chloride (up to 280 µg/kg in soil), were detected in samples collected from the area.
  - ➢ General areas at the site. A total of 19 soil vapor samples were collected across the site. Low VOC concentrations (maximum of 66 µg/L TCE) were detected at two locations within the Rocketdyne Conservation Yard. Samples recollected at this location were either non detect or low (less than 11 µg/L TCE).

- NCY RFI Site

  - NCY (CMS Area NCY 1-1). Toluene was detected at 110 µg/kg in one of six samples collected from the New Conservation Yard (not labeled on figure). No other VOCs were detected.

- Building 064 RFI Site

  - No VOCs were detected in the soil vapor sample collected prior to removal of the leach field.

4.1.2 Near-Surface Groundwater

Four piezometers have been installed to monitor NSGW within Group 6 (PZ-056, PZ-113, PZ-114, and PZ-115). PZ-115, located south of NCY, has been dry since installation. PZ-113, at the southern boundary of the Group 6 Reporting Area, has not been sampled for chemical analysis based on its remote location relative to other RFI sites. PZ-114 and PZ-056 are located within the eastern drainage (Figure 4-1) downgradient of OCY and NCY, respectively. PZ-056 has been analyzed twice (2001 and 2003) for VOCs, and PZ-114 has been analyzed once for VOCs (2002). NSGW results for the Group 6 Reporting Area are summarized as follows:

- Methylene chloride and acetone were detected once (2001) in PZ-056 at 16 µg/L (above the maximum contaminant level [MCL] of 5 µg/L) and 6 µg/L, respectively. Both of these compounds are common laboratory contaminants, and were non detect in 2003 (not labeled on figure).

- No VOCs were detected in PZ-114.

Additional information for NSGW quality, occurrence, and temporal trends is contained in Appendix B.

4.1.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.1.4 Chatsworth Formation Groundwater

In general, VOCs in Group 6 groundwater were detected at low concentrations and infrequently exceed MCLs. TCE is the most commonly detected VOC in Group 6 wells, and has been detected in 5 of 7 CFOU monitoring wells at least once since monitoring began in 1985.

The highest TCE concentrations have been detected in the northern portion of the Group 6 Reporting Area, at monitoring wells RD-14 and RD-86. The maximum TCE concentration detected at well RD-14 was 13 µg/L in December 1990. By 1992, TCE had decreased to below the MCL of 5 µg/L, and has remained below the MCL since 2001. TCE was detected in well RD-86 at a concentration of 10 µg/L in August 2004, but was not detected in February 2005 (<0.26 µg/L).

TCE has been detected at concentrations below the MCL in wells RD-15 and RD-18 and were not detected in 2005. WS-7 also contained TCE below the MCL during the last sampling round in 1992.

Benzene was detected in RD-85 in 2004 at 0.58 µg/L (not labeled on figure), below the MCL of 1 µg/L. Benzene was not detected in a subsequent sample in 2005 (<0.28 µg/L), and was not detected in any other CFOU monitoring wells. RD-14, located at the OCY RFI Site where fueling (diesel) activities occurred and diesel fuel ASTs were located, was analyzed for benzene in several samples; benzene was not detected (most recently in 2004, <0.28 µg/L).

VOCs in groundwater are attributed to small spills within operational areas. The low-level VOCs infrequently detected in Group 6 monitoring wells are consistent with data collected in surficial soil. TCE plumes in adjacent reporting group areas (Groups 3 and 7) are located cross-gradient of Group 6, or are separated from Group 6 by fine-grained units. Therefore, it is believed that these neighboring plumes do not contribute to VOCs detected in the Group 6 Reporting Area (Appendix B).

Additional information for CFOU groundwater quality, occurrence, and temporal trends is contained in Appendix B.

4.1.5 Completeness of Characterization

Soil and soil vapor samples were collected from all known or suspected source areas and analyzed for VOCs. In addition, soil vapor screening was conducted at representative locations to provide characterization of potential VOC impacts at Group 6 RFI sites. Generally low VOC concentrations at a few locations were detected in soil and soil vapor. Individual chemical use areas are delineated sufficiently for risk assessment and evaluation of potential groundwater impacts as detailed in Appendix A.

Both NSGW and CFOU groundwater have been sampled and analyzed for VOCs at locations proximal to operational areas, and results are consistent with limited VOC use during Group 6 operations and with soil data.

No further characterization of VOCs is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.2 SVOCs

4.2.1 Soil/Sediment

A total of 118 samples were analyzed for SVOCs. Locations were based on site use (known or suspected chemical use area), screening and sample results (stepouts). Group 6 Reporting Area SVOC sampling results are depicted on Figure 4-2. Each sample location is represented by a color corresponding to a maximum ratio of detected SVOCs concentrations to respective RBSLs in that sample.

SVOC concentrations were generally low or not detected throughout the group; although there are a few notable exceptions which are localized to defined areas. These include:

- SRE RFI Site. Polynuclear aromatic hydrocarbons (PAHs) were detected at highest concentrations within the leach field (CMS Area SRE 7-1) and western SRE Pond (CMS Area SRE 14-1), with up to 25,000 µg/kg fluoranthene and 15,000 µg/kg benzo(a)pyrene. Concentrations decreased down-drainage.

- OCY RFI Site

  - North Slope Storage Area and North Slope Debris Area "A" (CMS Areas OCY 1-3, 1-4, 6-4). Benzo(a)pyrene was detected at 190 µg/kg in shallow storage area samples, but was not detected at several downslope storage area locations. Further downslope within Northern Debris Area "A") PAHs were detected at generally lower concentrations near surficial debris in drainage downslope (benzo(a)pyrene at 3.6 µg/kg).

  - North Slope Debris Area "B" (CMS Area OCY 6-5). SVOCs were detected within the debris area and in the downslope drainage, with the highest concentration of 53 µg/kg chrysene in surficial debris area sample. Concentrations decreased downslope within the drainage to less than 8 µg/kg.

  - Northern and Southern Debris Areas (CMS Areas OCY 6-1 and 6-2). Up to 65 µg/kg fluoranthene and 34 µg/kg benzo(a)pyrene were detected. PAHs decreased to non detect in downslope soil areas.

  - Telephone Pole Storage Area (CMS Areas OCY 5-1). Up to 29 µg/kg benzo(a)pyrene was detected in surficial samples, but was not detected in a sample within the Rocketdyne Conservation Yard.

  - Rocketdyne Conservation Yard (CMS Area OCY 1-1). Fluoranthene was detected at 2,100 µg/kg and phenanthrene was detected at 1,600 µg/kg in shallow samples within a slight depression in the southwestern portion of the yard.

  - Topographic Low Spot/Downslope Drainage Area (CMS Areas OCY 8-1 and 8-2). Benzo(a)pyrene was detected at 280 µg/kg in the Low Spot, and decreased to 220 µg/kg in the lined drainage leading to NCY.

- NCY RFI Site. Benzo(b)fluoranthene (up to 65 µg/kg) and benzo(a)pyrene (up to 43 µg/kg) were detected within the Ash Pile (NCY 2-1); PAHs decreased downslope (NCY 2-3) and into the drainage down to non detect.

4.2.2 Near-Surface Groundwater

NSGW was not analyzed for SVOCs in the Group 6 Reporting Area. Additional information for NSGW quality, occurrence, and temporal trends is provided in Appendix B.

4.2.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.2.4 Chatsworth Formation Groundwater

SVOCs were analyzed in five Group 6 monitoring wells: RD-14 and RS-86, where SVOCs were most elevated in soil, and RD-15, RD-18, and WS-7 (Figure 2-4). These wells are located at OCY, NCY, and SRE and include areas of known SVOC impacts. SVOCs were not detected. Additional information for CFOU groundwater quality, occurrence, and temporal trends is provided in Appendix B.

4.2.5 Completeness of Characterization

Soil and groundwater samples were collected and analyzed for SVOCs from all known potential source areas and downgradient drainages. Individual chemical use areas have been delineated sufficiently for risk assessment and evaluation of potential impacts to groundwater as detailed Appendix A.

No SVOCs were detected in Group 6 monitoring wells.

No further characterization of SVOCs is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.3 PETROLEUM FUELS

4.3.1 Soil/Sediment

A total of 129 soil samples were collected and analyzed for TPH. Locations were based on site use (known or suspected chemical use area), screening and sample results (stepouts). Group 6 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 respective RBSLs in that sample. TPH at Group 6 RFI sites generally was detected at low concentrations (<100 milligrams per kilogram [mg/kg]) but was detected as high as 9,400 mg/kg in areas with historical petroleum fuel use. These include:

- SRE RFI Site
    - Building 003 Leach Field (CMS Area SRE 7-1). Up to 358 mg/kg TPH (diesel and lubricant oil) detected in association with leach lines at 4 feet bgs, with the lubricant

oil range predominating (95%). Gasoline-range TPH was detected at 10 mg/kg in one sample.

- Oil Stain at Building 003 (CMS Area SRE 11-1). Predominantly lubricant oil-range TPH was detected at up to 510 mg/kg in surface soil, but not at deeper intervals.

- SRE Pond and Drainage (CMS Area SRE 14-1 and 14-2). Lubricant oil-range TPH was detected at 350 mg/kg in pond standpipe sediment sample; all other pond samples were non detect. Downslope drainage sediment samples contained up to 420 mg/kg lubricant oil-range TPH, which decreased to less than 6.25 mg/kg downstream.

- OCY RFI Site:

  - AI Conservation Yard (CMS Area OCY 1-2). Surface soil samples contained up to 1,100 mg/kg diesel range and 8,300 mg/kg lubricant oil-range TPH. A sample immediately beneath the asphalt contained 3,500 mg/kg lubricant oil-range TPH. Deeper samples did not contain detectable TPH.

  - Northern and Southern Debris Areas (CMS Areas OCY 6-1 and 6-2). Lubricant oil-range TPH was detected at 550 mg/kg at 5 feet bgs and at 120 mg/kg in a surface sample at the downslope limit of debris (not labeled on figure).

  - Former Fuel Spill Excavation (CMS Area OCY 3-1). Up to 4,000 mg/kg heavy oil (C22-C40) TPH detected in historical samples. More recent samples contained less than 300 mg/kg TPH.

  - Low Spot (CMS Area OCY 8-1). Surface sediment samples contained over 1,000 mg/kg TPH (diesel plus lubricant oil ranges) in 1997 and less than 100 mg/kg in 2006. TPH was not detected in a deeper sample. Up to 4.2 mg/kg diesel-range and 69 mg/kg lubricant oil-range hydrocarbons were detected in the asphalt-lined swale leading to the NCY RFI Site (not labeled on figure).

- NCY RFI Site. TPH was not detected within the New Con Yard (CMS Area NCY 1-1) or within the lined drainage (CMS Area NCY 2-3).

4.3.2 Near-Surface Groundwater

NSGW was not analyzed for TPH in the Group 6 Reporting Area; additional information for NSGW quality, occurrence, and temporal trends is provided in Appendix B.

4.3.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.3.4 Chatsworth Formation Groundwater

RD-14 was analyzed for total recoverable petroleum hydrocarbons (TRPH) in 1989, based on proximity to fueling areas. TRPH was detected at 50 µg/L. This low concentration, and the absence of detected benzene (see Section 4.1.4 for VOCs), does not suggest groundwater impacts from TPH.

Additional information for CFOU groundwater quality, occurrence, and temporal trends is provided in Appendix B.

4.3.5 Completeness of Characterization

Soil and groundwater samples were collected from all known or suspected TPH source areas and downgradient drainages. Individual chemical use areas have been delineated sufficiently for risk assessment and evaluation of potential impacts to groundwater as detailed Appendix A.

CFOU groundwater at RD-14, near the highest detected TPH concentrations in Group 6, was sampled and TPH was detected at 50 µg/L. Benzene, the most mobile of TPH constituents, has not been detected in RD-14 groundwater. Based on these analyses, TPH impacts to groundwater in Group 6 locations are adequately assessed.

No further characterization of TPH is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.4 PCBs

4.4.1 Soil/Sediment

A total of 105 samples were collected and analyzed for PCBs. Locations were based on site use (known or suspected chemical use areas), screening, and sample results (stepouts). Group 6 PCB sampling results are depicted on Figure 4-4. Each sample location is represented by a color corresponding to a maximum ratio of detected PCBs concentrations to respective RBSLs in that sample. PCBs were detected in three of four sites within the Group 6 Reporting Area. PCB detects are reported as Aroclors. PCBs were non detect in many areas but localized in known source areas (such as transformer areas). These include:

- SRE RFI Site:
  - Transformer Area South of Building 003 (CMS Area SRE 10-1). Aroclor 1254 was detected near the transformer pad at up to 430 µg/kg.
  - Building 003 Leach Field (CMS Area SRE 7-1). Aroclor 1254 was detected in waste characterization samples from septic tank and leach field up to 2,574 µg/kg (not labeled on figure) (Boeing, 2001d).
  - Transformer Area 693 (CMS Area SRE 9-1). Aroclor 1260 was detected near the transformer pad at up to 7,800 µg/kg.
  - SRE Pond (CMS Area SRE 14-1). Aroclor 1260 was detected in one sample in the SRE Pond at 180 µg/kg.
- OCY RFI Site:
  - North Slope Storage Area and North Slope Debris Area "A" (CMS Areas OCY 1-3 and 1-4, 6-4). PCBs were detected up to 24,000,000 µg/kg (Aroclor 1248) in the downslope portion of the North Slope Storage Area. Concentrations decreased downslope into North Slope Debris Area "A," where concentrations were between 110 µg/kg (Aroclor 1248) and 250 µg/kg (Aroclor 1254) (not labeled on figure). Concentrations decrease downslope into the drainage to non detect.
  - Northern and Southern Debris Area (CMS Areas OCY 6-1 and 6-2) and Transformer Area (CMS Area OCY 7-1). PCBs were detected at up to 94 µg/kg (Aroclor 1254) in the Northern Debris Area and at up to 240 µg/kg Aroclor 1254 in the transformer area. PCBs were not detected downslope of these areas or in the drainage beyond.
  - AI Conservation Yard (CMS Areas OCY 1-2). Aroclor 1254 was detected at 2,200 µg/kg within the storage area.
  - Transformer Area 737 (CMS Area OCY 7-2). PCBs detected around the transformer at concentrations up to 1,900 µg/kg Aroclor 1248.
  - Topographic Low Spot/Downslope Drainage Area (CMS Areas OCY 8-1, 8-2). PCBs were detected in the Low Spot at up to 480 µg/kg (Aroclor 1254). Concentrations decreased down the drainage to non detect in the furthest downstream sediment sample.
- NCY RFI Site. Aroclor 1254 was detected at 71 µg/kg in one sample in the drainage just south of the site (CMS Area NCY 2-3) (not labeled on figure). No other PCBs were detected in this sample and none were detected in downstream samples.

4.4.2 Near-Surface Groundwater

PCBs were analyzed once in PZ-114, which is down slope from the location where PCBs were detected at the OCY transformer and debris area. No PCBs were detected. Additional information for NSGW quality, occurrence, and temporal trends is provided in Appendix B.

4.4.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.4.4 Chatsworth Formation Groundwater

PCBs were not detected in Group 6 groundwater samples collected from RD-14. Additional information for CFOU groundwater quality, occurrence, and temporal trends is provided in Appendix B.

4.4.5 Completeness of Characterization

Soil samples were collected and analyzed for PCBs at all known or suspected source areas and in downgradient drainages except at the SRE Building 003 Leach Field (SRE CMS Area 7-1). This area is recommended for additional evaluation in the CMS due to PAH and metals results (see Sections 4.2.1 and 4.6.1), so PCB sampling was not necessary. Individual chemical use areas have been delineated sufficiently for risk assessment and evaluation of potential impacts to groundwater as detailed Appendix A.

Both NSGW and CFOU groundwater have been sampled and analyzed for PCBs at locations proximal to operational areas; PCBs were not detected in groundwater.

No further characterization of PCBs is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.5 DIOXINS

4.5.1 Soil/Sediment

A total of 44 samples were analyzed for dioxins based on site use (known or suspected chemical use area), screening and sample results (stepouts). Group 6 dioxin sampling results are depicted on Figure 4-5. Each sample location is represented by a color corresponding to the maximum dioxins TEQ from that location (dioxin congeners and TEQ definition is provided in the list of acronyms). Dioxins were detected at the three northern sites, within known source areas and/or drainages. Known source areas are those with historical burning activities (e.g., Ash Pile at the NCY RFI site). TEQs ranged from below background up to 180 times background in known source areas to 660 times background in drainages. These include:

- SRE RFI Site:
  - ➢ SCE Power Plant area (CMS Area SRE 3-1). Dioxins were detected with a TEQ of 2.9 nanograms per kilogram (ng/kg).
  - ➢ SRE Pond (CMS Area SRE 14-1). Dioxins were detected with a TEQ of 26 ng/kg.
  - ➢ SRE Pond Drainage (CMS Area SRE 14-2). Dioxins were detected with TEQs of 6 ng/kg to 12 ng/kg.
  - ➢ Dioxin TEQs exceeded the NPDES Outfall 004 permit limit 10 times since 2004; the highest concentrations were detected immediately following the 2003 Piru Fire and the 2005 Topanga Fire. The location of Outfall 004 is shown on Figure 2-7B.
- OCY RFI Site:
  - ➢ Telephone Pole Storage Area (CMS Area OCY 5-1). Dioxins were detected with TEQs up to 180 ng/kg.
  - ➢ Northern and Southern Debris Areas (CMS Areas OCY 6-1 and 6-2). Dioxins were detected with TEQs up to 52 ng/kg; dioxins were detected down the eastern drainage, with TEQs of 8.3 ng/kg decreasing to 0.99 ng/kg.
  - ➢ SRE Pipeline Discharge Area (CMS Area OCY 7-2) and Topographic Low Spot/Downslope Drainage Areas (CMS Areas OCY 8-1, 8-2, 6-3). Dioxins were detected with TEQs of 36 ng/kg
- NCY RFI Site. Dioxins were detected in the Ash Pile (CMS Area NCY 2-1), slope (CMS Area NCY 2-2), and associated drainage (CMS Area NCY 2-3). TEQs ranged

from 66 ng/kg in soils beneath the Ash Pile to 2.4 ng/kg downslope near the asphalt-lined drainage. TEQs within the natural drainage ranged up to 66 ng/kg.

4.5.2 Near-Surface Groundwater

PZ-056 was analyzed in 2006 for dioxins. Dioxins were detected with a TEQ of 0.167 picograms per liter (pg/L). The presence of dioxins is considered related to fine particulate matter in suspension in the sample and not due to dissolved transport. Additional information for NSGW quality, occurrence, and temporal trends is provided in Appendix B.

4.5.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.5.4 Chatsworth Formation Groundwater

Dioxins were analyzed in RD-14 in 2006, adjacent to the highest dioxins concentrations detected at the OCY. No dioxins were detected in this sample. Additional information for CFOU groundwater quality, occurrence, and temporal trends is provided in Appendix B.

4.5.5 Completeness of Characterization

Soil samples were collected and analyzed for dioxins from areas of known or suspected source areas and downgradient drainages. Individual chemical use areas have been delineated sufficiently for risk assessment and evaluation of potential impacts to groundwater as detailed Appendix A.

NSGW and CFOU groundwater were sampled and analyzed for dioxins to screen for potential migration to groundwater near the highest dioxin concentrations in soil. Although detected, dioxins in NSGW are considered related to suspended sediment in the sample, and not site related.

No further characterization of dioxins is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.6 METALS

4.6.1 Soil/Sediment

A total of 229 soil samples were collected and analyzed for metals, based on site use (known or suspected chemical use area), screening, or sample results (stepouts). Group 6 RFI metals sampling results are depicted on Figure 4-6. Each sample location is represented by a color corresponding to a maximum ratio of any detected metal concentration to its respective background metal concentration. Metals were detected at the highest concentrations above background in association with known chemical use areas in Group 6:

- <u>SRE RFI Site:</u>
  - SCE Mercury Release Area (CMS Area SRE 3-1). Up to 35 mg/kg mercury was detected in the release area, with downslope concentrations in the range of 0.1 to 1.1 mg/kg. Near and upstream of the mercury release area, waste characterization data resulting from two excavations for cesium 137 impacts along the drainage ditch indicated few metals above background (copper up to 50.4 mg/kg, cadmium up to 6.6 mg/kg, lead up to 59.3 mg/kg, and zinc up to 361 mg/kg) (Boeing, 2001c).
  - Building 003 Leach Field (CMS Area SRE 7-1). Mercury was detected at up to 2.7 mg/kg; silver (11.4 mg/kg) and thallium (2.1 mg/kg) also were detected above background concentrations. Several metals, most notably silver (22.4 mg/kg) and mercury (21.5 mg/kg) were also detected above background in waste characterization samples collected during septic tank removal (Boeing, 2001d).
  - SRE Pond and drainage (CMS Areas SRE 14-1 and 14-2). Mercury was detected at up to 1.3 mg/kg), and decreased to background down-drainage. Other metals above background levels in the pond (e.g., silver, zinc, thallium, and copper) also decreased to background concentrations downstream.
  - NPDES permit limits have been exceeded at Outfall 004 for mercury and copper.
    - Copper was detected at slightly above the permit limit in one sampling event, but has been below the limit in all subsequent events.
    - Mercury exceeded the NPDES permit limit for several consecutive sampling events up to 2001; the soil source was identified, and plastic tarps were applied. Mercury has been below or near the permit limit in subsequent sampling events.

- OCY RFI Site:

  - North Slope Debris Area B (CMS Area OCY 6-5). Mercury, lead, and boron were detected above background, with the highest concentrations in the debris area. Concentrations decreased to background downstream.

  - Northern/Southern Debris Areas and the eastern tributary (CMS Areas OCY 6-1/6-2 and 6-3). Metals were detected above background, including silver, zinc, thallium, lead, and cadmium. Concentrations decreased downslope and into the eastern tributary.

  - SRE Pipeline Discharge and Low Spot (CMS Areas OCY 4-1 and 8-1). Silver, cadmium, and lead were detected at concentrations above background. Mercury was detected at up to 23 mg/kg.

- NCY RFI Site:

  - New Conservation Yard (CMS Area NCY 1-1). Cadmium, chromium, copper, lead, mercury, silver, and zinc were detected above background concentrations in surface samples. Metals concentrations in the drainage were below background except for lead, which was slightly above background and may be fire-related.

  - Building 040 Ash Pile (CMS Area NCY 2-1). Silver, barium, lead, and zinc were detected above background levels, with silver detected up to 190 times background. Concentrations decrease downslope and are non detect in the drainage.

- B064 LF RFI Site:

  - Thallium detected in one sample at 0.048 mg/kg, slightly above the maximum background level (0.046 mg/kg). Thallium concentrations were below background downslope. Maximum concentrations of lead and zinc were also above maximum background but those metals were determined to be consistent with background when the overall dataset was evaluated (Appendix A).

4.6.2 Near-Surface Groundwater

Samples were analyzed for metals in PZ-114 and PZ-056. Total silver was detected above the SSFL GWCCs at 2.3 mg/L in PZ-114. While the total silver result is likely higher than the actual dissolved concentration, the metal is considered potentially site-related based on elevated silver concentrations within the drainage and upstream soil samples (Appendix B).

Additional information for NSGW quality, occurrence, and temporal trends is provided in Appendix B.

4.6.3 Bedrock

No bedrock samples were collected in the Group 6 Reporting Area.

4.6.4 Chatsworth Formation Groundwater

Metals were analyzed in six of the seven CFOU monitoring wells. Several metals were detected above GWCCs. Based on soil metals concentrations and hydrogeologic conditions (recharge potential, depth to groundwater, gradients, etc.), copper and thallium are potentially site-related as described in Appendix B. Additional information for CFOU groundwater quality, occurrence, and temporal trends is contained in Appendix B.

4.6.5 Completeness of Characterization

Soil and groundwater samples were collected at known potential source areas and downgradient drainages. Individual chemical use areas have been delineated sufficiently for risk assessment and evaluation of potential impacts to groundwater as detailed Appendix A.

NSGW and CFOU groundwater were sampled and analyzed for metals at each of the Group 6 wells. Potential impacts to groundwater have been identified for copper, thallium, and silver, and are considered site-related (Appendix B).

No further characterization of metals is needed at Group 6 RFI sites for purposes of the RFI and CMS recommendations.

4.7 SUMMARY OF POST-TOPANGA FIRE BACKGROUND SAMPLING

Potential post-Topanga fire impacts on metals concentrations in soil were evaluated as described in Appendix D. A total of 80 post-fire samples were analyzed for metals and 66 of these samples contained metals up to two times maximum DTSC-approved background concentrations.

A total of 26 post-fire samples were analyzed for dioxins and 23 of these had total dioxins TEQ concentrations up to three times the maximum background dioxins TEQ. RFI site-specific discussions of the post-Topanga fire data evaluation are presented in Section 2.3.4 of Appendices A1 through A3.

SECTION 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 6 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 6 Reporting Area.

5.1 CONCEPTUAL SITE MODEL

A CSM 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 6 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, and metals) 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)
    - As leachate to groundwater
    - Associated with dust/particulates to outdoor air

- 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)
  - Within groundwater to down-gradient locations
  - To surface water as seeps/springs

5.2 TRANSPORT AND FATE TOOLS USED FOR EVALUATION

The transport and fate evaluation for the Group 6 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 6 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 more detailed descriptions provided in Appendices B and C.

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 C (see Attachment C8, Riskbook00-README file).

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 C.

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 vapor air dispersion. Input parameters for these models are presented in spreadsheets in Appendix C.

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 contaminated soil or NSGW as a source. The second is a modified version that has been used to predict indoor air concentrations using CFOU groundwater as a source and migration through bedrock and any overlying soil as a pathway. 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). The results of the field validation activities will be incorporated into the application of the model when they are available. Risk assessments and reports will be revised as necessary. 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 risk assessment uses a model endorsed by the USEPA and is described in Appendix C. That model predicts the airborne concentration of dust that has as its source contaminated surficial soil.

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. 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 a SSFL site-specific air dispersion model based on measurements that have been completed 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 6 RFI HRAs. Further description of the airborne dispersion factors is presented in Appendix C.

5.2.1.2.4 Groundwater Transport

Groundwater transport evaluations predict future groundwater concentrations based on migration of mobile groundwater contaminants. The evaluations may employ models and parameters for groundwater flow and contaminant transport through fractured bedrock, as described in the Technical Memorandum Conceptual Site Model, Movement of TCE in the Chatsworth Formation (MW, 2000a) and in the Perchlorate Source Evaluation and Technical Report (MWH, 2003c). Model results are used to predict appropriate contaminant levels for use in risk assessment when plume migration is predicted to result in changing exposure point concentrations (EPCs). Based on groundwater contaminant concentrations within and surrounding the Group 6 RFI sites, groundwater elevation gradients, and aquifer characteristics, modeling was deemed unnecessary for risk assessment, and current concentrations were used as future concentrations. A description of this decision for the Group 6 Reporting Area is presented in Appendix B.

5.2.2 Qualitative Tools

Several qualitative tools have been used to evaluate the potential for contaminant migration at the Group 6 RFI sites. These are described in this section.

5.2.2.1 Surficial Soil/ Sediment Transport

Chemical migration in soil and sediment in surface water drainages, or across slopes, has been evaluated for Group 6 RFI site-related contaminants. Sampling and analysis to assess chemical distributions in surficial soils and sediments were based, in part, on potential downslope 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., colocated) groundwater concentrations. The evaluation was based on chemical concentrations, DTSC-approved soil background concentrations (metals and dioxins only), spatial relationships, groundwater elevation gradients, and hydrogeologic relationships (e.g., potential recharge). This provided conclusions regarding soil sources for detected chemicals 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, groundwater elevation gradients, and hydrogeologic relationships, conclusions were made regarding whether each metal was site-related or naturally occurring. This evaluation is summarized below in Section 5.3.5 and presented in more detail in Appendices A and B. In particular, the reader is referred to Table 3-2B in Appendices A1 through A4, and Table B-14 in Appendix B.

5.3 TRANSPORT AND FATE FINDINGS FOR SITE-RELATED GROUP 6 CHEMICALS

The following sections provide a brief summary of transport and fate evaluation findings for the Group 6 Reporting Area for the evaluation tools previously listed. Each of these summaries has a more detailed description in either Appendix B (Groundwater) or Appendix C (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 these other sections.

5.3.1 Vapor from Groundwater

Several VOCs, including TCE, were detected in groundwater in the Group 6 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 risk assessment results in spreadsheets provided in Appendix C, Attachment C8.

5.3.2 Vapor from Soil

Several VOCs, including methylene chloride, were detected in soil in the Group 6 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 risk assessment results in spreadsheets provided in Appendix C, Attachment C8.

5.3.3 Migration Within Groundwater

As discussed in Appendix B, matrix diffusion (for all chemicals) plus high retardation of other chemicals (e.g., metals) slows their transport within the groundwater by storing them in the rock matrix pore water. Based on an evaluation of hydrogeologic characteristics and extent of chemical concentrations, chemical migration within the

Group 6 Reporting Area groundwater is limited. Concentrations are low (below or just above regulatory levels or GWCCs) and have limited mobility. In addition, VOC plumes in neighboring reporting areas are not believed to be migrating to the Group 6 Reporting Area based on topography, groundwater elevations, and the general understanding of groundwater flow conditions.

Based on this conclusion, and the limited detection of groundwater contaminants, quantitative modeling was not applied to establish future groundwater concentrations for risk assessment. Although concentrations have decreased in the past, the current concentrations are assumed constant and are conservatively used as future concentrations for estimating risk. This evaluation is described in Appendix B.

5.3.4 Surficial Soil/Sediment Migration

A transport and fate discussion is presented here for the Group 6 Reporting Area based on the distribution of site chemicals summarized in Section 4 and presented in Appendix A. 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 BMPs have been implemented to control erosion and surface water transport of contaminants at a number of areas within the SSFL, including Group 6 RFI sites (MWH, 2006). Based on sampling results and evaluations conducted for this report, additional erosion control measures are recommended at some CMS Areas. These measures are focused on areas most likely to undergo erosion that results in transport of contaminants such as steep slopes where chemical concentrations significantly exceeding RBSLs and/or background are present. Current erosion control measures at the RFI sites are described in Section 3 and in Appendix A (see Table 3-2A in Appendices A1 through A3). Recommended areas for stabilization measures are further described in Section 7.

Results presented on Figures 4-1 through 4-6 are described below to illustrate chemical distribution relationships as a basis for a transport and fate discussion. As noted in Section 4, data are presented relative to RBSLs and/or DTSC-approved background concentrations 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 near evaluation areas, soil and sediment migration evaluation is presented by chemical group.

Surface water flow patterns are described above in Section 2 and presented on Figure 2-7B. A discussion of flow patterns is presented here to support the transport and fate evaluation below, beginning at the SRE RFI Site, continuing to the OCY and NCY RFI Sites, and ending at drainages flowing south to Silvernale Reservoir.

Based on drainage patterns shown on Figure 2-7B, surface water flow over the majority of the SRE RFI Site is to the east toward the SRE Pond (CMS Area SRE 14-1, Figures 4-1 through 4-6). In the western portion of the SRE RFI Site, drainage occurs mostly via sheet flow. In the northern portion of the SRE RFI Site, a shallow asphalt-lined drainage swale along the base of a bedrock outcrop leads to an unlined drainage channel that discharges eastward into the northwest end of the pond. Two concrete channels along the steep slope east of Building 003 also convey surface water from the flat southwestern areas of the site into the southwestern portion of the SRE Pond. The southeastern portion of the SRE RFI Site (near the Sodium Component Cleaning area) drains either to the east end of the SRE Pond, or flows via small bedrock channels to the drainage downslope of the pond.

Surface water flow at the OCY RFI Site is to the south over the majority of the site, although a small portion drains to the north across steep topography (Figure 2-7B). In the southern portion of the site, surface water flow leads to either an eastern or western tributary drainage. Sheet flow from the Northern and Southern debris areas and the eastern part of the Rocketdyne Conservation Yard leads to the eastern tributary drainage that becomes well-defined south of the paved road (east of the NCY site). Surface water discharge from the remainder of the site (south of the surface water divide) leads to the western tributary drainage and the topographic ‘low spot.’ This area also formerly received discharge from the SRE Pipeline. The central portion of the eastern tributary drainage is asphalt-lined. Discharge from both tributaries is conveyed under the paved road by storm water culverts.

North and above the NCY RFI site, the western tributary drainage is also asphalt-lined south of the road until the drainage turns and trends east-west south of the site (Figure 2-7B). Within the NCY RFI Site, discharge is by sheet flow on the western slope eastward toward the asphalt-lined drainage. On the east side of the drainage, the New Con Yard slopes gently south and has a 3- to 5-foot soil bank above the drainage. East of NCY RFI site, the western tributary drainage joins the eastern tributary drainage and trends south toward Silvernale Reservoir. The Group 6 RFI site characterization was conducted downstream until a confluence with a third tributary drainage leading from other RFI sites in Area II (the Alfa/Bravo/SPA area).

Surface water discharge from the B064 LF RFI site flows north and joins an east-west trending concrete-lined drainage channel. The channel turns north and discharges into an unlined drainage along the west side of the road until it is transmitted east under the road via a storm water culvert. The stormwater culvert pipe discharges to an unlined channel in the northwest portion of the NCY RFI site. This drainage joins the asphalt-lined drainage leading from the OCY RFI site 'low spot'.

5.3.4.1 VOCs

Group 6 RFI soil VOC results are summarized in Section 4.1 and on Figure 4-1. Detailed evaluations of VOC sampling results by chemical use area are contained in each RFI site report (Appendix A).

As shown on Figure 4-1, VOC concentrations typically are non detect to less than 100 parts per billion (µg/kg soil or µg/L soil vapor) to a maximum of 5,200 µg/kg acetone just below the SRE Pond (CMS Area 14-2). Based on site operations, soil data, and groundwater monitoring results (Appendix B), the concentrations likely resulted from a few small, isolated releases. As shown on Figure 4-1, the detected concentrations are limited in extent as defined by samples containing no detectable VOC concentrations (most of the SRE and OCY RFI sites). Moreover, based on their volatile characteristics, these compounds are not likely to be present in shallow (0 to 1 foot bgs) soil. Therefore, surficial transport of VOCs is not considered significant within the Group 6 Reporting Area.

5.3.4.2 SVOCs

Group 6 RFI soil SVOC results are summarized in Section 4.2 and on Figure 4-2. Detailed evaluations of SVOC sampling results (primarily PAHs) by chemical use area are provided in each RFI site report (Appendix A).

As shown on Figure 4-2, the highest PAH concentrations were detected in three primary areas: one at the Building 003 Leach Field (up to 15,000 µg/kg benzo(a)pyrene at 4 feet bgs, CMS Area SRE 7-1), and two at OCY (North Slope Storage, CMS Area OCY 1-4, and the OCY Low Spot, CMS Area OCY 8-1). PAHs in both down-drainage locations are generally non detect or detected at a few parts per billion (µg/kg), indicating minimal migration of these low-mobility compounds within the Group 6 Reporting Area.

5.3.4.3 TPH

Group 6 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 (Appendix A).

TPH was only sporadically detected, with the highest concentrations in the former fuel spill excavation area (CMS Area OCY 3-1, Figure 4-3) and AI Conservation Yard (CMS Area 1-2), both at the OCY RFI Site. The predominantly detected TPH fraction is lubricant oil, with lesser amounts of diesel- and kerosene-range hydrocarbons. Gasoline-range hydrocarbons were detected at low concentrations in a few sample locations. Surface transport of TPH is described by RFI site. Based on this evaluation, minimal to insignificant transport of TPH is indicated within the Group 6 Reporting Area.

<u>SRE RFI Site:</u>
TPH concentrations at the SRE RFI site ranged up to 510 mg/kg near Building 003 (CMS Areas SRE 11-1, 7-1). TPH concentrations were dominated by diesel/lubricant oil-range hydrocarbons. Most of the SRE RFI Site, including these locations, drains to the SRE Pond. However, based on: (1) the relatively low TPH concentration (350 mg/kg lubricant oil-range) detected in the SRE Pond (CMS Area SRE 14-1), and (2) the lack of detected TPH in most samples leading to and within the pond, significant transport of petroleum fuels is not indicated within the SRE RFI Site.

TPH within the SRE Pond is likely the result of small releases at the site along with surface water runoff from paved surfaces (e.g., from vehicles and other operations). TPH concentrations in the SRE Pond drainage (CMS Area SRE 14-2) were 420 mg/kg, decreasing to 6 mg/kg, indicating little transport from the pond. Likewise, small amounts of TPH may have been included in wastewater discharged via pipeline to the OCY RFI Site.

OCY RFI Site:

Both the former fuel spill excavation area and AI Conservation Yard flow toward the low spot (CMS Area OCY 8-1), as do the other western areas at the OCY RFI Site. TPH concentrations in the low spot have been detected exceeding 1,000 mg/kg in historical samples, but more recent samples contained a few hundred mg/kg TPH. A sediment sample collected from the asphalt-lined swale south of the OCY RFI site contained just over 70 mg/kg diesel and lubricant oil range hydrocarbons (not labeled on figure), indicating some limited transport of TPH-contaminated soil from the low spot.

5.3.4.4 PCBs

Group 6 RFI soil PCB results are summarized in Section 4.4 and on Figure 4-4. Detailed evaluations of PCB sampling results by chemical use area are provided in each RFI site report (Appendix A).

The highest detected PCB concentrations were localized near transformer and debris area sources at the SRE (CMS Areas SRE 9-1 and 10-1) and OCY (CMS Areas OCY 1-2, 1-3, 6-4, 7-1, 7-2 and 8-1) RFI sites. The maximum PCB concentration, 24,000,000 µg/kg at CMS Area OCY 1-3, decreased down-drainage, and the extent was limited by four samples without detected PCBs. Down-drainage non detect samples also occurred in all other drainages (CMS Areas SRE 14-2, OCY 6-3, NCY 2-3). All detected PCB concentrations were within proposed CMS Areas within the Group 6 Reporting Area. PCBs (up to 2,574 µg/kg Aroclor 1254) were reported in the waste characterization data from the Building 003 Leach Field and septic removal action (Boeing, 2001d). The presence of PCBs in the septic tank and within the pond suggests that migration between these two chemical use areas may have occurred.

5.3.4.5 Dioxins

Group 6 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 (Appendix A).

Dioxins were detected in several areas associated with several areas:

- TEQs up to 26 ng/kg at the SRE Pond (CMS Areas SRE 14-1) and down-drainage samples with TEQs ranging between 6.5 and 12 ng/kg;
- TEQs up to 52 ng/kg in the OCY Northern and Southern Debris areas, including the downslope and down-drainage locations (CMS Areas OCY 6-1, 6-2, 6-3);
- TEQs up to 180 ng/kg in the OCY Telephone Pole Storage Area (CMS Area OCY 5-1);
- TEQs up to 36 ng/kg at the SRE Pipeline discharge and OCY Low Spot (CMS Areas OCY 4-1 and 8-1); and
- TEQs up to 66 ng/kg at the NCY Ash Pile (CMS Area NCY 2-1)

Dioxin concentrations in soil were highest within the Group 6 Reporting Area in surficial overbank deposits along the NCY drainage, with TEQs up to 660 ng/kg – over three times the maximum RFI site TEQ concentration (180 ng/kg at CMS Area OCY 5-1) and almost 10 times the maximum TEQ detected at the closest source (66 mg/kg at NCY 2-1). Moreover, four metals were present at concentrations up to 190 times background (silver) in soils beneath the NCY Ash Pile, but were not present in the down-drainage overbank soils. All four metals present at the Ash Pile decreased to within or near background concentrations at the asphalt-lined swale. Only one metal (lead) was detected slightly above background levels further downstream and may be fire-related. The distribution of metals and dioxin does not suggest a clear, single source of the high dioxin concentrations in the NCY drainage overbank deposits. Rather, multiple sources from the OCY RFI Site and the Ash Pile source at the NCY RFI Site likely contributed through time to the observed overbank dioxin concentrations. Although not likely significant, dioxins present at the SRE Pond were also possibly contributory to the observed NCY drainage dioxins results. This natural drainage is an alternating depositional/erosive sedimentary environment that concentrates both naturally occurring and anthropogenic dioxins bound to sedimentary particles. During low flow periods, fine-grained sediments accumulate within the drainage. Subsequent high flows during large rain events then erode the main channel, leaving the higher dioxin concentrations detected in overbank deposits south of the NCY RFI Site. Dioxin concentrations decreased further down drainage, with a TEQ result of approximately 14 ng/kg detected just above the confluence with the Alfa/Bravo/SPA tributary drainage. Dioxins were detected at Silvernale Reservoir at TEQs up to 27 ng/kg.

Dioxin and other chemical data indicate transport between the SRE Pond and downstream drainage. Dioxin data upslope of the SRE Pond (TEQ of 2.9 ng/kg) and in the Building 003 Leach Field (TEQ of 0.01 ng/kg), and site operations do not suggest an onsite source of dioxins. Dioxin concentrations in the SRE Pond and drainage may reflect some contribution from naturally occurring fire related dioxins that concentrate in ponds and streams from surrounding hill slopes. The SRE Pond and down-drainage are recommended for further evaluation in the CMS.

5.3.4.6 Metals

Group 6 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 (Appendix A). Based on this evaluation, transport of metals has occurred within the Group 6 Reporting Area. Most notably, metals transport included mercury at the SRE RFI Site from the release area and possibly from the leach field to the pond and the OCY RFI Site Low Spot, and ash-related metals (silver, barium, led, and zinc) within the NCY RFI Site from the Ash Pile to downslope locations, but not within the primary drainages leading to the Silvernale Reservoir.

<u>SRE RFI Site:</u>

The highest metals concentrations were detected at the Mercury Release Area (CMS Area SRE 3-1), the Building 003 Leach Field (CMS Area SRE 7-1), and the SRE Pond (CMS Area SRE 14-1). Mercury was detected up to 35 mg/kg in shallow soils in the release area. Migration is limited to the north (by rock outcrops) and concentrations decrease to near background levels to the south and west. Mercury has migrated via sediment transport downslope to the east and into the SRE Pond, where concentrations ranged up to 1.3 mg/kg. Mercury concentrations ranged up to 0.25 mg/kg in the drainage immediately below the pond dam (CMS Area 14-2), but decreased to background concentrations downstream.

The mercury soil source area at the SRE RFI Site has been covered with plastic tarp to control further contaminant migration and will be maintained until corrective measures are complete.

Several other metals were detected above background in the Building 003 Leach Field and in the SRE Pond, including silver, zinc, thallium, copper, selenium, and cadmium. These metals range up to 14 times background concentrations (silver). As noted in Section 4, high concentrations of mercury and silver were also detected in the waste samples collected from the septic tank (mercury at approximately 100 times background and silver at 20 times background). Given the proximity of the leach field and the SRE Pond, some migration between these two chemical use areas may have occurred. Below the SRE Pond in the drainage, several of these metals were detected above background concentrations, but decreased to background concentrations downslope.

Mercury was detected up to 0.72 mg/kg within narrow bedrock channels at the Sodium Component Cleaning Facility (near monitoring well RD-18), but concentrations decrease to background levels in downslope samples.

<u>OCY RFI Site:</u>
The highest metals concentrations were detected in the SRE Pipeline Discharge and Low Spot (CMS Areas OCY 4-1 and OCY 8-1), the Northern and Southern Debris Areas (CMS Area OCY 6-1), and North Slope Debris Area B (CMS Area OCY 6-5).

Metals were detected exceeding background concentrations in soil samples at the SRE Pipeline Discharge and Low Spot, including mercury (up to 23 mg/kg at the Low Spot), silver, lead, cadmium, and zinc. Each of these metals was detected above background in the SRE Pond (see above), suggesting a potential source for these metals via entrainment of suspended sediment load and discharge to the Low Spot. Continual settling of fine-grained soils at this location likely concentrated these metals and inhibited migration to downstream drainages at the NCY RFI Site (see below) and beyond to Silvernale Reservoir.

Metals were detected up to 14 times background (silver at approximately 11 mg/kg) within the Northern and Southern Debris Areas. Thallium, copper, lead, antimony, and zinc were also detected above background levels (not labeled on figure). Concentrations decreased to the south and west, and several soil samples collected immediately down slope of the debris areas contained metals within background concentrations. Sheet flow occurs in this area and transitions to an unlined drainage that passes through a culvert under the road. Silver decreased from approximately 3 mg/kg to 1.4 mg/kg within the drainage south of the road (CMS Area OCY 6-3). Downstream samples did not contain metals (including silver) above background levels, indicating limited transport down this drainage.

Mercury, boron, and lead were detected at concentrations less than three times background levels in the North Slope Debris Area. Concentrations of these metals were below background in downslope drainage samples.

NCY RFI Site:
Metals concentrations were detected above background in the New Con Yard (CMS Area 1-1, Figure 4-6) and the Ash Pile/downslope area (CMS Areas 2-1 and 2-2).

Silver (up to 150 mg/kg), barium, lead, and zinc were detected above background concentrations in the Ash Pile. Silver concentrations decreased rapidly downslope to near background (<1 mg/kg) near the asphalt-lined swale, while the other metals decreased to below background levels. Metals in the southern New Conservation Yard exceeded three times background levels. With the exception of lead (41 mg/kg compared to 34 mg/kg background, which may be fire-related), all soil samples within the downslope drainage from these areas contained metals at concentrations less than background. These data do not suggest significant migration of metals from the NCY and OCY RFI Sites down this drainage.

The NCY-OCY drainage joins another tributary drainage leading from the RFI sites in Reporting Group 3 (Figure 1-5), and then discharges to Silvernale Reservoir (SWMU 6.8). Several metals detected above background in SRE, OCY, and NCY RFI Site soils have been detected above background concentrations in Silvernale Reservoir sediment samples. Metals above background present in Silvernale sediments included aluminum, cadmium, copper, lead, silver, vanadium, and zinc. Silvernale Reservoir sediment samples also contained metals above background that were not detected above background in Group 6 RFI sites: arsenic, barium, beryllium, chromium, cobalt, iron, manganese, and nickel. Silvernale Reservoir sampling data collected through 2003 are presented in the RFI Program Report (MWH, 2004). The relationship between all western SSFL RFI site sources and the receiving surface water reservoirs (Silvernale and R-2) will be evaluated in the Group 9 RFI Report. Further down-drainage, sampling will be completed as part of the other RFI group reports.

5.3.5 Migration from Soil to Groundwater

Group 6 Reporting Area groundwater occurrence and quality is presented in Appendix B, including evaluation of potential migration from soil to groundwater for contaminants detected in Group 6 Reporting Area soils. A brief summary is presented below.

VOCs, including TCE, were detected in groundwater and are considered related to site activities at Group 6 RFI sites. Based on limited VOCs detected in Group 6 Reporting Area soils, the lack of identified use or storage of solvents, and the low concentrations detected in Group 6 monitoring wells and piezometers, VOCs are believed to have resulted from small isolated spills related to incidental solvent use.

Although several metals were detected in groundwater above their GWCCs, only silver (PZ-114), copper (RD-86) and thallium (RD-15 and RD-86) are considered potentially site-related. Chromium and cobalt, also detected above GWCCs, were not detected in soil at concentrations likely to cause groundwater impacts or in areas where hydrogeologic conditions were conducive to significant transport through the vadose zone to groundwater in recharge areas like the SRE Pond, and the Building 003 and Building 064 Leach Fields.

Groundwater sampling results for SVOCs and PCBs do not suggest transport of soil impacts to NSGW or CFOU groundwater. Dioxins, detected in NSGW (PZ-014), are considered likely related to suspended sediment in the sample and not related to dissolved transport in groundwater. As a conservative measure, however, dioxins are included in evaluation for the risk assessment (Section 6).

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 risk assessment spreadsheets provided in Appendix C, Attachment C8.

5.3.7 Dust Generation

SVOCs, PCBs, dioxins, and metals in soil were modeled in airborne dust generated from soil within the Group 6 Reporting Area. The exposure point concentrations for these chemical classes in dust are presented in risk assessment spreadsheets provided in Appendix C, Attachment C8.

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SECTION 6.0

RISK ASSESSMENT SUMMARY

This section presents and integrates the risk assessment findings for the Group 6 Reporting Area. Human health and ecological risks for the four Group 6 RFI sites are presented in Appendix C, and summarized along with site-specific RFI findings in Appendix A. The details of how the risk assessments have been performed are presented in the SRAM Work Plan, Revision 2 (MWH, 2005b), and in Appendix C.

Three types of risks have been evaluated.

1) Human health risks based on total exposures: surficial media (e.g., soil and sediment) plus indirect groundwater (i.e., vapor migration) plus direct groundwater (i.e., drinking water);

2) Human health risks based on total exposures without direct groundwater exposures; and

3) Ecological risks.

The receptors included in the human health risk assessment 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 have been presented together as the recreator. The ecological receptors representing the site are the deer mouse, the thrush, the hawk, the bobcat, the mule deer, the heron, and a generic aquatic receptor.

These risks have been calculated for each of the four Group 6 RFI sites separately. A generalized CSM for human receptors is shown on Figure 6-1, and a generalized CSM for ecological receptors is shown on Figure 6-2. 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 Appendix C, Attachments C1 through C4.

In the following sections, risks for each of the four Group 6 RFI sites are presented. Tables 6-1 through 6-6 present information regarding chemicals evaluated in the risk assessment, risk estimates, and associated uncertainties for the Group 6 RFI evaluation.

6.1 ACCEPTABLE RISKS

For comparison purposes, estimated potential human health risks are generally considered acceptable for non-cancer Hazard Index (HI) values less than 1.0 and theoretical upper-bound incremental lifetime cancer risks (ILCRs) between 10^{-4} and 10^{-6} (USEPA, 1993). Also, blood lead concentrations less than 10 micrograms per deciliter (µg/dl) are generally considered acceptable for making remedial decisions (DTSC, 1992). These criteria are provided to assist the reader in interpreting the reported risk estimates and served as the basis for the CMS 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 often inherent and intentional conservatism in the use of these assumptions and parameters, and also uncertainty. To assist interpretation of the risk results presented in this section, the main sources of conservatism and uncertainty are listed below:

- A number of metals (e.g., antimony, barium, and copper) 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. (uncertainty)

- The extrapolation of soil TPH concentrations to individual petroleum constituent (i.e., BTEX or PAHs) concentrations was conducted using a data set containing elevated detection limits. Therefore, the estimated EPCs are considered conservative. (conservatism)

- The maximum detected concentration of each COPC detected in groundwater was used as the EPCs for both direct and indirect exposures (see Appendix B). (conservatism)

- Risks associated with drinking groundwater are not realistic because the groundwater beneath SSFL is currently not used as a drinking water source and the presence of the contamination will likely require a restriction on its future use as well. (conservatism)

- Groundwater monitoring data and comparison concentrations (i.e., background) are for filtered samples (i.e., dissolved concentrations) as per the agency-approved groundwater monitoring work plan. Although dissolved concentrations represent the concentrations that may migrate, the total concentration in groundwater may be greater when there are significant amounts of suspended solids present (i.e., total concentration). (uncertainty)

- VOCs detected in one medium, but not analyzed for in another medium to which the VOC could migrate, were assumed to be present based on medium-to-medium extrapolation. (conservatism)

- Vapor migration into indoor air has been estimated using a model which is being validated for the site. Migration estimates may be changed once the model validation is complete. (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 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)

- PCBs were not characterized in the soils beneath the SRE Building 003 Leach Field, however, this area is recommended for further evaluation in the CMS due to the presence of other contaminants. (uncertainty)

- Metals were not characterized in the drainage area upstream of the SRE RFI site mercury release area, however, this area is recommended for further evaluation in the CMS due to the potential presence of metals in soil. (uncertainty)

- PAHs and BTEX were assumed to be present in soil based on conservative extrapolation factors from TPH concentrations. (conservatism)

- PCB congeners were assumed to be present in soil based on conservative extrapolation factors for Aroclor concentrations. (conservatism)

- All dioxin congeners are assumed to be present above background concentrations if only one congener is found to be present above background concentration. (conservatism)

- Thallium was not selected as a COPC in soil at the B064 LF RFI site. The thallium data set was evaluated using the Wilcoxon Rank Sum Test and was determined to be different from background. However, the one thallium concentration slightly above background is consistent with background considering the range of analytical uncertainty and the detection of thallium in the laboratory method blank. If thallium had been included in the full risk assessment, the resultant risks would have been well within acceptable levels, and would not require further action.

- Areas of mercury concentrations in soil have limited analyses for methyl mercury. (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)

6.3 SUMMARY OF RFI SITE RISKS

A summary of the individual RFI site risks is presented below. This includes the human health risks for the residential, commercial, and recreational scenarios. For ecological risks, terrestrial, avian, and aquatic receptors have been evaluated, as appropriate, for the given site conditions. Risks from contaminants in surficial media are presented by RFI site. Direct groundwater risks (i.e., drinking water) are presented separately since they are based on a Group 6 Reporting Area-wide concentration.

6.3.1 NCY RFI Site Risk Estimates

Reasonable maximum exposure (RME) incremental lifetime cancer risk (ILCR) estimates (for all surficial media plus indirect exposure to VOCs in groundwater) range from 1 x 10^{-5} (for adult recreator) to 7 x 10^{-5} (for child resident). RME non-cancer HIs range from 0.02 (for adult recreator) to 0.81 (for child resident). These estimated risks are within the acceptable risk range typically used for CMS decisions. Dioxins and cadmium are the greatest contributors to estimated risk.

If future residents are assumed to be exposed to surficial media with both indirect (vapor) and direct groundwater (drinking water) exposures, then these exposures are additive for both the ILCRs and HIs. RME ILCR estimates range from 3 x 10^{-5} (for adult resident) to 7 x 10^{-5} (for child resident). RME non-cancer HIs range from 2.3 (for adult resident) to 9.0 (for child resident). The ILCRs are within the acceptable risk range typically used for CMS decisions; however, the HIs are above acceptable values. Dioxins, cadmium, and TCE are the greatest contributors to estimated risk.

Ecological risks have been also estimated for the NCY RFI site. The receptor HIs range from 24 for the bobcat to >1,000 for the thrush. The chemicals contributing the greatest to ecological risks are dioxins and metals.

6.3.2 OCY RFI Site Risk Estimates

RME ILCR estimates (for all surficial media plus indirect exposure to VOCs in groundwater) range from 5 x 10^{-3} (for child recreator) to 2 x 10^{-2} (for child resident). RME non-cancer HIs range from 0.4 (for adult recreator) to 5.5 (for child resident). Both the estimated ILCRs and HIs are above the typically acceptable risk ranges used for CMS decisions. PCBs, dioxins, and PAHs are the greatest contributors to estimated risk.

If future residents are assumed to be exposed to surficial media with both indirect (vapor) and direct groundwater (drinking water) exposures, then these exposures are additive for both the ILCRs and HIs. RME ILCR estimates range from 8 x 10^{-3} (for adult resident) to 2 x 10^{-2} (for child resident). RME non-cancer HIs range from 2.9 (for adult resident) to 13.7 (for child resident). These estimated risks are both above the typically acceptable risk ranges used for CMS decisions. PCBs, dioxins, PAHs, and TCE are the greatest contributors to estimated risk.

Ecological risks have been also estimated for the OCY RFI site. The receptor HIs ranged from 143 for the hawk to >1,000 for the deer mouse, bobcat and mule deer. The chemicals contributing the greatest to ecological risks are PCBs, dioxins, and metals.

6.3.3 SRE RFI Site Risk Estimates

Although all SRE RFI Site risks are presented in Appendix C, the highest risks from either the wet-pond or dry-pond exposure scenarios are described here and presented in Table 6-2. RME ILCR estimates (for all surficial media plus indirect exposure to VOCs in groundwater) range from 8×10^{-6} (for child recreator) to 4×10^{-4} (for child resident). RME non-cancer HIs range from 0.04 (for adult recreator) to 1.3 (for child resident). Surface water is not a contributor to human risks. The estimated ILCRs are within the typically acceptable risk range used for CMS decisions, but the HIs are above acceptable values. PAHs, PCBs, and methylene chloride are the greatest contributors to estimated risk.

If future residents are assumed to be exposed to surficial media with both indirect (vapor) and direct groundwater (drinking water) exposures, then these exposures are additive for both the estimated ILCRs and HIs. RME ILCR estimates range from 2×10^{-4} (for adult resident) to 4×10^{-4} (for child resident). RME non-cancer HIs range from 2.3 (for adult resident) to 9.5 (for child resident). The ILCRs are within the typically acceptable risk range used for CMS decisions; however, the HIs are above acceptable values. PAHs, PCBs, methylene chloride, and TCE are the greatest contributors to estimated risk.

Ecological risks have also been estimated for the SRE RFI site. The receptor HIs ranged from 7.3 for the great blue heron to exposure to surface water, to >100 for the thrush, hawk, and great blue heron exposure to sediments. The chemicals contributing the greatest to ecological risks are PCBs and metals.

6.3.4 B064 LF RFI Site Risk Estimates

There were no COPCs identified in soil for quantitative analysis at the B064 LF RFI Site; therefore, there are no current or future human health risks (any receptor) or ecological risks. Thallium was not selected as a COPC even though the data set fails the Wilcoxon Rank Sum Test, because the one detection is well within the range of analytical uncertainty (one result was approximately 4 percent higher than the background comparison value), and thallium was also detected in the laboratory method blank. If site thallium concentrations had been calculated in a full risk assessment, the resultant risks would have been well within acceptable levels, and would not require further action. Indirect groundwater risks were insignificant. Direct groundwater risks for the B064 LF RFI Site are the same as for the other sites within the Group 6 Reporting Area and are presented in the next section.

6.3.5 Group 6 RFI Groundwater Risks

The risks from direct exposure to groundwater through use as drinking water are summarized here. A single set of chemical groundwater concentrations, representing the maximum concentrations from the entire Group 6 Reporting Area, were used to estimate risks. The only receptor assumed to consume contaminated groundwater is the future resident. The RME ILCR estimates are 3×10^{-6} for both child and adult residents. RME non-cancer HIs range from 2.2 (for adult resident) to 8.2 (for child resident). These estimated ILCRs are within the typically acceptable risk range for CMS decisions; however, the HI estimates are above acceptable values. TCE is the greatest contributor to estimated risk.

6.4 CHEMICAL RISK-DRIVERS

Several chemicals significantly contribute to estimated human risks, both ILCR and non-cancer HI, and ecological risks within the Group 6 Reporting Area. The identified chemical risk-drivers are used as the basis for the CMS 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), the chemical risk drivers for the Group 6 Reporting Area are summarized below using these divisions.

Residential

- Soil/sediment risk drivers include dioxins, PAHs, PCBs, VOCs (benzene and methylene chloride), and metals (cadmium).
- The groundwater risk driver is TCE.

Commercial

- Soil/sediment risk drivers include dioxins, PAHs, PCBs, VOCs (methylene chloride), and metals (cadmium).
- There are no groundwater risk drivers (no groundwater ingestion assumed).

Recreational

- Soil/sediment risk drivers include dioxins, PAHs, and metals (cadmium).
- There are no groundwater risk drivers (no groundwater ingestion assumed).

Ecological

- Soil/sediment risk drivers include dioxins, PAHs, PCBs, and metals (silver, aluminum, barium, cadmium, copper, lead, mercury, manganese, nickel, selenium, vanadium, thallium, and zinc) without the large home range adjustments.
- There are no groundwater risk drivers.

SECTION 7.0
GROUP 6 RFI REPORT SUMMARY
AND SITE ACTION RECOMMENDATIONS

This section presents a summary of RFI reporting requirements as they apply to the Group 6 RFI Report. Section 7.1 describes RFI reporting requirements, particularly 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 6 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 6 RFI Report accomplishes these requirements by:

1) Presenting detailed characterization findings, source area identification, and investigation completeness determinations by media and by chemical class for all chemical use areas (and associated down-drainage locations) for each of the four RFI sites in Appendix A. 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 based 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.

2) Evaluating groundwater migration pathways in Appendix B, and other potential transport pathways in Appendix C. Section 5 presents summaries of these evaluations for the entire reporting area, and also describes the group-wide surface water pathway evaluation.

3) Identifying potential receptors and estimating potential risks at each RFI site in Appendix C. Estimated risks are also summarized by RFI site in Appendix A, and presented for the entire reporting area in Section 6.

4) Identifying areas requiring further work by RFI site in Appendix A 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 6 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 6 RFI site in Appendix A.

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 no further action (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, additional work is recommended for the CMS or as an interim corrective measures 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, and which cleanup technologies should be used during the CMI phase.

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

- further evaluation in the CMS (CMS Areas),
- no further action (NFA),
- interim corrective measures to stabilize source areas and control contaminant migration (Stabilization Areas).

Site action recommendations are based on the RFI evaluation presented in the Group RFI Reports, utilizing and integrating characterization and risk assessment findings. 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.

The three site action recommendations listed above result from two evaluations as described below. CMS or NFA Area recommendations are based on an integrated evaluation of characterization and risk assessment results. Stabilization Area recommendations rely on characterization evaluations, including transport and fate analysis, and comparison to risk-based levels.

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.

As the first step in making site action recommendations, risk assessment results for human and ecological receptors are compared to "acceptable" levels published by the USEPA or DTSC as guidance for site managers (DTSC, 1992; USEPA, 1992). Human receptors are evaluated for all potential land use scenarios (residential, industrial and recreational). In cases where acceptable risks are specified as a range of values (see Section 6.1), the low end of the risk range (i.e., 1×10^{-6}, or 1 in 1,000,000) is used to conservatively estimate the areal 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.

In the second step, when estimated RFI site risks are greater than 1×10^{-6} (cancer risks) or HI values 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 (residential, industrial, recreational, and ecological). Risk-drivers are detected chemicals with associated risks greater than 1×10^{-6}. Risk contributors are those chemicals which contribute to total risk but where individual chemical associated risk is less than 1×10^{-6} or HI values less than 1. Individual chemical contribution to total risk was conservatively considered at risk levels of about 2×10^{-7} (cancer risk) or at HI values of about 0.2. These contribution departure evaluation points are approximate and may vary based on the chemical type detected and the individual chemical risk or hazard estimated.

In the third step, after chemical risk drivers and contributors are identified for each potential receptor, 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 potential receptors or 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.

In the fourth step, any 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.

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 potential receptor. CMS Areas are also depicted graphically to illustrate location and approximate areal extent. Areas shown are intended to be comprehensive of all potential receptors or land use scenarios. Based on 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.

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 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 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.

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,
- 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 topographic low (i.e., 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 use best management practices (BMPs) such as installation of straw bales, fiber rolls, or silt fencing, or covering areas with plastic tarp. Soil or sediment that meets the criteria identified above but are 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, 2006). 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 6 REPORTING AREA SITES

Based on the evaluations presented in this document, data collected for the Group 6 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.

Group 6 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 some CMS Areas as noted. CMS Areas shown on Figure 7-1 are approximate and represent evaluations inclusive of all potential receptors. 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 prepared as needed.

Group 6 areas recommended for further evaluation in the CMS, including associated chemical drivers/contributors, are summarized below. Portions of Group 6 outside of these CMS Areas are recommended for NFA, including the entire B064 LF RFI site.

- NCY – Four CMS Areas, including the New Con Yard (metals), the Building 040 Ash Pile, downslope, and down-drainage areas (dioxins, PAHs, metals).

- OCY – Sixteen CMS Areas, including storage and transformer areas (PAHs, PCBs), debris areas (PAHs, PCBs, dioxins, metals), the fuel spill area (methylene chloride, benzene, and 2,4-dinitrophenol), and down-slope areas (PAHs, PCBs, dioxins, metals) (see Table 7-1).

- SRE – Seven CMS Areas, including transformer areas (PCBs), a metals release area near the Steam Power Plant (mercury), the Building 003 Leach Field (PAHs, metals), an oil stain area (methylene chloride, PAHs), and the SRE Pond and down-drainage areas (methylene chloride, PAHs, PCBs, dioxins, metals).

Group 6 areas recommended for surficial soil source stabilization measures are summarized below. As described in Section 5 and reported in the SSFL SWPPP (MWH, 2006), BMPs have been installed at many of these areas. Since source areas are contained within CMS Areas, they are identified in Table 7-1 within the CMS Area designations.

- NCY – Three Stabilization Areas, including the Building 040 Ash Pile, down-slope, and down-drainage areas (dioxins, PAHs, metals). Source stabilization measures are currently present at each of these areas (MWH, 2006).

- OCY – Eight Stabilization Areas, including the Northern Storage Area, and associated down-slope and down-drainage areas (PAHs, PCBs), the Telephone Pole and North/South Debris Areas (PAHs, PCBs, dioxins, metals), and the down-slope areas (PAHs, PCBs, dioxins, metals). Source stabilization measures are currently present at the Telephone Pole and Northern Debris Areas (MWH, 2006), so additional measures are recommended for the others identified above (see Table 7-1).

- SRE – Two Stabilization Areas, including the metals release area near the Steam Power Plant (mercury), and down-drainage from the SRE Pond (PAHs, dioxins, metals). Source stabilization measures are currently present at each of these areas (MWH, 2006).

SECTION 8.0
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SECTION 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 trichloroethylene (TCE), perchloroethylene (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.

Table 3-1
Description of Types Chemical Use Areas and Typical Target Analytical Suites for RFI Soil
(Page 1 of 2)

		Typical Analytical Methods Used for RFI Characterization										
Chemical Use Area Type	**Chemical Use Type Descriptions**	**VOCs**	**SVOCs**	**TPH**	**PCBs**	**Metals**	**Dioxins**	**Energetic Constituents**	**Perchlorate**	**NDMA**	**Formaldehyde**	**pH**
Solvents	Engine/component testing areas, laboratories, storage areas, clarifiers, sumps/pits, degreasers, and storage tanks and associate pipelines	X										
Petroleum Fuels	Gasoline, jet or rocket fuel, diesel storage tanks and associated pipelines, and engine/component testing areas	X [(a)]		X								
Oil-Related Materials	Hydraulic and lubricant oils, sumps/pits, waste oils, and transformers		X	X	X	X						
Metal Wastes *(not associated with debris disposal)*	Corrosive activities/areas, sumps/pits, and storage tanks					X						X
Debris Areas	Landfills and debris and burn areas (incinerators)	X [(b)]	X [(b)]	X	X [(b)]	X	X [(b)]					
Perchlorate and Energetic Constituents	Storage, testing, and handling					X		X	X			

Table 3-1
Description of Types Chemical Use Areas and Typical Target Analytical Suites for RFI Soil
(Page 2 of 2)

		Typical Analytical Methods Used for RFI Characterization										
Chemical Use Area Type	**Chemical Use Type Descriptions**	**VOCs**	**SVOCs**	**TPH**	**PCBs**	**Metals**	**Dioxins**	**Energetic Constituents**	**Perchlorate**	**NDMA**	**Formaldehyde**	**pH**
Hydrazine Fuels	Small engine or system testing areas									X	X	
Other Areas Screened for Potential Chemical Use / Impacts	Leach fields, general storage areas, disturbed terrain	X		X		X						

(a) VOCs were analyzed in areas of gasoline use.

(b) VOCs were typically screened for in these areas, and dioxins/ SVOCs analyzed if visible burned materials were present. PCBs were typically analyzed if elevated concentrations of lubricant oil-range TPH were detected.

Notes:

1. Typical RFI sampling suites used for investigation of areas. Specific analytical suites vary depending on site activities or other sampling results. Target analytes do not include chemicals used for routine maintenance or construction activities.

2. See Figures 3-2 through 3-9 for color-coded identification of chemical use areas in Group 6 RFI sites. Table 3-2 contains a list of individual potential chemical use areas in Group 6 and identifies their Chemical Use Area Type as defined here.

3. In the case of downslope or downstream areas, analytical suites were based on upgradient potential chemical use

NDMA = N-nitrosodimethylamine
RFI = RCRA Facility Investigation
TPH = total petroleum hydrocarbons
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

Table 3-2
Chemical Use Investigation Areas
Group 6 Reporting Area
(Page 1 of 3)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used / Stored	Chemical Use Area Types and Typical Target Analytical Suites (a)							
			Solvent	Petroleum Fuels	Oil-Related Materials	Metal Wastes *(exclusive of debris areas)*	Debris Areas / Fill	Perchlorate and Energetic Constituents	Hydrazine	Screening For Potential Chemical Use / Impacts
			VOCs	TPH	SVOCs, TPH, PCBs, Metals[(b)]	Metals	TPH, Metals[(b)]	Perchlorate, Energetics	NDMA, Formaldehyde	VOCs, TPH, Metals [(b)]
New Conservation Yard (SMWU 7.8) – Appendix A1										
1	New Conservation Yard	Salvageable materials and equipment								X
2	Building 040 Ash Pile	Ash Pile from document incinerator					X (d)			
Old Conservation Yard (SWMU 7.4) – Appendix A2										
1a	Former Rocketdyne Conservation Yard	Salvageable materials, equipment and drums								X
1b	Former AI Conservation Yard	Salvageable materials, equipment and drums								X
1c	Former North Slope Storage Area	Storage area (unspecified)								X
1d	Former Container Storage Area	Container storage (casks, trailers, etc)								X
2a	Former AST 732 and Earthen Berm	Petroleum fuels (diesel fuel oil)	(c)	X						
2b	Former AST 731 and Earthen Berm	Petroleum fuels (diesel fuel oil)	(c)	X						
3	Former Fueling Area at Building 320	Petroleum fuels (diesel fuel oil)	(c)	X						
4	Former SRE Pond Discharge Pipeline	Discharge water from SRE Pond								X
5	Former Telephone Pole Storage Area	Telephone poles					X (b,d)			
6a	Northern Debris Area	Disposal area for construction debris					X (b,d)			
6b	Southern Debris Area	Disposal area for construction debris					X			
6c	North Slope Debris Area “A”	Disposal area for construction debris					X			
6d	North Slope Debris Area “B”	Disposal area for construction debris					X			
7a	Transformer Area in Southeast	PCB-containing oils			X					
7b	Transformer Area in Southwest	PCB-containing oils			X					
7c	Transformer Area 737 near Fueling Area	PCB-containing oils			X					
7d	Transformer Area in Southwest Corner of Rocketdyne Conservation Yard	PCB-containing oils			X					
7e	Transformer Area West of OCY	PCB-containing oils			X					
8	Topographic Low Spot and Downslope Drainage	Surface water runoff								X

Table 3-2
Chemical Use Investigation Areas
Group 6 Reporting Area
(Page 2 of 3)

Chemical Use Area Number	Chemical Use Area Name	Potential Chemicals Used / Stored	Chemical Use Area Types and Typical Target Analytical Suites (a)							
			Solvent	Petroleum Fuels	Oil-Related Materials	Metal Wastes *(exclusive of debris areas)*	Debris Areas / Fill	Perchlorate and Energetic Constituents	Hydrazine	Screening For Potential Chemical Use / Impacts
			VOCs	TPH	SVOCs, TPH, PCBs, Metals[(b)]	Metals	TPH, Metals[(b)]	Perchlorate, Energetics	NDMA, Formaldehyde	VOCs, TPH, Metals [(b)]
Sodium Reactor Experiment (Area IV AOC) – Appendix A3										
1	Toluene Process Unit / Tetralin Heat Exchanger	Solvents, PCB-containing oils	X		X					
2	Sodium Component Cleaning Area	PCB-containing oils, metal wastes			X	X				
3a	Southern California Edison (SCE) Steam Power Plant: Steam Generation Area	Solvents, lube/hydraulic oils, PCB-containing oils	X		X					
3b	Southern California Edison (SCE) Steam Power Plant: Cooling Tower	Solvents, hexavalent chromium	X			X				
3c	Southern California Edison (SCE) Steam Power Plant: Mercury Release Area	Metal wastes				X				
4	Underground Storage Tank UT-27	Petroleum fuels (diesel fuel oil)	(a)	X						
5	Underground Storage Tank UT-71	Solvents, petroleum fuels (gasoline)	(a)	X						
6	Underground Storage Tank UT-74	Petroleum fuels (diesel fuel oil)	(a)	X						
7	Building 003 Leach Field	Sanitary sewage (e)								X
8	Transformer Area 683 near Building 143	PCB-containing oils			X					
9	Transformer Area 693 East of Building 003	PCB-containing oils			X					
10	Transformer Area South of Building 003	PCB-containing oils			X					
11	Oil Stain at Building 003	Possible lubricant / hydraulic oils			X					
12	SRE Pond Influent Channels	Surface water runoff								X
13	Former Industrial Dry Well	Industrial wastewater								X
14	SRE Pond	Surface water runoff								X (f)
15	Entire Site as Potential Storage Area	Solvents								X
Building 064 Leach Field (Area IV AOC) – Appendix A4										
1	Building 064 Leach Field	Sanitary Sewage (e)								X

Table 3-2
Chemical Use Investigation Areas
Group 6 Reporting Area
(Page 3 of 3)

(a) Descriptions of types of chemical use areas and typical analytical suites further described in Table 3-1.
(b) Analytical suites for these types of chemical use areas were modified as appropriate based on site history information (types of storage, operations) or visual inspection of area (e.g., if burned material was noted, dioxins were included.). In the case of downslope or downstream areas, analytical suites were based on upgradient potential chemical use.
(c) Areas screened for solvent impacts; not considered primary use of area.
(d) Burn materials noted.
(e) Sanitary leach fields only used at SSFL prior to early 1960s.
(f) Dioxins analyzed at SRE Pond, upslope, and drainage based on dioxin concentrations detected at OCY RFI Site.

Note: Potential chemical use areas are shown on Figure 3-2 and defined by number on Appendix A figures.

AI = Atomics International
ASTs = Aboveground Storage Tanks
B064 LF = Building 064 Leach Field
Metals = various, including as appropriate hexavalent chromium
NCY = New Conservation Yard
NDMA = N-nitrosodimethylamine
OCY = Old Conservation Yard
SCE = Southern California Edison
SRE = Sodium Reactor Experiment
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
UT = Underground Tank
VOCs = volatile organic compounds

Table 6-1 (1 of 3)

Chemicals of Potential Concern for Human Health
Group 6

Chemical	Soil/Soil Vapor	Groundwater	Surface Water
Inorganic Compounds			
Aluminum			X
Antimony	X		X
Arsenic			X
Barium	X		
Boron	X		
Cadmium	X		X
Chromium	X		X
Copper	X	X	X
Fluoride		X	
Lead	X		X
Mercury	X		X
Molybdenum	X		
Nickel	X		X
Nitrate		X	
Selenium	X		
Silver	X		
Thallium	X	X	X
Vanadium			X
Zinc	X		
VOCs			
1,1,1-Trichloroethane	X		X
1,1,2-Trichloro-1,2,2-trifluoroethane	X		
1,1-Dichloroethane	X	X	
1,1-Dichloroethene	X		
1,2-Dichloroethane		X	
2-Butanone	X		
2-Hexanone	X		
Acetone	X	X	
Benzene	X	X	
Carbon disulfide		X	
Chloromethane		X	
cis-1,2-Dichloroethene		X	
Ethylbenzene	X		
m,p-Xylene	X		
Methylene chloride	X	X	
o-Xylene	X		
p-Isopropyltoluene	X		
Tetrachloroethene	X		

Table 6-1 (2 of 3)

Chemicals of Potential Concern for Human Health
Group 6

Chemical	Soil/Soil Vapor	Groundwater	Surface Water
Toluene	X	X	
Trichloroethene	X	X	X
Xylenes (total)	X		
SVOCs			
1-Methylnaphthalene	X		
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		
Chrysene	X		
Dibenz(a,h)anthracene	X		
Dibenzofuran	X		
Fluoranthene	X		
Fluorene	X		
Indeno(1,2,3-cd)pyrene	X		
Naphthalene	X		
Perylene	X		
Phenanthrene	X		
Pyrene	X		
Total Petroleum Hydrocarbons			
C08-C11(Gasoline Range)	X		
C11-C14(Kerosene Range)	X		
C14-C20(Diesel Range)	X	X	
C20-C30(Lubricant Oil Range)	X		
C22-C40 (Heavy Oil)	X		
Dioxins			
2,3,7,8-TCDD	X		
1,2,3,7,8-PeCDD	X		X
1,2,3,4,7,8-HxCDD	X		X
1,2,3,6,7,8-HxCDD	X		X
1,2,3,7,8,9-HxCDD	X		X
1,2,3,4,6,7,8-HpCDD	X		X
OCDD	X		X

Chemicals of Potential Concern for Human Health
Group 6

Chemical	Soil/Soil Vapor	Groundwater	Surface Water
2,3,7,8-TCDF	X		X
1,2,3,7,8-PeCDF	X		X
2,3,4,7,8-PeCDF	X		X
1,2,3,4,7,8-HxCDF	X		X
1,2,3,6,7,8-HxCDF	X		X
2,3,4,6,7,8-HxCDF	X		X
1,2,3,7,8,9-HxCDF	X		X
1,2,3,4,6,7,8-HpCDF	X		X
1,2,3,4,7,8,9-HpCDF	X		X
OCDF	X		X
Total Tetra	X		X
Total Penta	X		X
Total Hexa	X		X
Total Hepta	X		X
Total Octa	X		X
PCDD/PCDF	X		X
PCBs			
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:
VOC - volatile organic compound
SVOC - semi-volatile organic compound
PCDD/PCDF - polychlorinated dibenzo-p-dioxin and dibenzofurans
PCBs - polychlorinated biphenyls
COPC - chemical of potential concern
bgs - below ground surface

Table 6-2

Human Health Risk Estimates[1]
Group 6

Receptor	New Conservation Yard				Old Conservation Yard				Sodium Reactor Experiment				B/064 Leach Field			
	HI Range	CD	Risk Range	CD	HI Range	CD	Risk Range	CD	HI Range	CD	Risk Range	CD	HI Range	CD	Risk Range	CD
Adult Worker	0.007 - 0.12		1E-06 - 4E-05	a, c	0.04 - 0.78		6E-05 - 1E-02	d, e, f, a, g, h	0.017 - 0.2		2E-06 - 2E-04	e,g	<0.001 - <0.001		- - -	
Future Adult Recreator	<0.001 - 0.02		1E-07 - 1E-05	a	0.004 - 0.44		7E-06 - 6E-03	d, e, f, a	0.0011 - 0.04		3E-08 - 1E-05	e	<0.001 - <0.001		- - -	
Future Child Recreator	0.013 - 0.03		2E-06 - 2E-05	a	0.082 - 1.4	e	9E-05 - 5E-03	d, e, f, a, g	0.02 - 0.1		4E-07 - 8E-06	e	<0.001 - <0.001		- - -	
Future Adult Resident	1.4 - 2.3	b	3E-06 - 3E-05	a, b, c	1.5 - 2.9	b	1E-04 - 8E-03	d, e, f, a, g, b, h, i	1.4 - 2.3	b	3E-06 - 2E-04	b,e,g,h	1.4 - 2.2	b	8E-07 - 3E-06	b
without domestic use of groundwater[5]	0.012 - 0.09		2E-06 - 3E-05	a, c	0.06 - 0.7		1E-04 - 8E-03	d, e, f, a, g, b, h	0.033 - 0.17		2E-06 - 2E-04	e,g,h	<0.001 - <0.001		- - -	
Future Child Resident	5.0 - 9.0	b	1E-05 - 7E-05	a, b, c	5.5 - 13.7	f,b	7E-04 - 2E-02	d, e, f, a, g, b, h, i	5.2 - 9.5	b,j	2E-05 - 4E-04	a,b,e,f, g,h	4.9 - 8.2	b	2E-06 - 3E-06	b
without domestic use of groundwater[5]	0.11 - 0.81		1E-05 - 7E-05	a, c	0.6 - 5.5	f	7E-04 - 2E-02	d, e, f, a, g, b, h	0.26 - 1.3		1E-05 - 4E-04	a,e,f,g, h	<0.001 - <0.001		- - -	

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. Soil media risk estimates are a sum of all direct and indirect exposure so site soil and soil vapor.
3. Groundwater media risk estimates are a sum of indirect and direct exposure to site groundwater, except where indicated that direct exposure due to domestic groundwater use is excluded..
4. Chemical risk drivers are those COPCs detected onsite with an HI > 1, risk > $1x10^{-6}$. Only major risk contributors listed if (subjectively) cumulative HI >> 1 or cancer risk >> $1x10^{-6}$.
5. Groundwater media risk estimates are for indirect exposure only and assume no domestic use of groundwater.

a = Dioxins
b = Trichloroethene
c = Cadmium
d = Aroclor 1248
e = Aroclor 1260
f = Aroclor 1254
g = PAHs
h = Methylene chloride
i= Benzene
j = Thallium

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

Table 6-3 (1 of 1)

Human Health Risk Assessment Uncertainty Analysis
Group 6

Uncertainty	Magnitude of Impact	Direction of Impact
Exposure Assessment		
Domestic use of near surface groundwater was determined to be an incomplete exposure pathway because the estimated production rate is below the minimum criteria of 200 gpd specified in the SRAM.	Low	0
Metals that were demonstrated to be consistent with background were included as COPCs because the maximum detected concentrations were greater than the maximum detected background concentration.	Moderate	+
The maximum detected concentration of each COPC detected in groundwater was used as the exposure point concentration	Moderate	+
Estimates of COPCs concentrations are based on samples collected from known or suspected impacted areas within the RFI Site	Moderate	+
Extrapolation of soil TPH concentrations to individual petroleum constituent (i.e., BTEX), extrapolations were conducted on a data set containing elevated detection limits.	Moderate	+
Effects		
Extrapolation of dose-response data from laboratory animals to humans.	High	+
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	+
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	+

Notes:
\+ tends to overestimate potential risks
0 no anticipated effect on risks or effect is not known
– tends to underestimate potential risks
COPC - Chemical of potential concern
TPH - total petroleum hydrocarbons
BTEX - benzene, toluene, ethylbenzene, and xylenes
SRAM = Standardized Risk Assessment Methodology Workplan (MWH, 2005)

Table 6-4 (1 of 4)

Summary of Chemicals of Potential Ecological Concern
Group 6

Chemical	Soil/Sediment	Surface Water
Inorganic Compounds		
Aluminum		X
Antimony	X	X
Arsenic		X
Barium	X	
Beryllium		X
Boron	X	
Cadmium	X	X
Chromium	X	X
Copper	X	X
Lead	X	X
Mercury	X	X
Molybdenum	X	
Nickel	X	X
Selenium	X	X
Silver	X	X
Thallium	X	
Vanadium		X
Zinc	X	X
VOCs		
1,1,1-Trichloroethane	X	X
1,1,2-Trichloro-1,2,2-trifluoroethane	X	
1,1-Dichloroethane	X	
1,1-Dichloroethene	X	
2-Butanone	X	
Acetone	X	
Benzene	X	
Ethylbenzene	X	
m,p-Xylene	X	
Methylene chloride	X	
o-Xylene	X	
p-Isopropyltoluene	X	
Tetrachloroethene	X	
Toluene	X	
Trichloroethene	X	X
Xylenes (total)	X	

Summary of Chemicals of Potential Ecological Concern
Group 6

Chemical	Soil/Sediment	Surface Water
SVOCs		
1-Methylnaphthalene	X	
2,4-Dinitrophenol	X	
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
Butyl benzyl phthalate		X
Chrysene	X	
Dibenz(a,h)anthracene	X	
Dibenzofuran	X	
Diethylphthalate		X
Di-n-butylphthalate		X
Di-n-octyl phthalate		X
Fluoranthene	X	
Fluorene	X	
Hexachlorobutadiene		X
Hexachlorocyclopentadiene		X
Indeno(1,2,3-cd)pyrene	X	
Naphthalene	X	
Pentachlorophenol		X
Perylene	X	
Phenanthrene	X	
Pyrene	X	
Pesticides		
4,4'-DDT		X
Chlordane		X
Dieldrin		X
Endosulfan I		X
Endosulfan II		X

Table 6-4 (3 of 4)

Summary of Chemicals of Potential Ecological Concern
Group 6

Chemical	Soil/Sediment	Surface Water
Endrin		X
Heptachlor		X
Heptachlor epoxide		X
Toxaphene		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	X
1,2,3,7,8-PeCDD	X	X
1,2,3,4,7,8-HxCDD	X	X
1,2,3,6,7,8-HxCDD	X	X
1,2,3,7,8,9-HxCDD	X	X
1,2,3,4,6,7,8-HpCDD	X	X
OCDD	X	X
2,3,7,8-TCDF	X	X
1,2,3,7,8-PeCDF	X	X
2,3,4,7,8-PeCDF	X	X
1,2,3,4,7,8-HxCDF	X	X
1,2,3,6,7,8-HxCDF	X	X
2,3,4,6,7,8-HxCDF	X	X
1,2,3,7,8,9-HxCDF	X	X
1,2,3,4,6,7,8-HpCDF	X	X
1,2,3,4,7,8,9-HpCDF	X	X
OCDF	X	X
PCBs		
Aroclor-1016		X
Aroclor-1221		X
Aroclor-1232		X
Aroclor-1242		X
Aroclor-1248	X	X
Aroclor-1254	X	X
Aroclor-1260	X	X
PCB-105	X	
PCB-114	X	

Table 6-4 (4 of 4)

Summary of Chemicals of Potential Ecological Concern
Group 6

Chemical	Soil/Sediment	Surface Water
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:
VOC - volatile organic compound
SVOC - semi-volatile organic compound
PCB - polychlorinated biphenyl
CPEC - chemical of potential ecological concern
bgs - below ground surface

Table 6-5

Risk Estimates for Ecological Receptors
Group 6

Receptor	Total HIs						
	New Conservation Yard		Old Conservation Yard		Sodium Reactor Experiment		Building 064 Leach field
	HI Range[1]	CD	HI Range[1]	CD	HI Range[1]	CD	HI Range[1]
Deer Mouse	62 - 220	a, b, c, d, f, g, h, i, j, n	>1,000 - >1,000	k, l, m, j, n, d, a, b, o, t	13 - 31	d,c,l,b,o,i,p,j	NA - NA
without inhalation pathway	62 - 220	a, b, c, d, f, g, h, i, j, n	>1,000 - >1,000	k, l, m, j, n, d, a, b	11 - 29	d,c,l,b,i,p,j	NA - NA
Thrush	560 - > 1,000	a, b, c, e, f, g, i, j	304 - 466	l, d, b, m, p, j, a, q, r	305 - 654	d,b,c,i,p,l	NA - NA
Hawk	160 - 270	a, b, c, d, g, i	98 - 143	d, l, q, l, m	78 - 150	d,i,b,l	NA - NA
Using Large Home Range Factor[2]	1.6 - 2.7	None	4.9 - 7.1	d, l	3.7 - 7.1	d	NA - NA
Bobcat	7.2 - 24	a, d, g, i, j	>1,000 - >1,000	k, l, j, m	0.20 - 19.5	r	NA - NA
Using Large Home Range Factor[2]	0.012 - 0.041	None	14 - 153	k	0.0016 - 0.16	None	NA - NA
Mule Deer	57 - 280	a, b, d, g, i, j, n	>1,000 - >1,000	k, l, j, b, m, d, a, n	7.0 - 18.4	b,d,j,l	NA - NA
Using Large Home Range Factor[2]	0.6 - 2.9	None	104 - >1000	k, l	0.34 - 0.88	None	NA - NA
Great Blue Heron - Sediment	NA - NA		NA - NA		107 - 212	d, b, and i	NA - NA
Generic Aquatic Receptors - Sediment	NA - NA		NA - NA		12.7 29.1	i, p, b, r, (k, l, m), c, d	NA - NA
Great Blue Heron - Surface Water	NA - NA		NA - NA		6.6 - 7.3	u and d	NA - NA
Generic Aquatic Receptors - Surface Water	NA - NA		NA - NA		76 - 79	u,v,n,w,x,y,z, h,aa	NA - NA

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.

equal to the RFI site acreage. This is an extremely conservative assumption; RFI

3. CD = chemical drivers with Hazard Quotients >1.0.

a =	barium	k =	Aroclor-1248	u=	di-n-butylphthalate		
b =	cadium	l =	Aroclor-1260	v=	hexachlorocylcopentadiene		
c =	copper	m =	Aroclor-1254	w=	toxaphene		
d =	lead	n =	antimony	x=	beryllium		
e =	molybdenum	o =	methylene chloride	y=	bis(2-ethylhexyl)phthalate		
f =	nickel	p =	mercury	z=	aluminum		
g =	selenium	q =	2,4-Dinitrophenol	aa=	diethylphthalate		
h =	silver	r =	PAHs	CPE	Chemical of potential ecological concern		
i =	zinc	s =	Bromomethane	CD=	Chemical risk driver		
j =	dioxins/furans	t =	1,1-Dichloroethene	HI=	Hazard index	NA=	Not applicable

Table 6-6 (1 of 1)

Ecological Risk Assessment Uncertainty Analysis
Group 6

Uncertainty	Magnitude of Impact	Direction of Impact
Exposure Assessment		
Metals that were demonstrated to be consistent with background were included as CPECs because the maximum detected concentrations were greater than the maximum detected background concentration.	Moderate	+
Due to elevated detection limits above ESLs for several metals, these metals were considered as CPECs even though they were not detected in any soil samples. In these cases, it was assumed that chemicals may be present at half the detection limit.	Moderate	+
Extrapolation of soil TPH concentrations to individual petroleum constituent (i.e., BTEX), extrapolations were conducted on a data set containing elevated detection limits.	Moderate	+
The maximum detected concentration of each COPC detected in groundwater was used as the exposure point concentration.	Moderate	+
Estimates of CPECs concentrations are based on samples collected from known or suspected impacted areas within the RFI Site.	Moderate	+
Use of representative species and wildlife exposure factors	Low	0
Use of surrogate or modeled wildlife exposure factors when species-specific exposure factors are unavailable.	Low	0
Wildlife do not avoid contaminated areas or foods.	Moderate	+
Omission of dermal contact.	Low	–
Omission of inhalation exposure pathway for surface-dwelling wildlife.	Low	–
Bioaccumulation models.	Moderate	0
The estimated risks to far ranging species, the hawk, bobcat, and mule deer, assume that these species' spend all of their time at the Group 6 RFI sites.	High	+
Effects		
Use of chronic NOAEL-equivalent TRVs.	Moderate	+
Species-to-species toxicity extrapolations.	High	0
Laboratory-to-field toxicity extrapolations.	Moderate	0
Constituent-to-constituent extrapolations.	Moderate	+
Lack of relevant toxicity data for some representative species.	Moderate	–

Notes:
+ tends to overestimate potential risks
0 no anticipated effect on risks or effect is not known
– tends to underestimate potential risks
CPEC - chemical of potential ecological concern
TPH - total petroleum hydrocarbons
BTEX - benzene, toluene, ethylbenzene, and xylenes

Table 7-1 (Page 1 of 4)
Surficial Media Site Action Recommendations
Group 6 Reporting Area

Area	Associated Chemical Use Area(s)	CMS Area[1] (Figure 7-1)	Recommended for Further Consideration in CMS Based On:			
			Residential Receptor[2]	Industrial Receptor[2]	Recreational Receptor[2]	Ecological Receptor[2]
New Conservation Yard (SWMU 7.8)						
New Conservation Yard (New Con Yard)	1	NCY 1-1	Cadmium	Cadmium	--	Metals (Barium, Cadmium, Copper, Lead, Molybdenum, Nickel, Selenium, Silver, Zinc)
Building 040 Ash Pile	2	NCY 2-1 (stabilization)	Dioxins, PAHs,	Dioxins, PAHs,	Dioxins, PAHs	Dioxins, PAHs, Metals (Barium, Lead, Silver, Zinc)
Downslope Area	2	NCY 2-2 (stabilization)	Dioxins, PAHs	Dioxins, PAHs	Dioxins, PAHs	Dioxins, PAHs, Metals (Barium, Lead, Silver, Zinc)
Drainage [3]	2	NCY 2-3 (stabilization)	Dioxins, PAHs	Dioxins, PAHs	Dioxins, PAHs	Dioxins, Metals (Barium, Lead, Silver, Zinc)
Groundwater	--	--	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • Direct groundwater risks > 1 x 10^{-6} may affect surficial media CMS decisions	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct groundwater use	• Indirect groundwater risks insignificant, do not affect CMS surficial media decisions • No direct groundwater use	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct groundwater use
Old Conservation Yard (SWMU 7.4)						
Southwest Corner of Rocketdyne Conservation Yard	1a	OCY 1-1	--	--	--	Phenanthrene; 2,4-dinitrophenol[4]
Atomics International Conservation Yard	1b	OCY 1-2	PAHs (as TPH)[5], PCBs	PAHs (as TPH)[5], PCBs	PAHs (as TPH)[5], PCBs	PCBs
Northern Storage Area (downslope drainage areas)	1c	OCY 1-3 (stabilization)	PAHs, PCBs	PAHs, PCBs	PAHs, PCBs	--
Northern Storage Area (upper flat portion)	1c	OCY 1-4 (stabilization)	PAHs, PCBs	PAHs, PCBs	PAHs, PCBs	--
Container Storage Area	1d	--	--	--	--	--
Former AST 732 and Earthen Berm	2a	--	--	--	--	--
Former AST 732 and Earthen Berm	2b	--	--	--	--	--
Former Fuel Spill Excavation	3	OCY 3-1	Methylene chloride, Benzene (as TPH)[6]	Methylene chloride	--	Methylene chloride; 2,4-dinitrophenol[4]
SRE Pipeline Discharge Area	4	OCY 4-1 (stabilization)	Dioxins	Dioxins	Dioxins	Dioxins
Telephone Pole Storage Area	5	OCY 5-1 (stabilization	Dioxins	Dioxins	Dioxins	2,4-dinitrophenol[4], dioxins
Northern/ Southern Debris Areas (soil to approx. 5 feet bgs)	6a, 6b	OCY 6-1 (stabilization)	PAHs, PCBs, dioxins	PAHs, dioxins	PAHs, dioxins	PCBs, dioxins, 2,4-dinitrophenol[4], Metals (antimony, cadmium, copper, lead, silver, thallium, vanadium, zinc)
Soil Downslope of Northern/ Southern Debris Areas (to approx. 2 feet bgs)	6a, 6b	OCY 6-2 (stabilization)	PAHs, PCBs, dioxins	PAHs, PCBs, dioxins	PAHs, dioxins	PCBs, dioxins, Metals (cadmium, lead, silver, vanadium, zinc)

Table 7-1 (Page 2 of 4)
Surficial Media Site Action Recommendations
Group 6 Reporting Area

Area	Associated Chemical Use Area(s)	CMS Area[1] (Figure 7-1)	Recommended for Further Consideration in CMS Based On:			
			Residential Receptor[2]	Industrial Receptor[2]	Recreational Receptor[2]	Ecological Receptor[2]
Southeast Drainage	6a, 6b	OCY 6-3	Dioxins	--	--	Dioxins, silver
North Slope Debris Area A	6c	OCY 6-4 (stabilization)	PCBs	PCBs	PCBs	PCBs
North Slope Debris Area B	6d	OCY 6-5	PCBs	PCBs	PCBs	PCBs, Metals (lead)
Transformer Area in SE OCY	7a	OCY 7-1	--	--	--	PCBs
Transformer Area in SW OCY	7b	--	--	--	--	--
Transformer Area 737	7c	OCY 7-2	PCBs	PCBs	PCBs	PCBs
Transformer Area in South OCY	7d	--	--	--	--	--
Transformer Area near SRE	7e	--	--	--	--	--
Low Spot[7]	8	OCY 8-1 (stabilization)	PAHs, PCBs, Dioxins	PAHs, PCBs, Dioxins	PAHs, PCBs, Dioxins	PAHs, PCBs, Dioxins, Metals (aluminum, barium, cadmium, lead, mercury, silver, zinc)
Asphalt-lined drainage downslope of Low Spot	8	OCY 8-2	Samples collected above liner in drainage not included in risk assessment (i.e. contained unit). Sediments recommended for removal as part of facility maintenance activities based on concentrations similar to and downgradient of OCY CMS Area 8-1 (SVOCs, TPH, PCBs, dioxins, lead, mercury, and zinc).			
Groundwater	N/A	--	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • Direct groundwater risks > 1 x 10^{-6} may affect surficial media CMS decisions	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater
Sodium Reactor Experiment (Area IV AOC)						
Toluene Process Unit, and Tetralin Heat Exchanger	1	--	--	--	--	--
Sodium Component Cleaning Area	2	--	--	--	--	--
SCE Steam Power Plant and downslope area [8]	3a, 3c	SRE 3-1 (stabilization)	--	--	--	Mercury
Underground Storage Tank (UST) UT-27	4	--	--	--	--	--
Underground Storage Tank (UST) UT-71	5	--	--	--	--	--
Underground Storage Tank (UST) UT-74	6	--	--	--	--	--

Table 7-1 (Page 3 of 4)
Surficial Media Site Action Recommendations
Group 6 Reporting Area

Area	Associated Chemical Use Area(s)	CMS Area[1] (Figure 7-1)	Recommended for Further Consideration in CMS Based On:			
			Residential Receptor[2]	Industrial Receptor[2]	Recreational Receptor[2]	Ecological Receptor[2]
Building 003 Leach Field	7	SRE 7-1	PAHs	PAHs	PAHs	PAHs Metals (silver, mercury, copper, manganese)
Transformer Area 683	8	--	--	--	--	--
Transformer Area 693	9	SRE 9-1	PCBs	PCBs	PCBs	PCBs
Transformer Area South of Building 003	10	SRE 10-1	PCBs	PCBs[8]	PCBs	PCBs
Oil Stain at Building 003	11	SRE 11-1	methylene chloride, PAH (as TPH)[5]	methylene chloride, PAH (as TPH)[5,8]	methylene chloride, PAH (as TPH)[5,8]	--
SRE Pond Influent Channels (Contained Unit, not used in Risk Assessment)	12	--	Samples collected above liner in drainage not included in risk assessment (i.e.: contained unit). Sediments recommended for removal as part of facility maintenance activities based on concentrations of cadmium, lead, and zinc and the proximity of the area to the CMS Area SRE 7-1.			
Industrial Dry Well	13	--	--	--	--	--
SRE Pond	14	SRE 14-1	Wet: NFA Dry: dioxin, PAHs, methylene chloride	Wet: NFA Dry: dioxin, PAHs, methylene chloride	Wet: NFA Dry: dioxin, PAHs, methylene chloride	Dioxin, PCBs, Metals (silver, barium, mercury, cadmium, copper, vanadium, zinc)
Drainage Downslope of SRE Pond	14	SRE 14-2 (stabilization)	--	--	VOC, PAHs (as TPH)[4]	Dioxin, Metals (copper, manganese, selenium, zinc)
Entire Site as potential Storage Area	15	--	--	--	--	--
Groundwater	--	--	• Indirect groundwater risks << 1 x 10^{-6} and may not affect surficial media CMS decisions • Direct groundwater risks = 3 x 10^{-6} may affect surficial media CMS decisions	• Indirect groundwater risks << 1 x 10^{-6} and may not affect surficial media CMS decisions • No direct groundwater use	• Indirect groundwater risks << 1 x 10^{-6} and may not affect surficial media CMS decisions • No direct groundwater use	• Indirect groundwater HQ << 1, may not affect surficial media CMS decisions • No direct groundwater use
Building 064 Leach Field (Area IV AOC)						
None[9]	--	--	--	--	--	--
Groundwater	--	--	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • Direct groundwater risks > 1 x 10^{-6} may affect surficial media CMS decisions	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater	• Indirect groundwater risks insignificant, do not affect surficial media CMS decisions • No direct use of groundwater

Table 7-1 (Page 4 of 4)
Surficial Media Site Action Recommendations
Group 6 Reporting Area

General Notes:

(a) "—" Indicates area is recommended for No Further Action (NFA) for respective receptor, or parameter not applicable.

(b) 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).

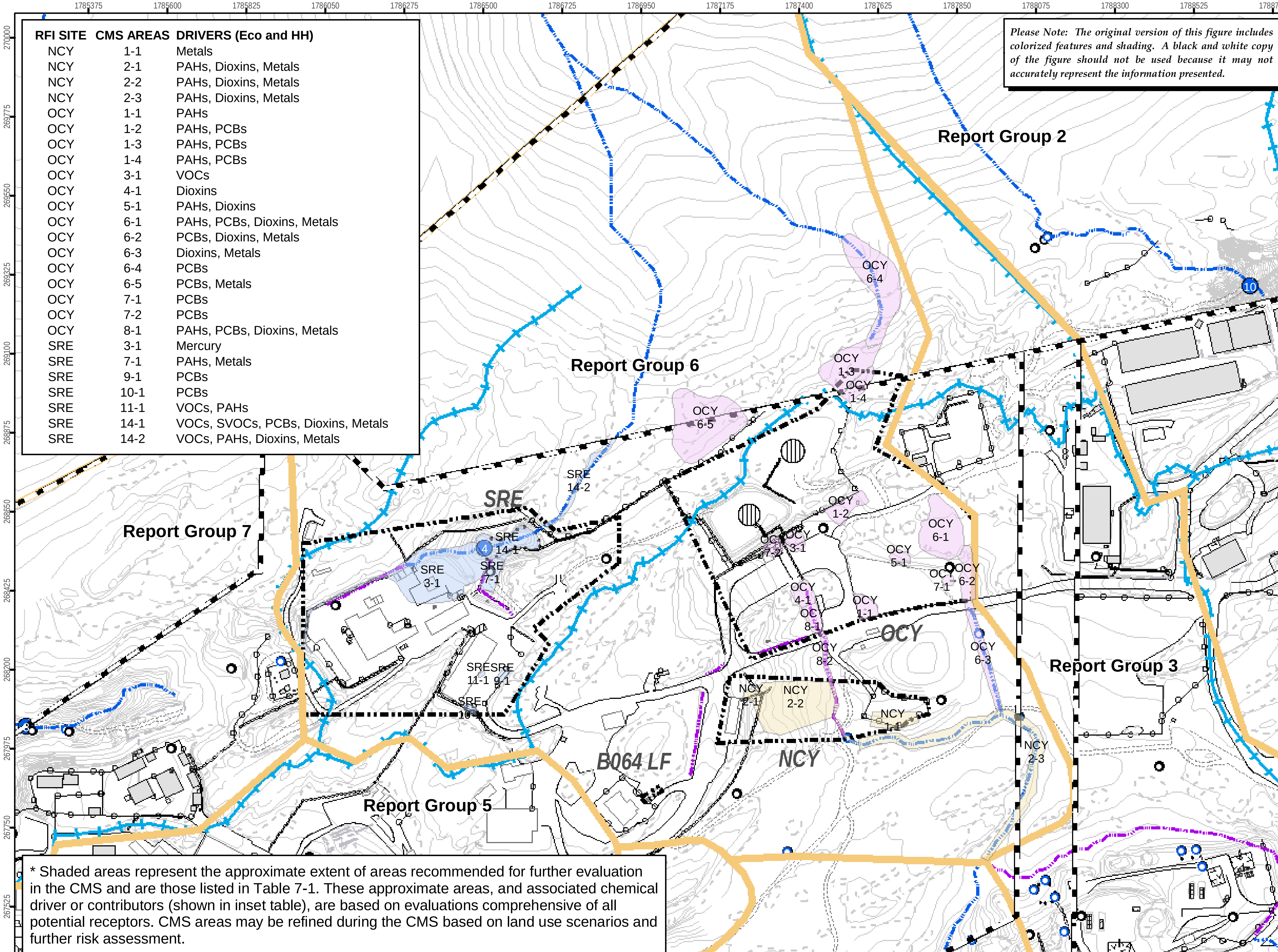
Footnotes:

1. CMS Areas are numbered in sequence based on associated Chemical Use Areas (e.g. 14-1, 14-2, for Chemical Use Area 14). Extent of CMS Areas shown on Figures 4-1 through 4-6 and 7-1 are approximate and reflect site action recommendations based on characterization and risk assessment results inclusive for all receptors (See Section 7.2).
2. CMS recommendations are based on compounds considered risk drivers (excess cancer risk > 1 x 10^{-6}) or hazard index > 1) and/or significant risk contributors.
3. The NCY drainage is potentially associated with either NCY Chemical Use Area 1 or 2; however, it is included as an area recommended for further consideration in the CMS with Chemical Use Area 2 based on the association of dioxins. A portion of this drainage is asphalt-lined, and sediments above the liner are recommended for removal as part of facility maintenance activities.
4. 2,4-dinitrophenol was not detected at OCY; however, elevated laboratory detection limits were reported and contribute to estimated risk.
5. Detected PAHs do not contribute significantly to risk; CMS recommendation is based on extrapolated PAHs concentrations based on detected diesel-, kerosene-, and lubricant-oil range petroleum hydrocarbons.
6. Benzene was not detected; CMS recommendation is based on extrapolated benzene concentrations based on detected gasoline-range petroleum hydrocarbons.
7. A portion of the OCY Low Spot drainage is asphalt-lined, and sediments above the liner are recommended for removal as part of facility maintenance activities.
8. SRE Chemical Use Area 3b (SCE Cooling Tower) is not recommended for further consideration in the CMS. The drainage ditch near and upstream of the mercury release area (Chemical Use Area 3-c) is included in the CMS based on uncertainty regarding elevated metals in waste characterization samples.
9. For the B064 LF RFI site, there are no surficial media areas recommended for further evaluation in the CMS.

ACRONYMS
AOC = Area of Concern
CMS = Corrective Measures Study
CMS = Corrective Measures Study
N/A = Not applicable
NCY = New Conservation Yard
New Con Yard = New Conservation Yard (refers to Chemical Use Area 1, not the entire RFI site)
NFA = No further action
OCY = Old Conservation Yard
PAH = Polynuclear aromatic hydrocarbons
PCB = polychlorinated biphenyls
SCE = Southern California Edison
SRE = Sodium Reactor Experiment
SVOC = Semivolatile organic compound
SWMU = Solid Waste Management Unit
TPH = total petroleum hydrocarbons

RFI SITE	CMS AREAS	DRIVERS (Eco and HH)
NCY	1-1	Metals
NCY	2-1	PAHs, Dioxins, Metals
NCY	2-2	PAHs, Dioxins, Metals
NCY	2-3	PAHs, Dioxins, Metals
OCY	1-1	PAHs
OCY	1-2	PAHs, PCBs
OCY	1-3	PAHs, PCBs
OCY	1-4	PAHs, PCBs
OCY	3-1	VOCs
OCY	4-1	Dioxins
OCY	5-1	PAHs, Dioxins
OCY	6-1	PAHs, PCBs, Dioxins, Metals
OCY	6-2	PCBs, Dioxins, Metals
OCY	6-3	Dioxins, Metals
OCY	6-4	PCBs
OCY	6-5	PCBs, Metals
OCY	7-1	PCBs
OCY	7-2	PCBs
OCY	8-1	PAHs, PCBs, Dioxins, Metals
SRE	3-1	Mercury
SRE	7-1	PAHs, Metals
SRE	9-1	PCBs
SRE	10-1	PCBs
SRE	11-1	VOCs, PAHs
SRE	14-1	VOCs, SVOCs, PCBs, Dioxins, Metals
SRE	14-2	VOCs, PAHs, Dioxins, Metals

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.



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

Base Map Legend

- Administrative Area Boundary
- RFI Boundary RFI 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
- Leachfield
- Pipe
- Well
- NPDES Outfall

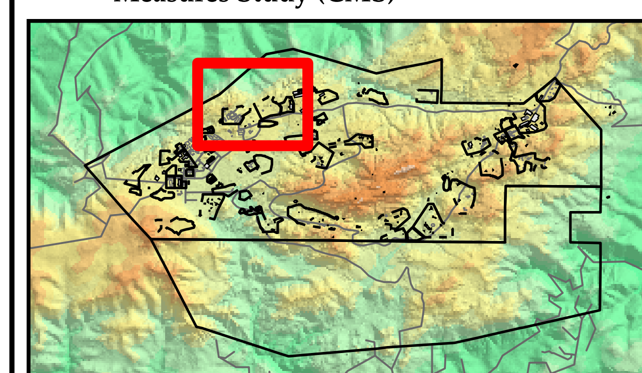
Groundwater Wells

- Shallow
- Deep

CMS Areas

- NCY CMS Areas
- OCY CMS Areas
- SRE CMS Areas

CMS Areas-Areas recommended for further consideration in Corrective Measures Study (CMS)



Date: Sep 28, 2006

Document: RFI-Report-Group6_CMS_Areas.mxd

1 inch equals 300 feet

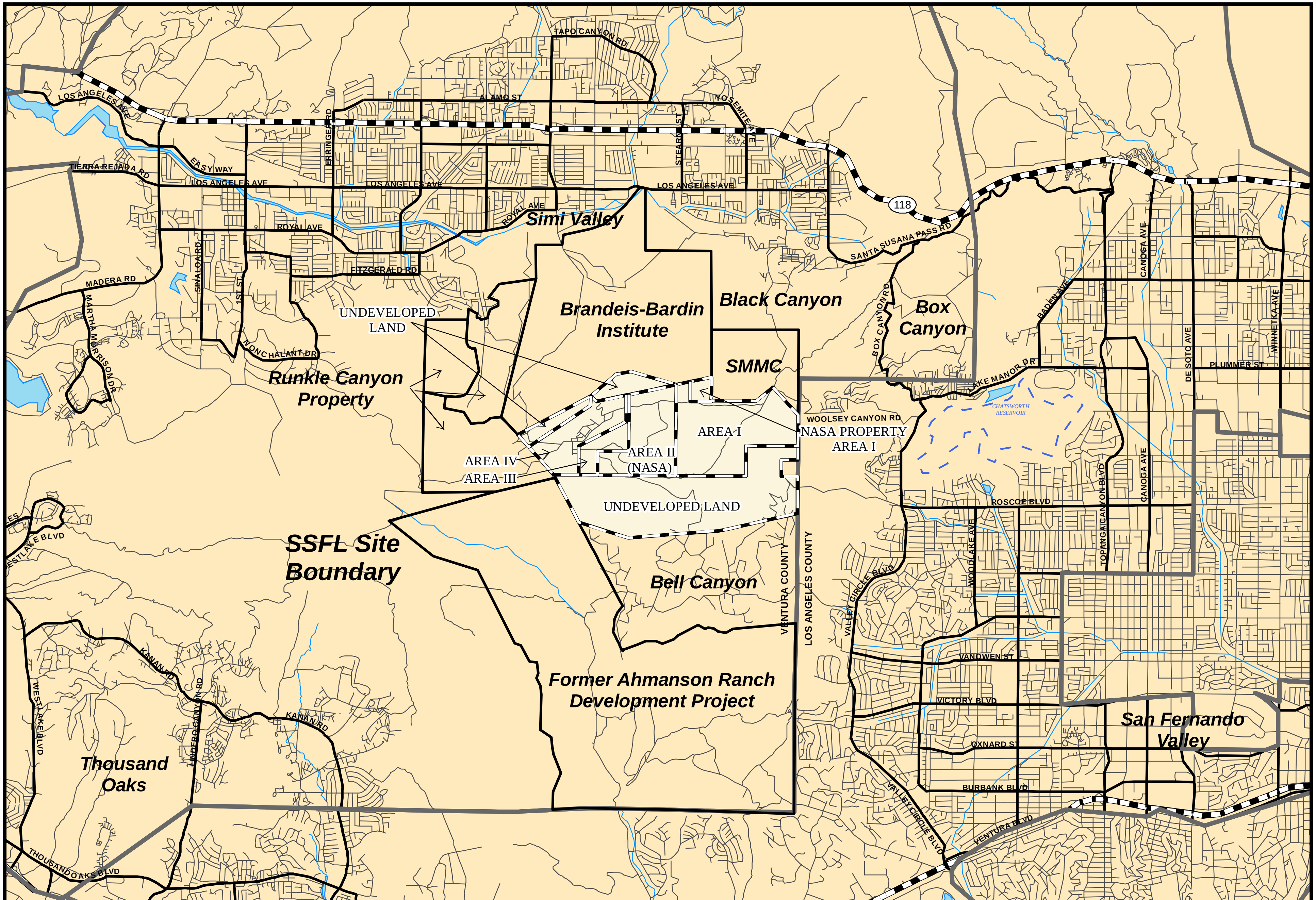
0 300 600 Feet

SANTA SUSANA FIELD LABORATORY

Surficial Media Site Action Recommendations

MWH MONTGOMERY WATSON HARZA

FIGURE ES-1



1 inch equals 1.5 miles

0 1.5 3 Miles

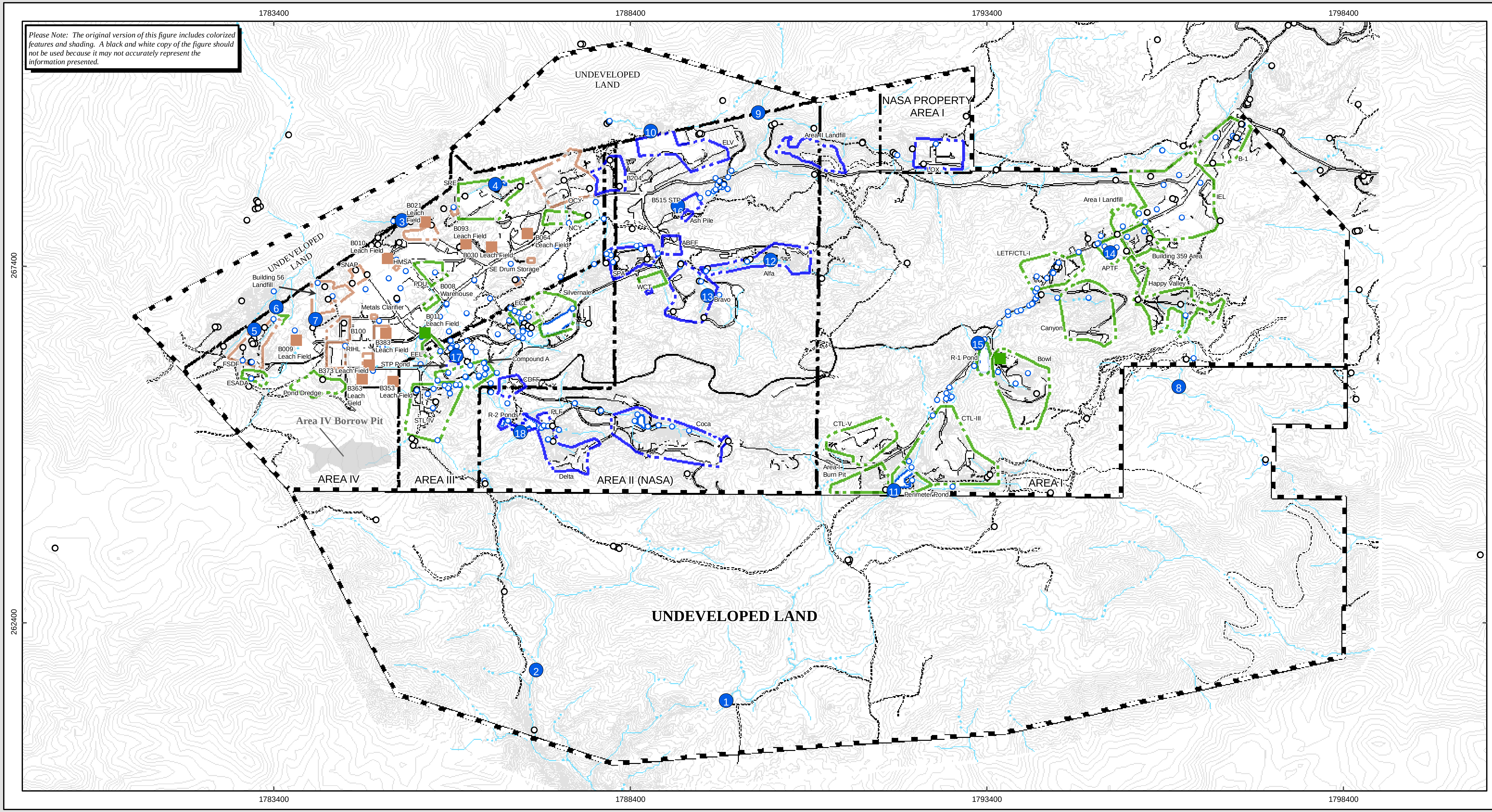
SANTA SUSANA FIELD LABORATORY

Regional Map

FIGURE 1-1

Document: RFI-Report-Group6_regional_map.mxd

Date: Sep 29, 2006



RFI Sites by Responsibility

- DOE
- NASA
- BOEING

Leach Fields by Responsibility

- DOE
- BOEING

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

Notes:

1. Property ownership labeled for administrative areas.
2. DOE has leased and used several buildings in Area IV as shown.
3. All leach fields in areas I, II, III are located at RFI sites.
4. Site ownership/responsibility shown as developed for RFI.

Base Map Legend

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

0 1,300 FEET

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

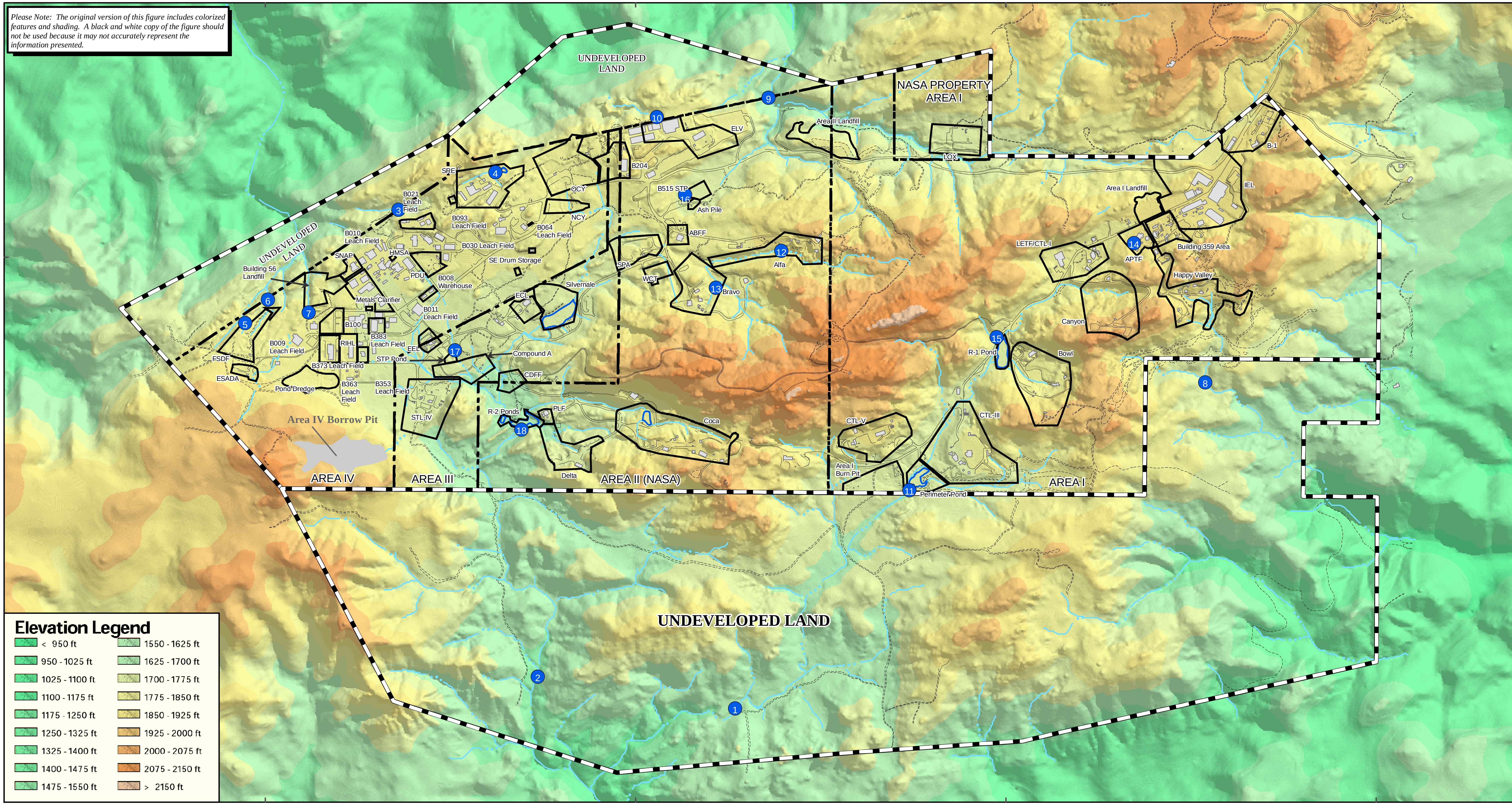
SSFL Site Plan

SANTA SUSANA FIELD LABORATORY

Date: Sep 29, 2006
RFI-Report-Group6_Site_Plan_SSFL_11x17.mxd

MWH MONTGOMERY WATSON HARZA

FIGURE 1-2



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
- AOC - Component Test Laboratory V (CTL-V)

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

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 (New Con)
- 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 Are 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

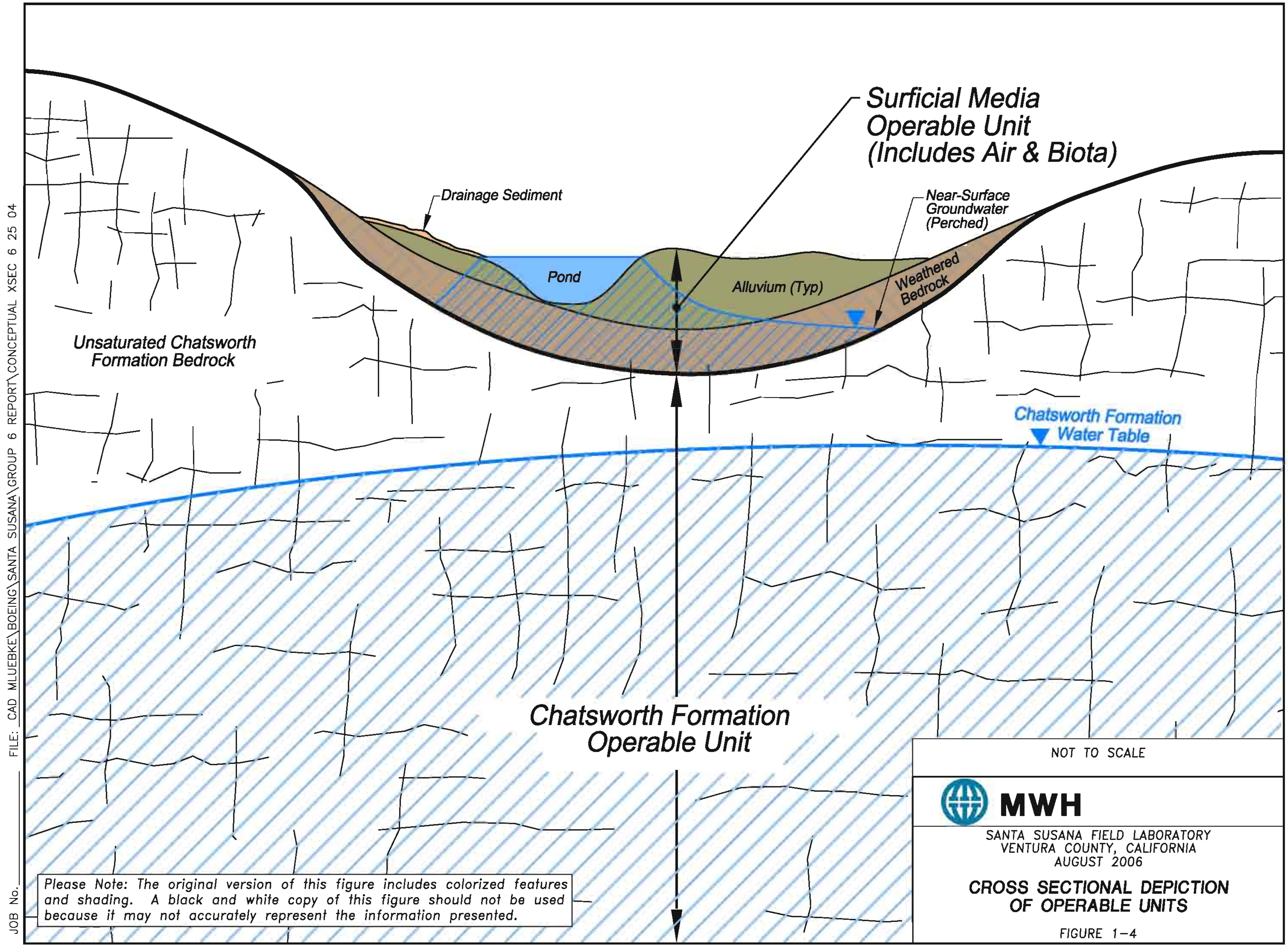
RFI Site Location Map

SANTA SUSANA FIELD LABORATORY

Date: Sep 28, 2006
FILE: r:\rock\plots\arcmap\RFI-Report\RFI-Report-group6_RFI_Location.mxd

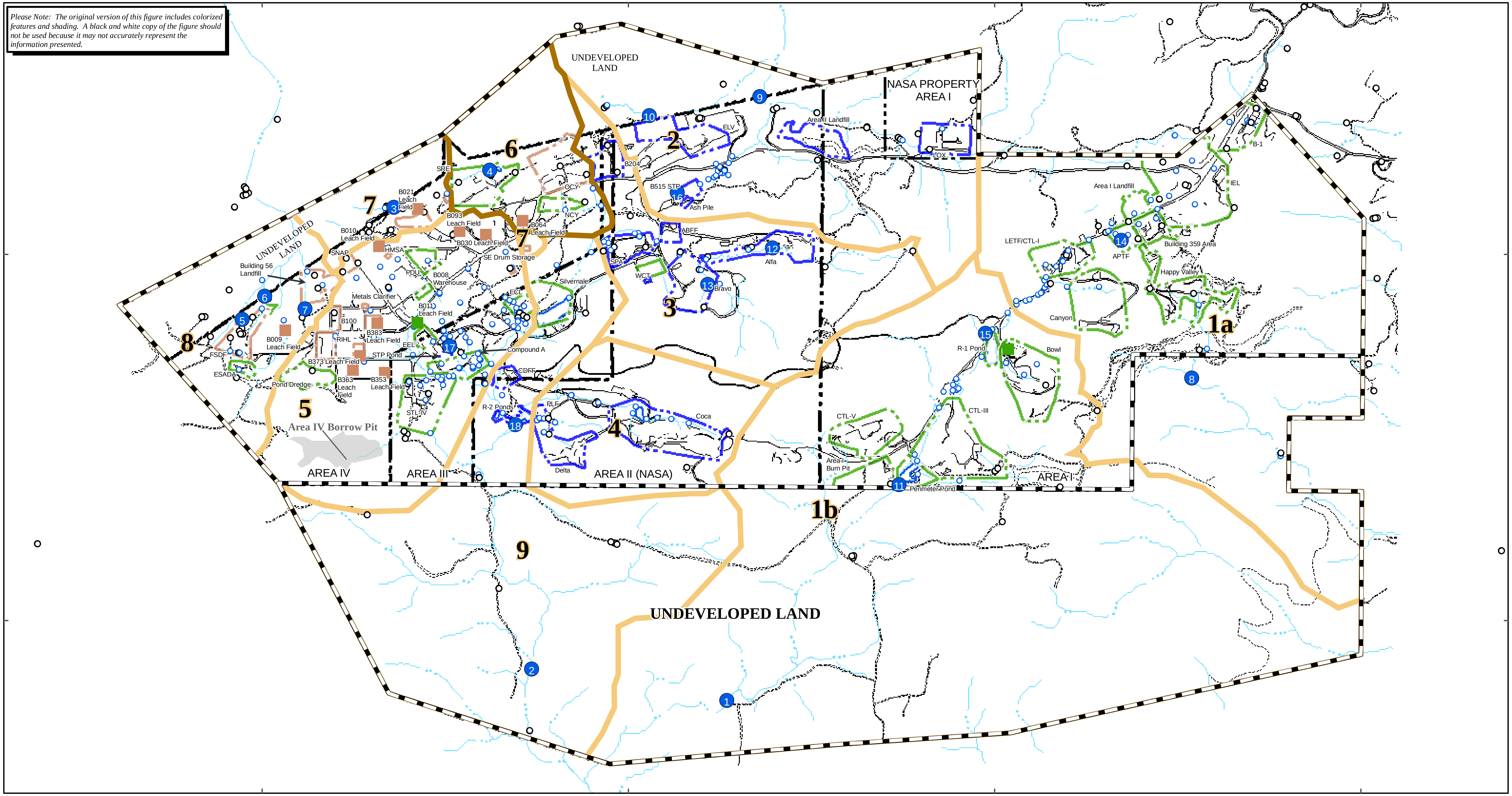
MWH MONTGOMERY WATSON HARZA

FIGURE 1-3



CROSS SECTIONAL DEPICTION OF OPERABLE UNITS

FIGURE 1–4



RFI Sites by Responsibility

- DOE
- NASA
- BOEING

Leach Fields by Responsibility

- DOE
- BOEING

- Report Group 6 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

N

0 1,300 FEET

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

SSFL RFI Report Groupings

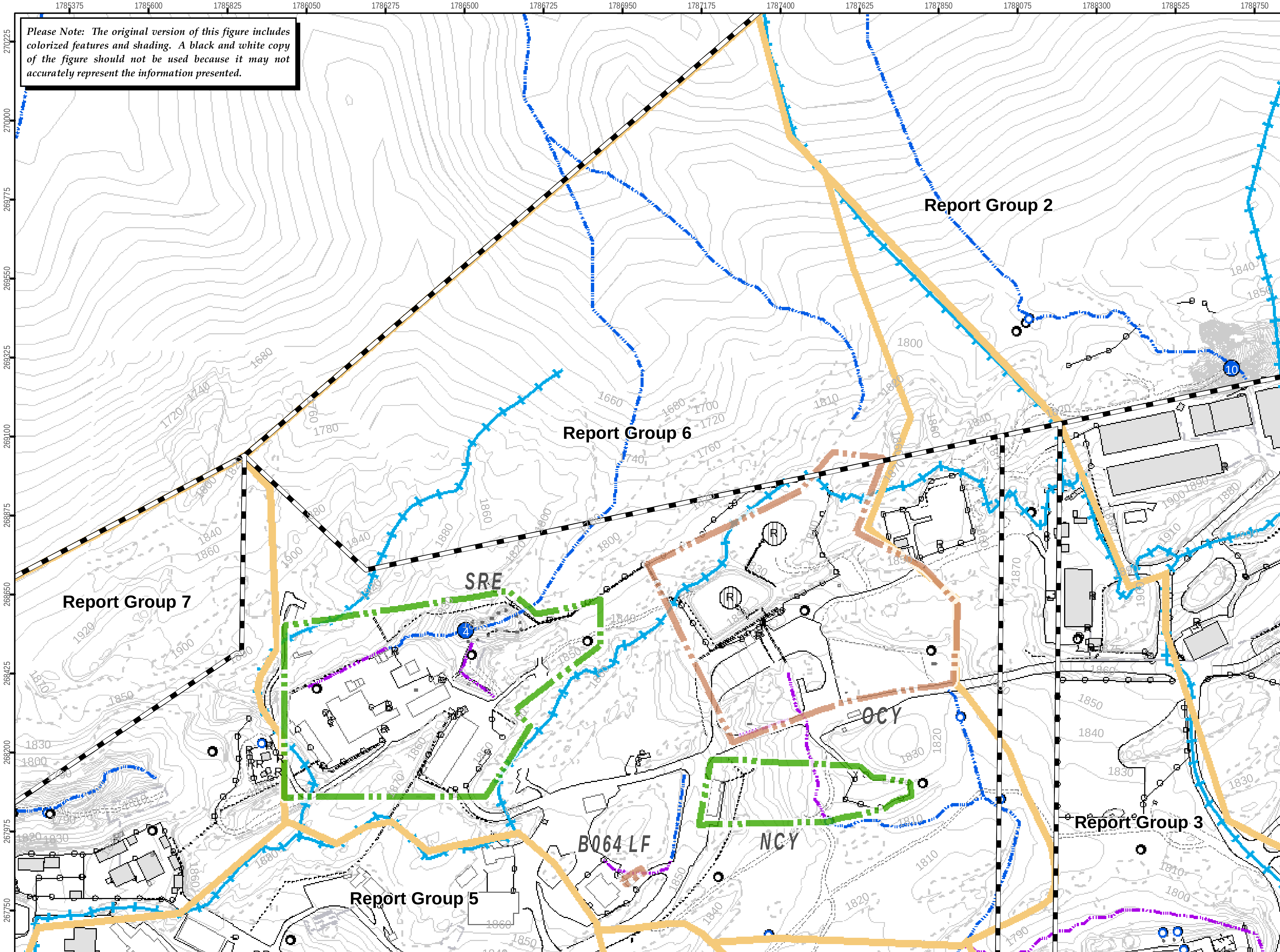
SANTA SUSANA FIELD LABORATORY

Date: Sep 29, 2006

RFI-Report-Group6_GroupAreas.mxd

MWH MONTGOMERY WATSON HARZA

FIGURE 1-5



Base Map Legend

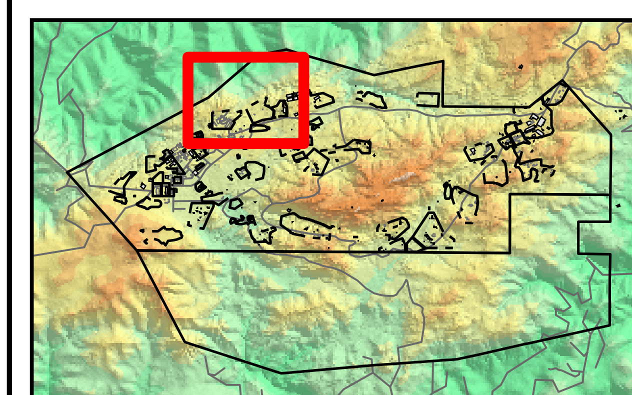
- Administrative Area Boundary
- Report Group Boundary
- Existing Building or Structure
- Removed Building or Structure
- Awning
- Other Tanks
- Solvent Tank
- Petroleum Fuel/Oil Tank
- Hydrazine Tank
- Dirt Road
- A/C Curbing
- Fence
- Rock Outcrop
- Elevation Contour
- Surface Water Divide
- Drainage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

Groundwater Wells

- Shallow
- Deep

RFI Sites By Responsibility

- DOE
- BOEING



Group 6 Reporting Area

Date: Sep 29, 2006

Document: RFI-Report-Group6_Reporting_Area.mxd

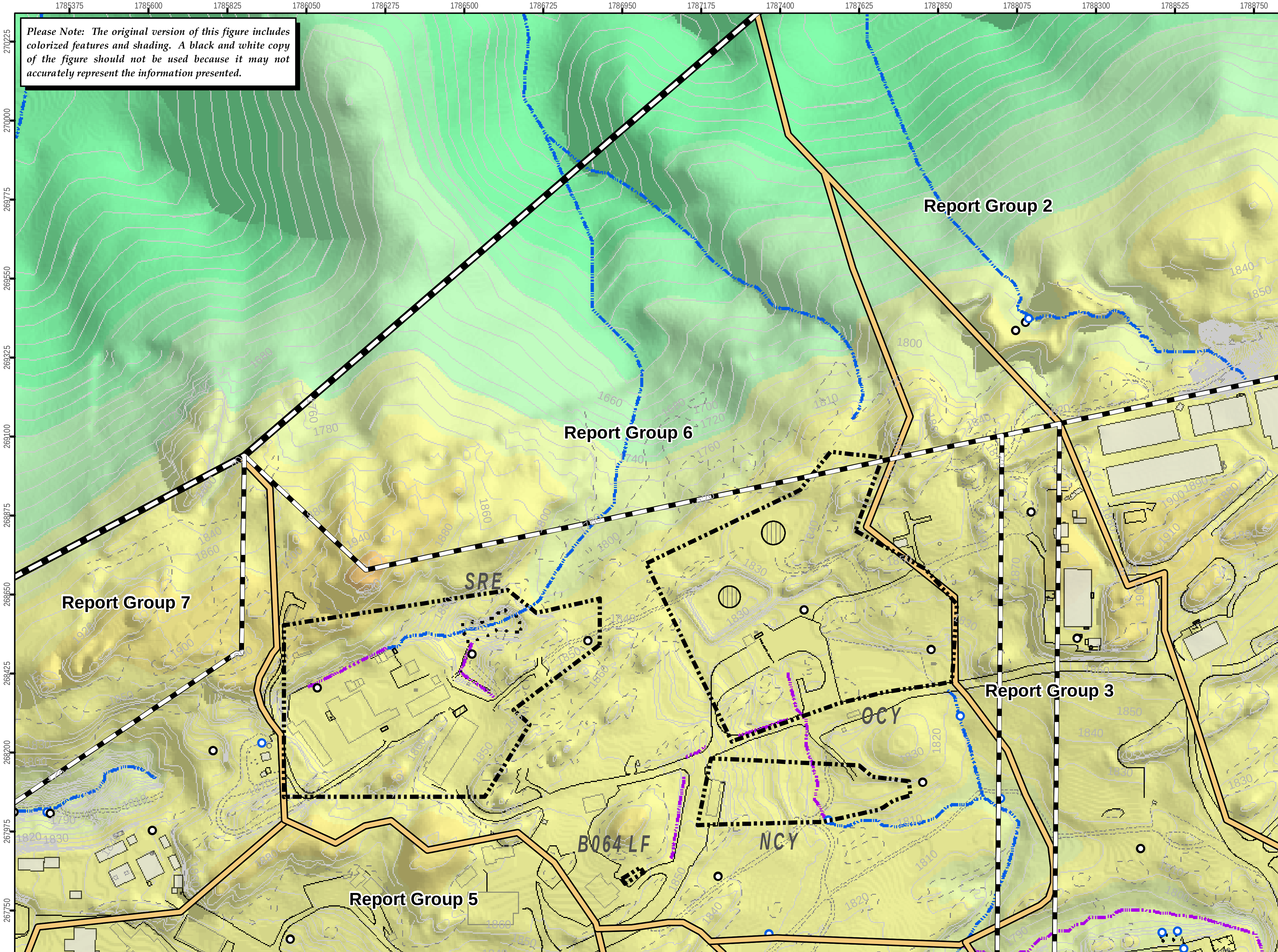
1 inch equals 300 feet

0 300 600 Feet

SANTA SUSANA FIELD LABORATORY

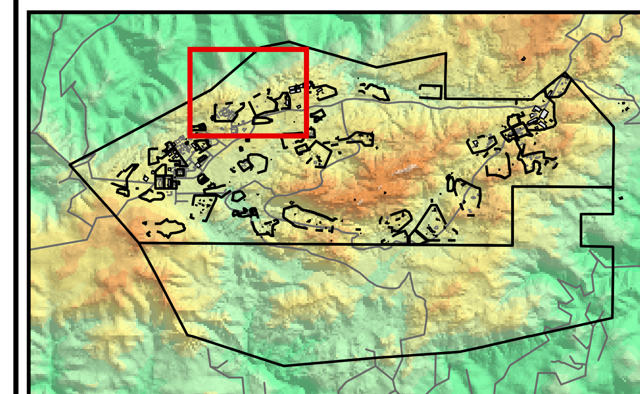
MWH MONTGOMERY WATSON HARZA

FIGURE 1-6



Elevation Legend

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



Base Map Legend

- Administrative Area Boundary
- RFI Boundary RFI 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

Topographic Relief Map
Group 6 Reporting Area

Date: Sep 29, 2006

Document: RFI-Report-Group6_TopoRelief.mxd

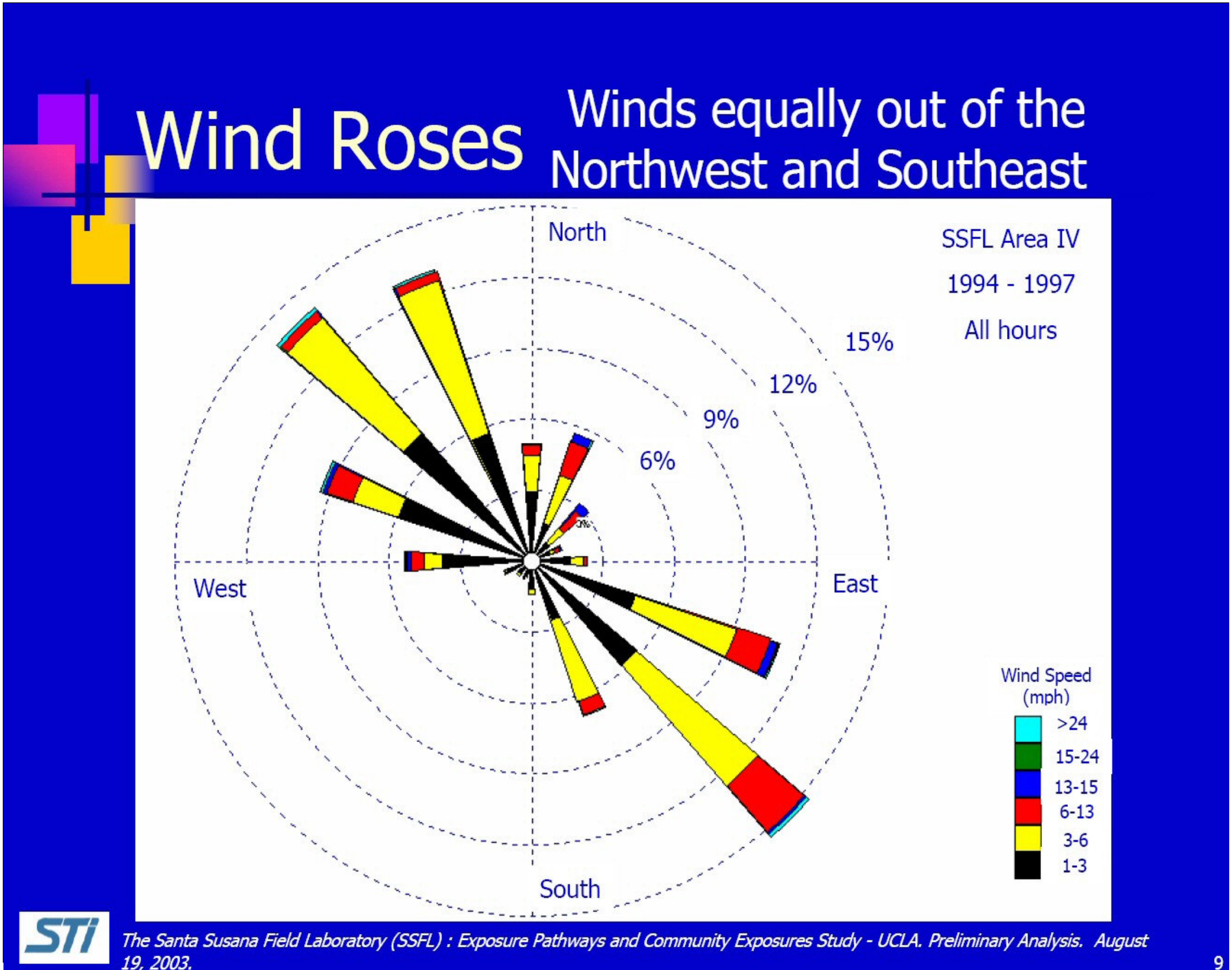
1 inch equals 300 feet

0 300 600 Feet

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 2-1



Source: STI (2003)

Figure 2-2

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

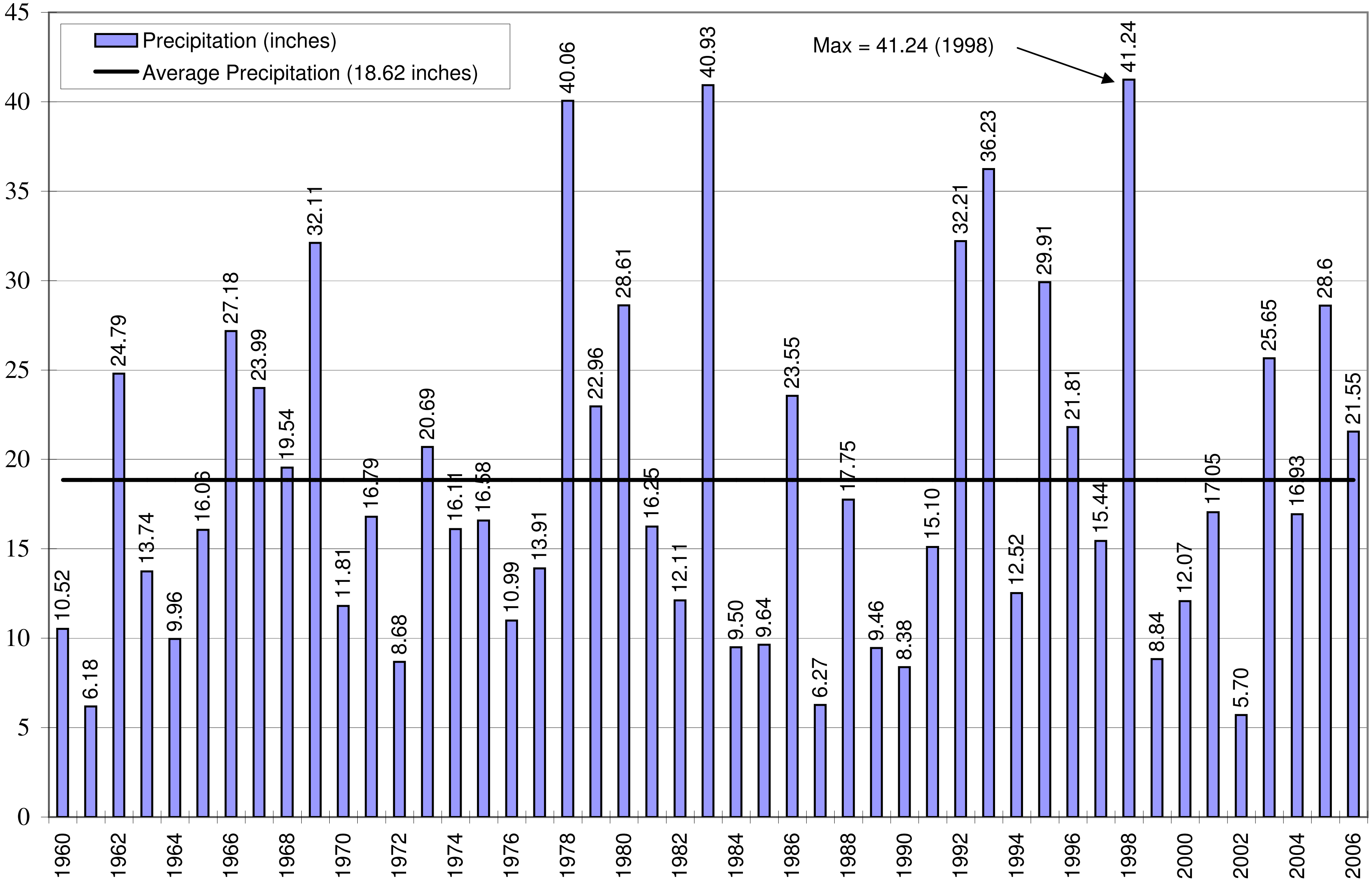
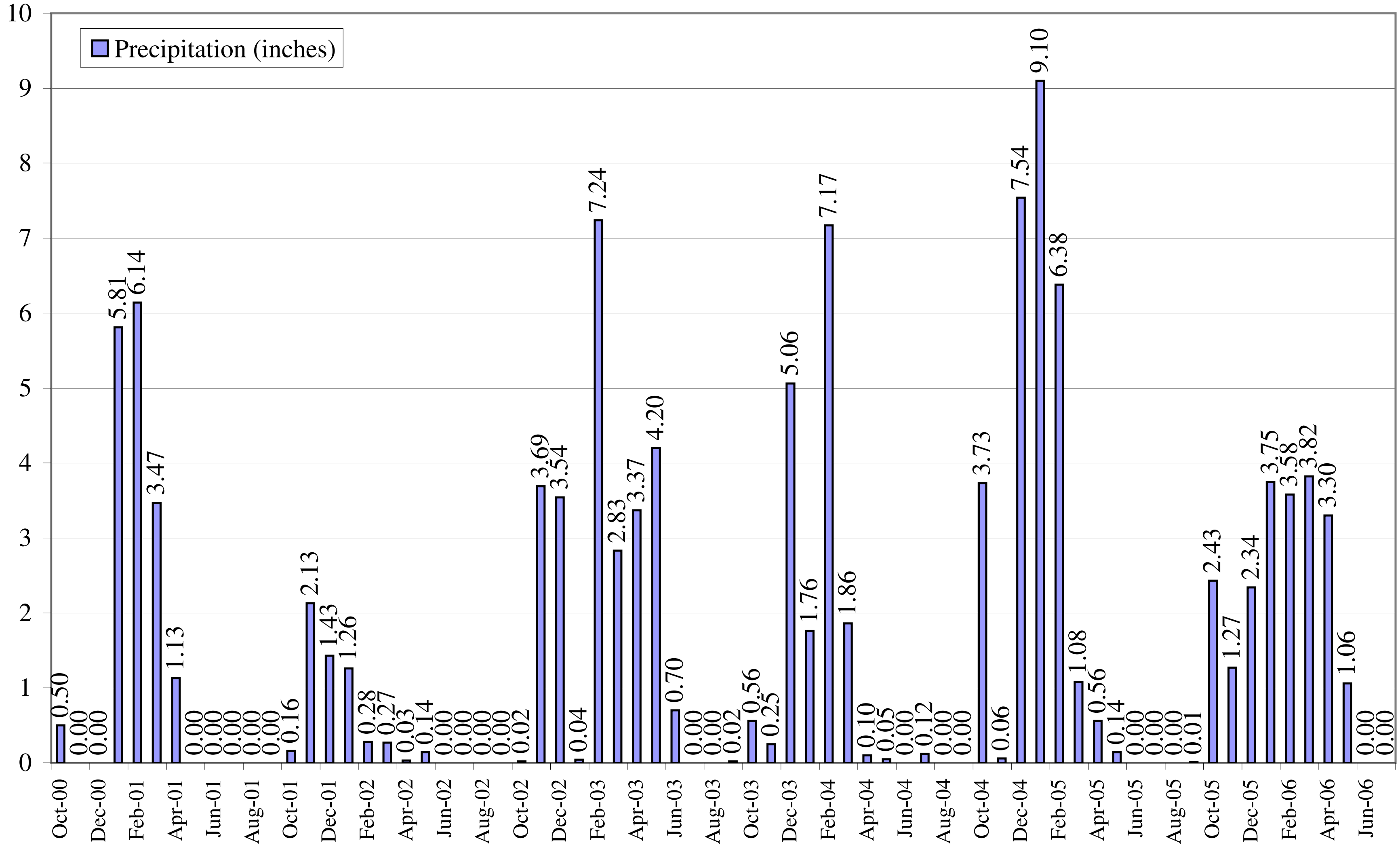
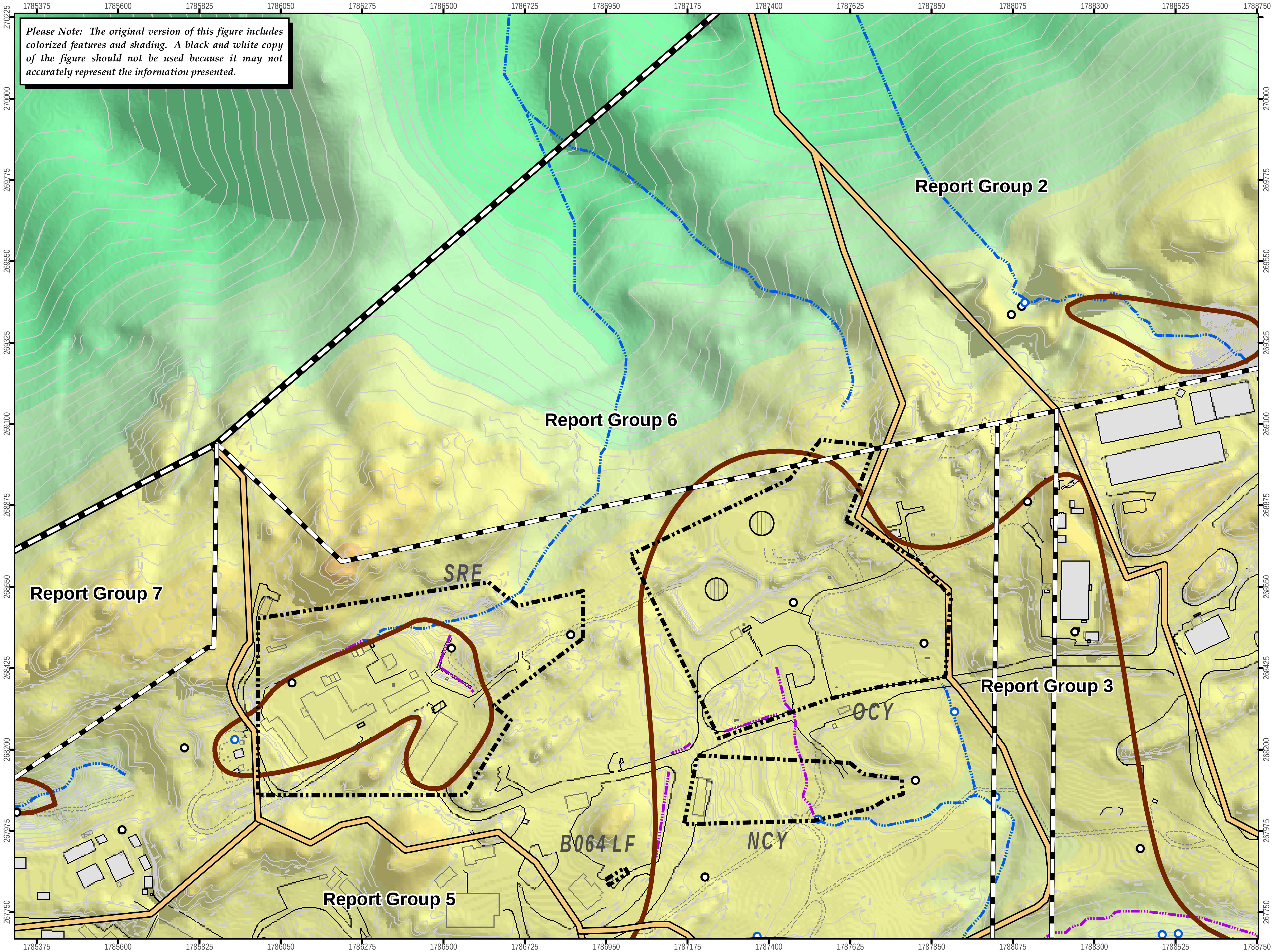


FIGURE 2-3B
MONTHLY PRECIPITATION AT SSFL, OCTOBER 2000 - JUNE 2006





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	Dirt Road
RFI Boundary RFI Boundary	A/C Curbing
Report Group Boundary	Rock Outcrop
Existing Building or Structure	Elevation Contour
Removed Building or Structure	Drainage
Awning	Lined Drainage
Other Tanks	Groundwater Wells
Solvent Tank	Shallow
Petroleum Fuel/Oil Tank	Deep
Hydrazine Tank	

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 native fill.

Generalized Extent of Alluvium Group 6 Reporting Area

Date: Sep 29, 2006

Document: RFI-Report-Group6_Alluvium.mxd

1 inch equals 284 feet

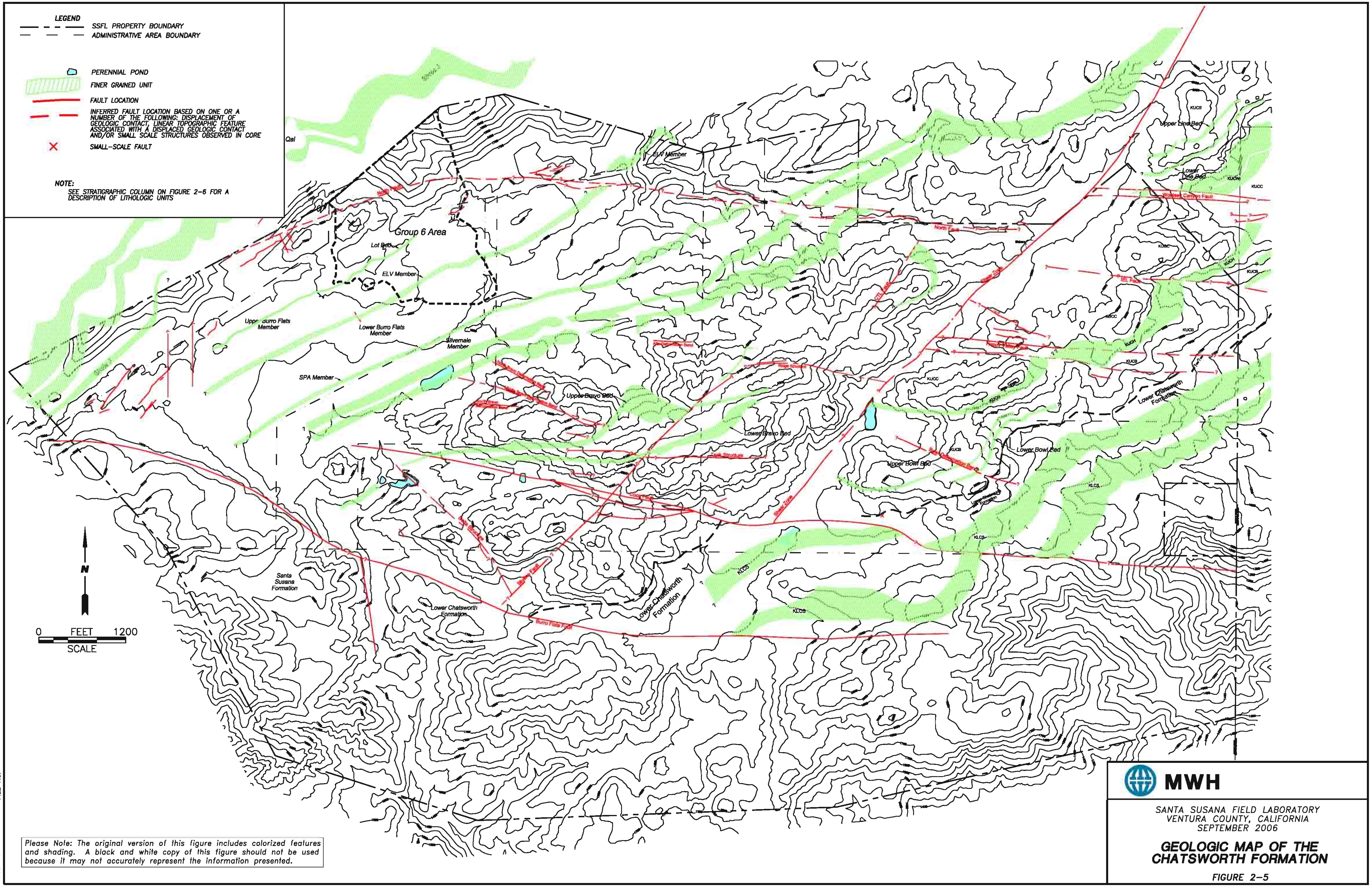
0 300 600 Feet

N

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 2-4



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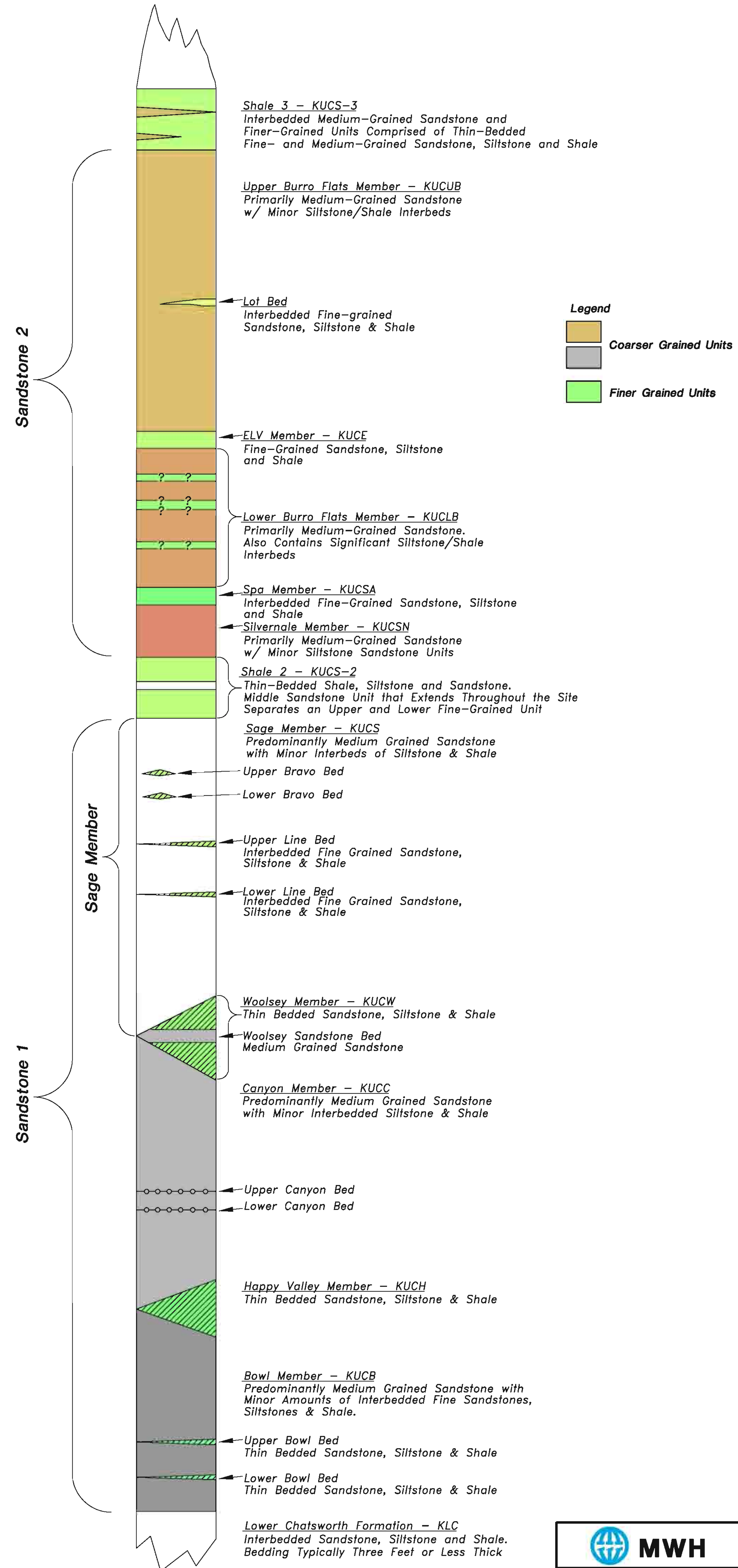
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2006

GEOLOGIC MAP OF THE CHATSWORTH FORMATION

FIGURE 2-5

JOB No. ___ FILE No. ___ INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 6 FIGS\GEOLOGY SSFL 6 1 04



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

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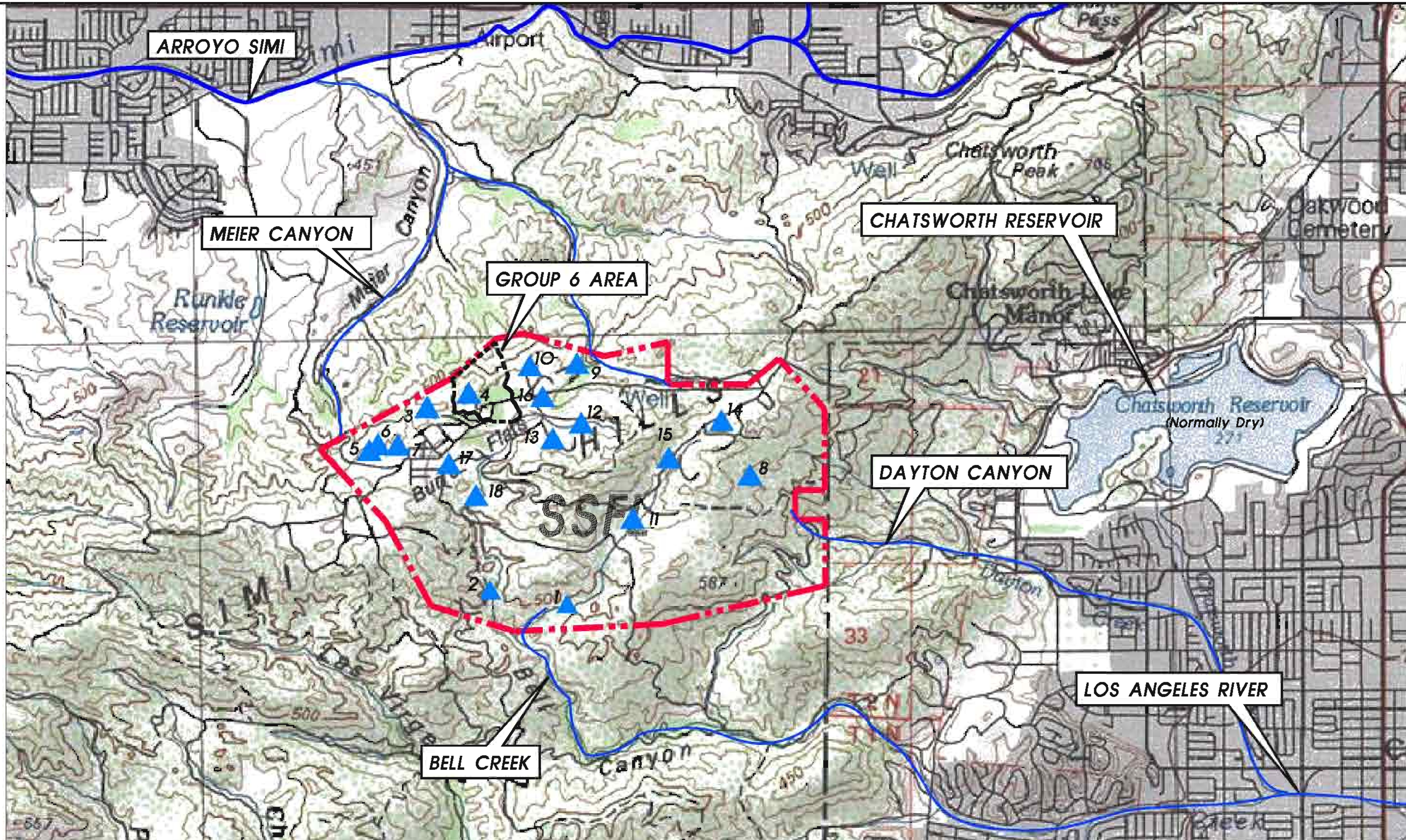
VENTURA COUNTY, CALIFORNIA
AUGUST 2006

STRATIGRAPHIC COLUMN OF THE CHATSWORTH FORMATION

FIGURE 2-6

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



Legend

▲ NPDES Outfalls

0 FEET 5280
SCALE

MWH

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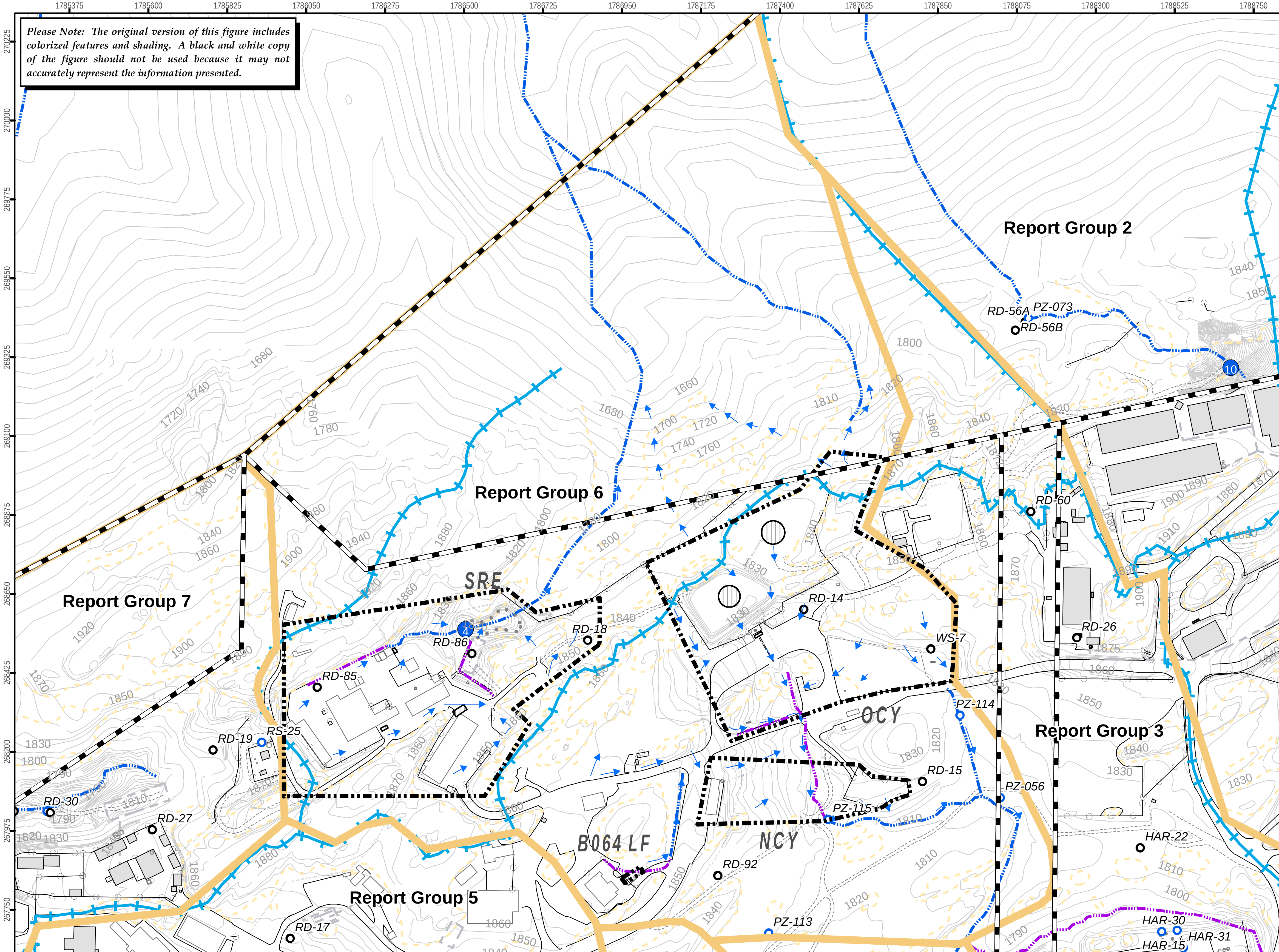
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2006

DRAINAGES LEADING FROM SSFL

FIGURE 2–7A

JOB No. ___ FILE No. CAD MLUEBKE\BOI

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 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
- Leachfield
- Pipe
- NPDES Outfall

Groundwater Wells

- Shallow
- Deep

Legend

- Surface Flow

Surface Water Drainages Group 6 Reporting Area

Date: Sep 29, 2006

Document: RFI-Report-Group6_Surface_Flow.mxd

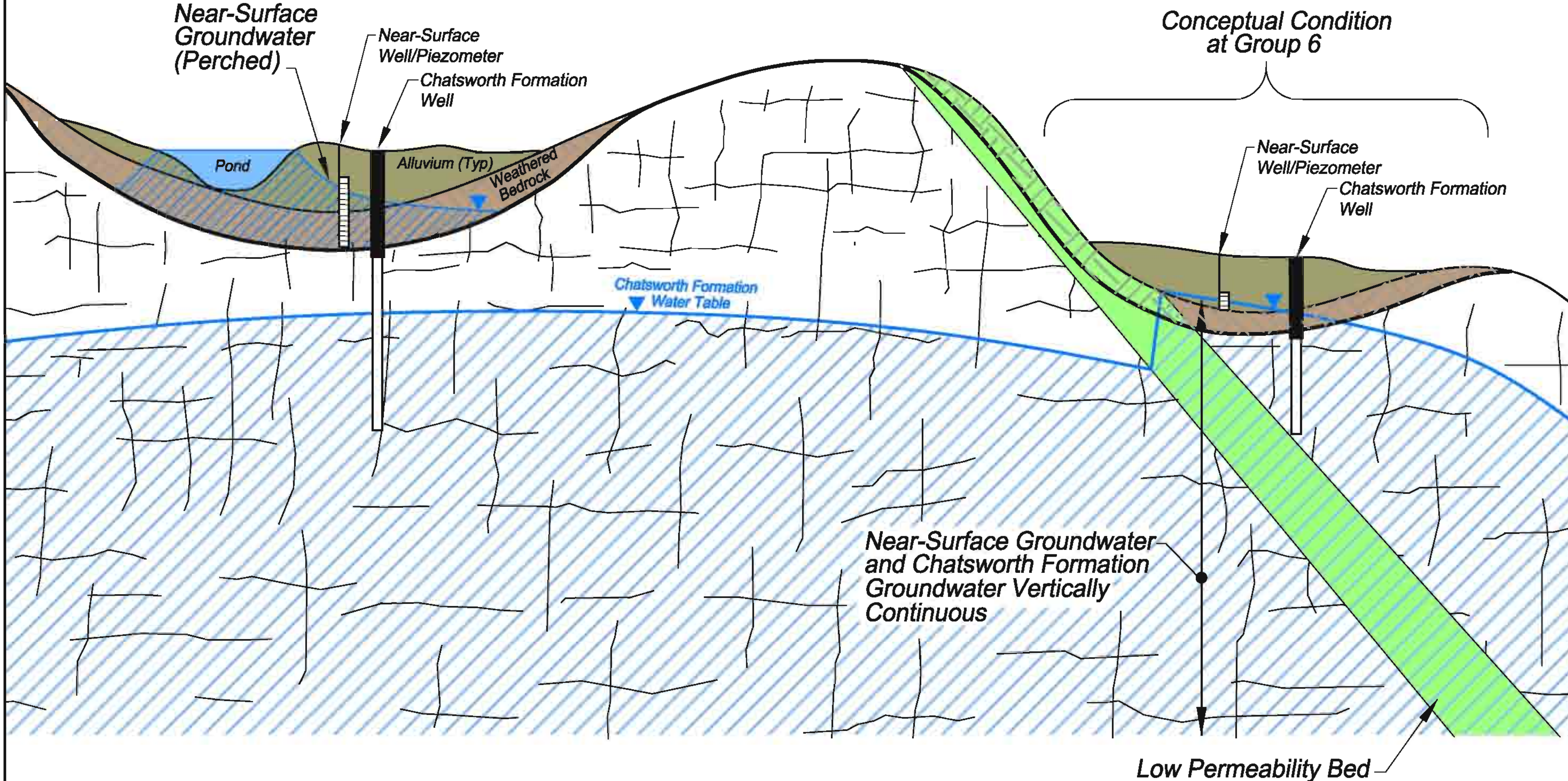
1 inch equals 300 feet

0 300 600 Feet

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 2-7B



NOT TO SCALE

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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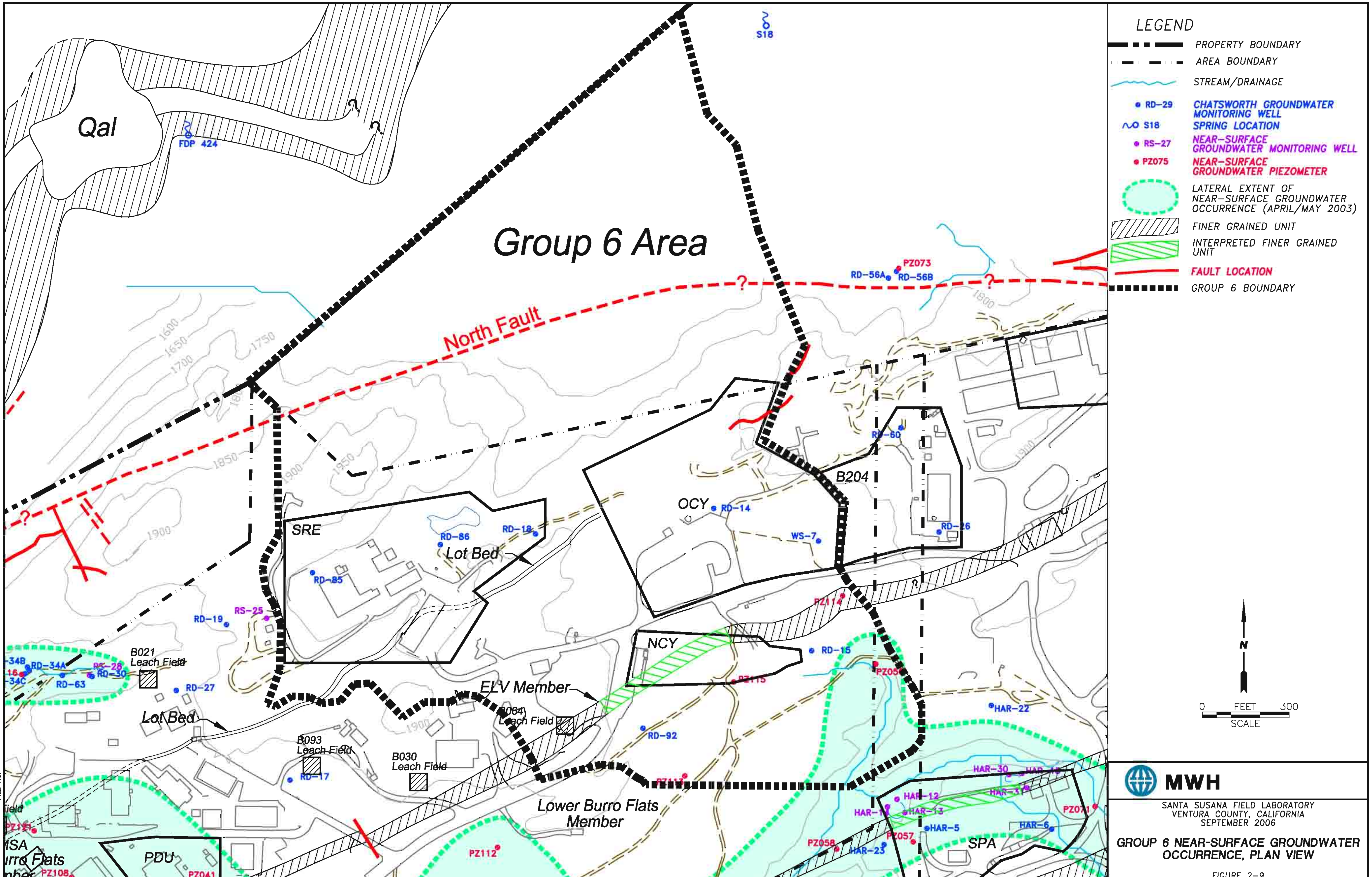
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
AUGUST 2006

CONCEPTUAL CROSS SECTION OF NEAR-SURFACE & CHATSWORTH FORMATION GROUNDWATEROCCURENCE IN GROUP 6

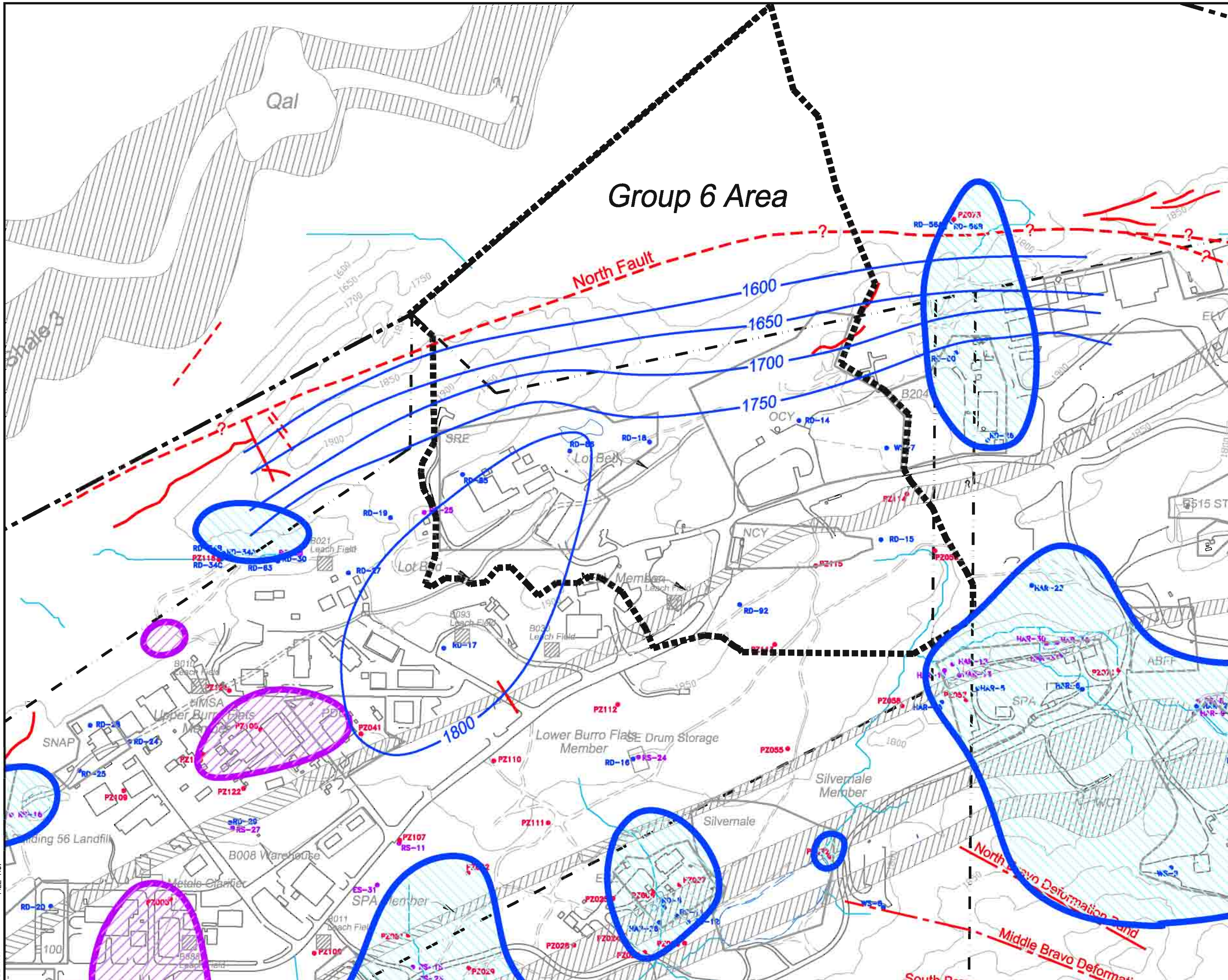
FIGURE 2–8

FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\GROUP 6 FIGS 8 06\CONCEPTUAL XSEC 8 15 06

JOB No.



CADMLUEBKE\BOREING SANTA SUSANA\GROUP 6 FIGS 8 06\NEAR SURFACE GW 8 15 06



LEGEND

- PROPERTY BOUNDARY
- AREA BOUNDARY
- STREAM/DRAINAGE
- RD-29 — CHATSWORTH GROUNDWATER MONITORING WELL
- RS-27 — NEAR-SURFACE GROUNDWATER MONITORING WELL
- PZ075 — NEAR-SURFACE GROUNDWATER PIEZOMETER
- TCE IN GROUNDWATER > 5 ug/L (CHATSWORTH AND/OR NEAR-SURFACE GW)
- TCE IN GROUNDWATER > 5 ug/L (NEAR-SURFACE GW ONLY)
- CHATSWORTH GROUNDWATER POTENTIOMETRIC SURFACE (2005)
- FINER GRAINED UNIT
- INTERPRETED FINER GRAINED UNIT
- FAULT LOCATION
- GROUP 6 BOUNDARY

NOTE:
TCE CONCENTRATION RD-86 EXCEEDED 5 PPB IN 2004, DECREASED TO <0.26 PPB IN 2005

N

0 FEET 400
SCALE

MWH

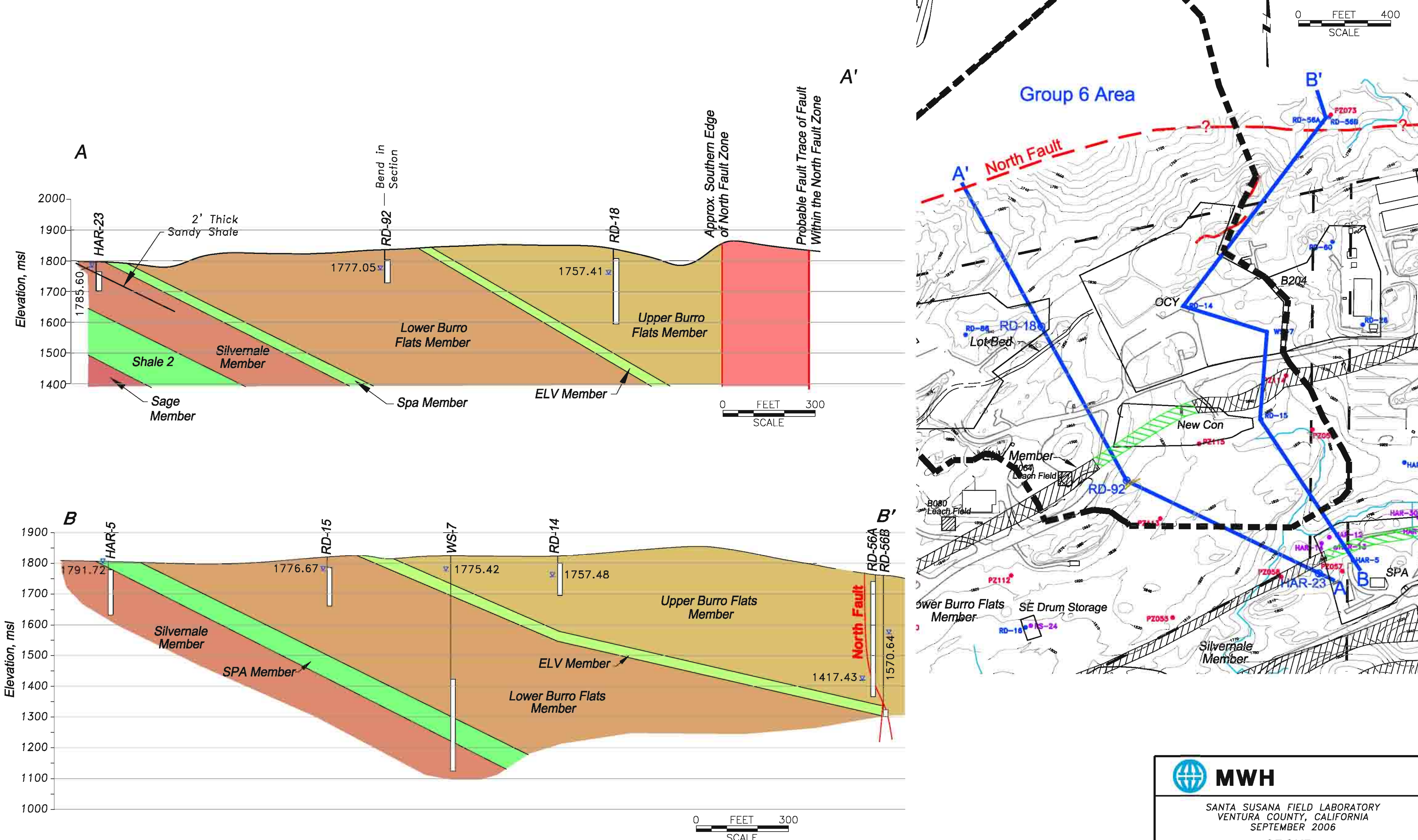
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2006

TCE PLUME MAP
NEAR GROUP 6 REPORTING AREA

FIGURE 2-10

JOB No. ___ FILE No. CADMLUEBKE\BOREING SANTA SUSANA\GROUP 6 FIGS 8 06\TCE IN GW 8 15 06

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

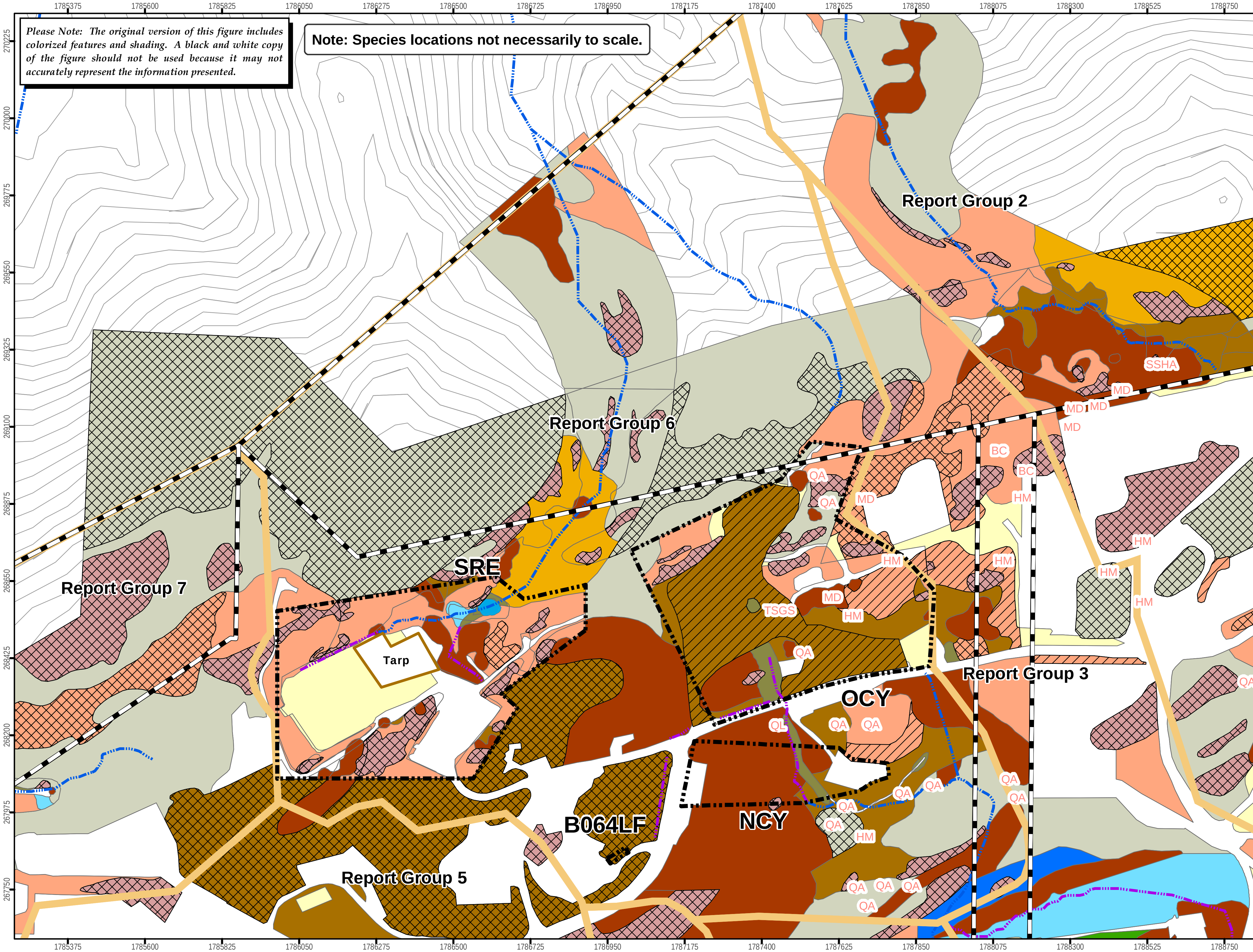
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
SEPTEMBER 2006

GROUP 6
HYDROGEOLOGIC CROSS SECTIONS

FIGURE 2-11

CAD MLUEBKE\BOEING SANTA SUSANA\GROUP 6 FIGS 8 06\XSEC AB 8 11 06

FILE No. ___ JOB No. ___



Base Map Legend

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

Legend

- 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
- VEGETATION WITH ROCK OUTCROPS OVERLAY
- DISTURBED VEGETATION OVERLAY

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 6 Reporting Area

Date: Sep 29, 2006

Document: RFI-Report-Group6_Biological.mxd

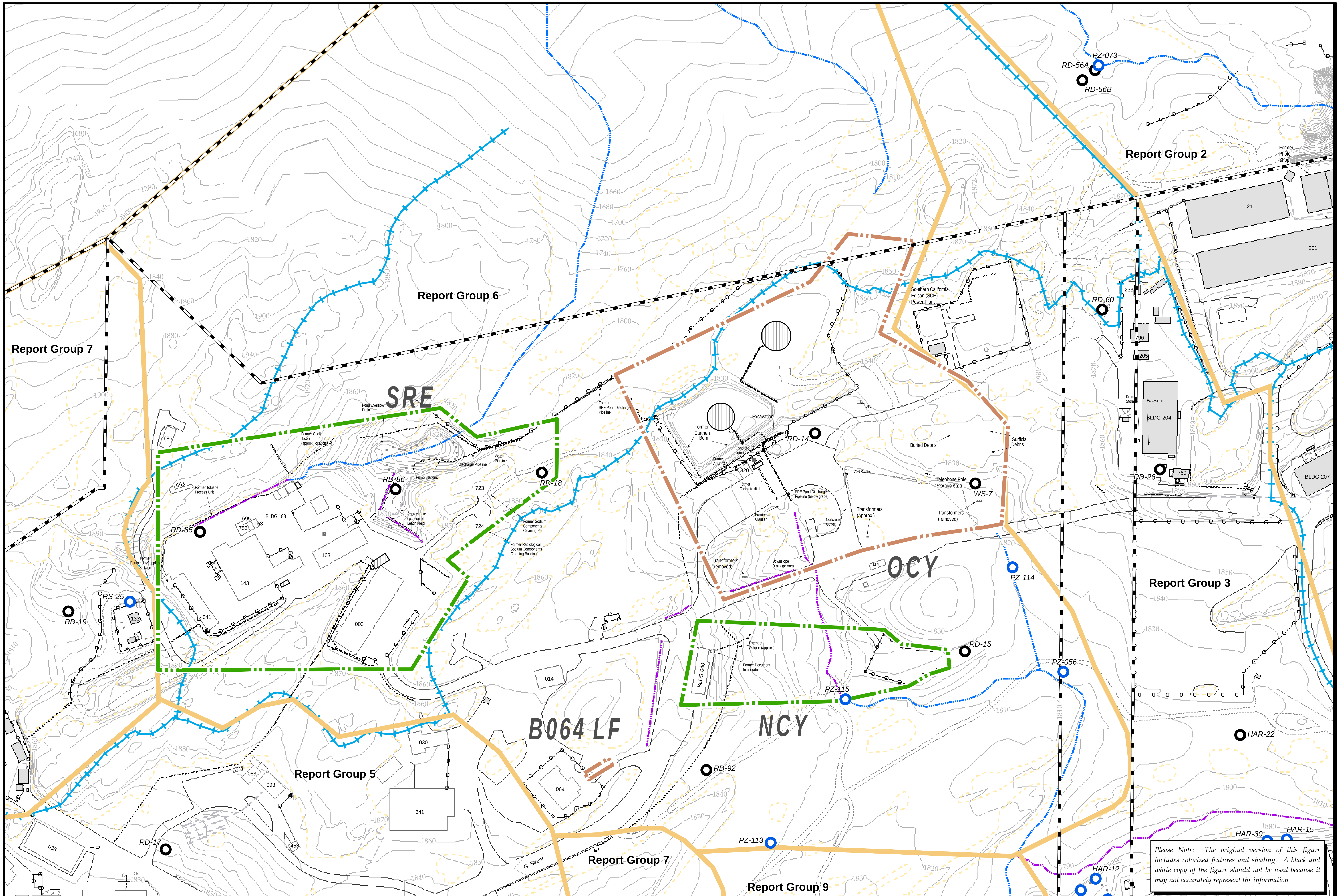
1 inch equals 300 feet

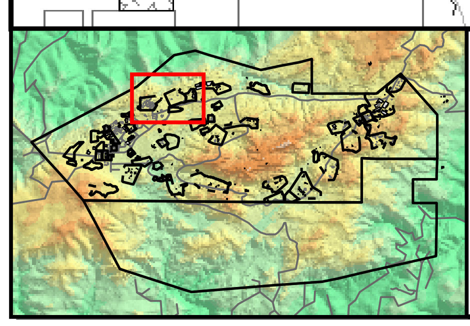
0 300 600 Feet

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 2-12





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

Groundwater Wells

Near Surface

Chatsworth

RFI Sites by Responsibility

DOE

BOEING

Site Plan
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

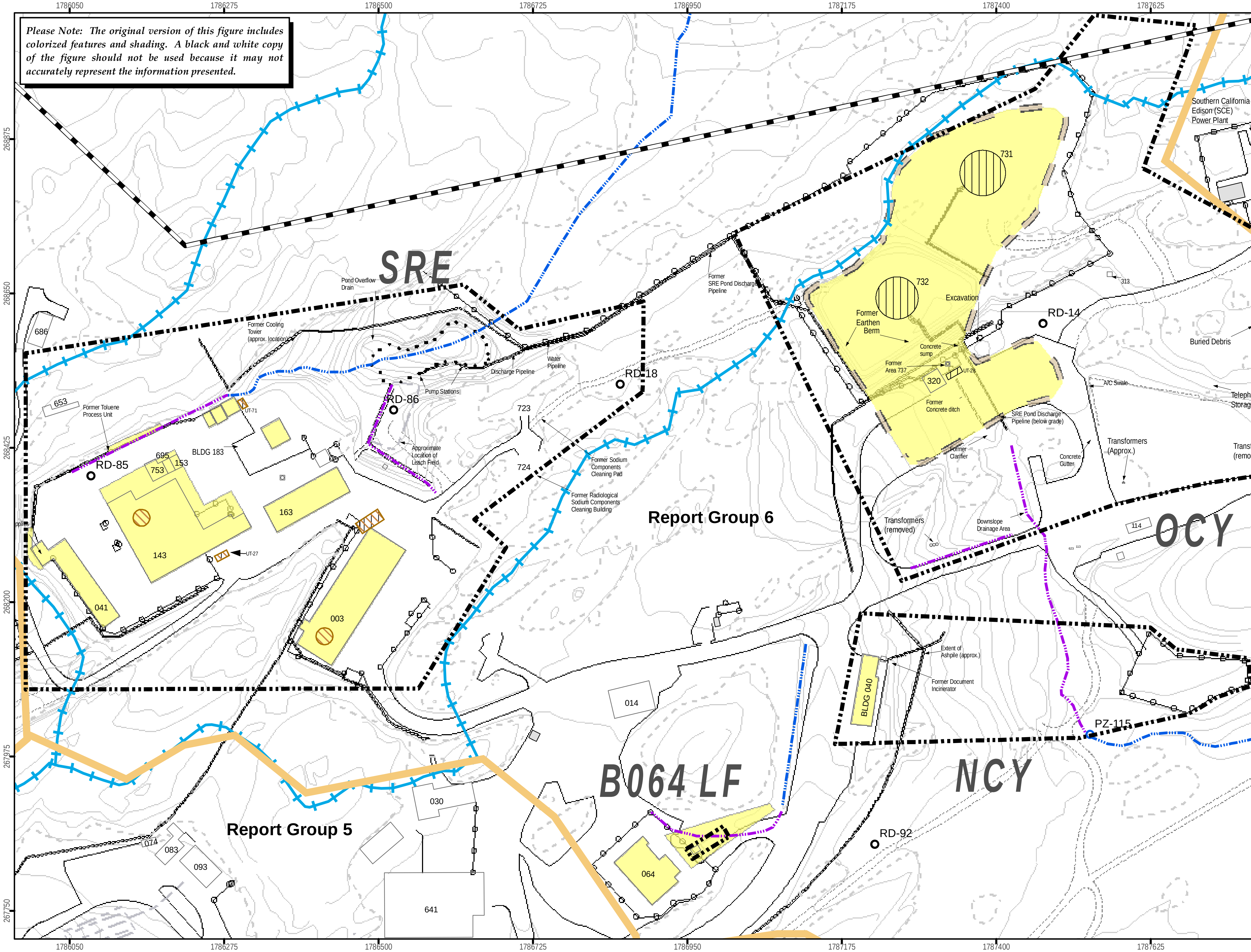
1 inch equals 150 feet

0 150 300 Feet

Date: Sep 29, 2006

Document: RFI-Report-Group6_Site_Plan.mxd

FIGURE 3-1



Base Map Legend

- Administrative Area Boundary
- RFI 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
- Leachfield
- Pipe

Groundwater Wells

- Shallow
- Deep

Approximate Areas of Soil Disturbance

- Eathern Berm Soil Fill Extent
- Removed Building or Structure
- Back Fill Area

Buildings, Improvements, and Soil Disturbances Within Group 6 Reporting Area

Date: Sep 30, 2006

Document: RFI-Report-Group6_Bldgs.mxd

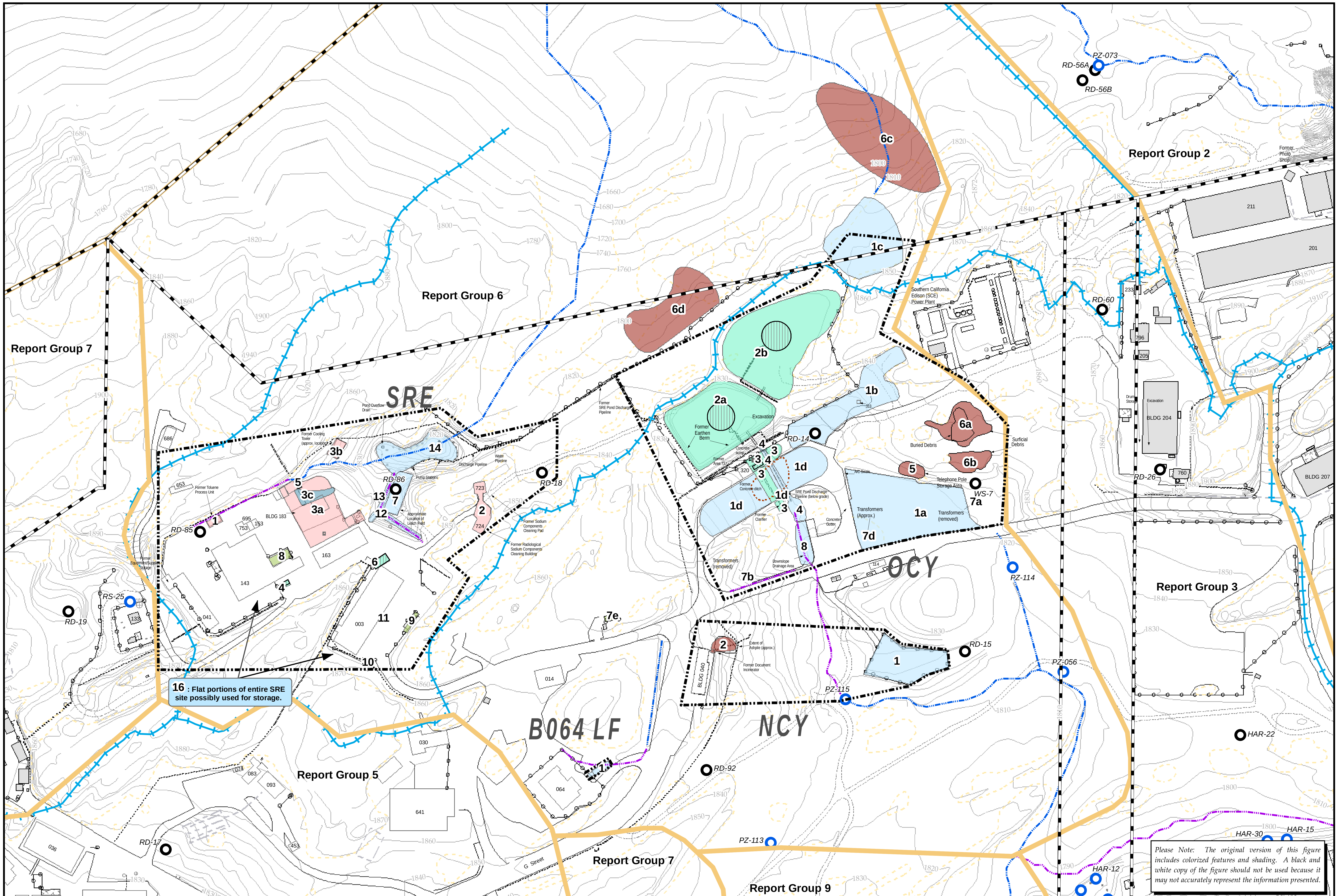
1 inch equals 150 feet

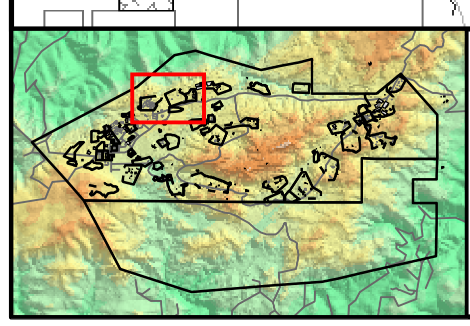
0 150 300 Feet

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 3-2





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

Groundwater Wells
Near Surface
Chatsworth

Chemical Use Area

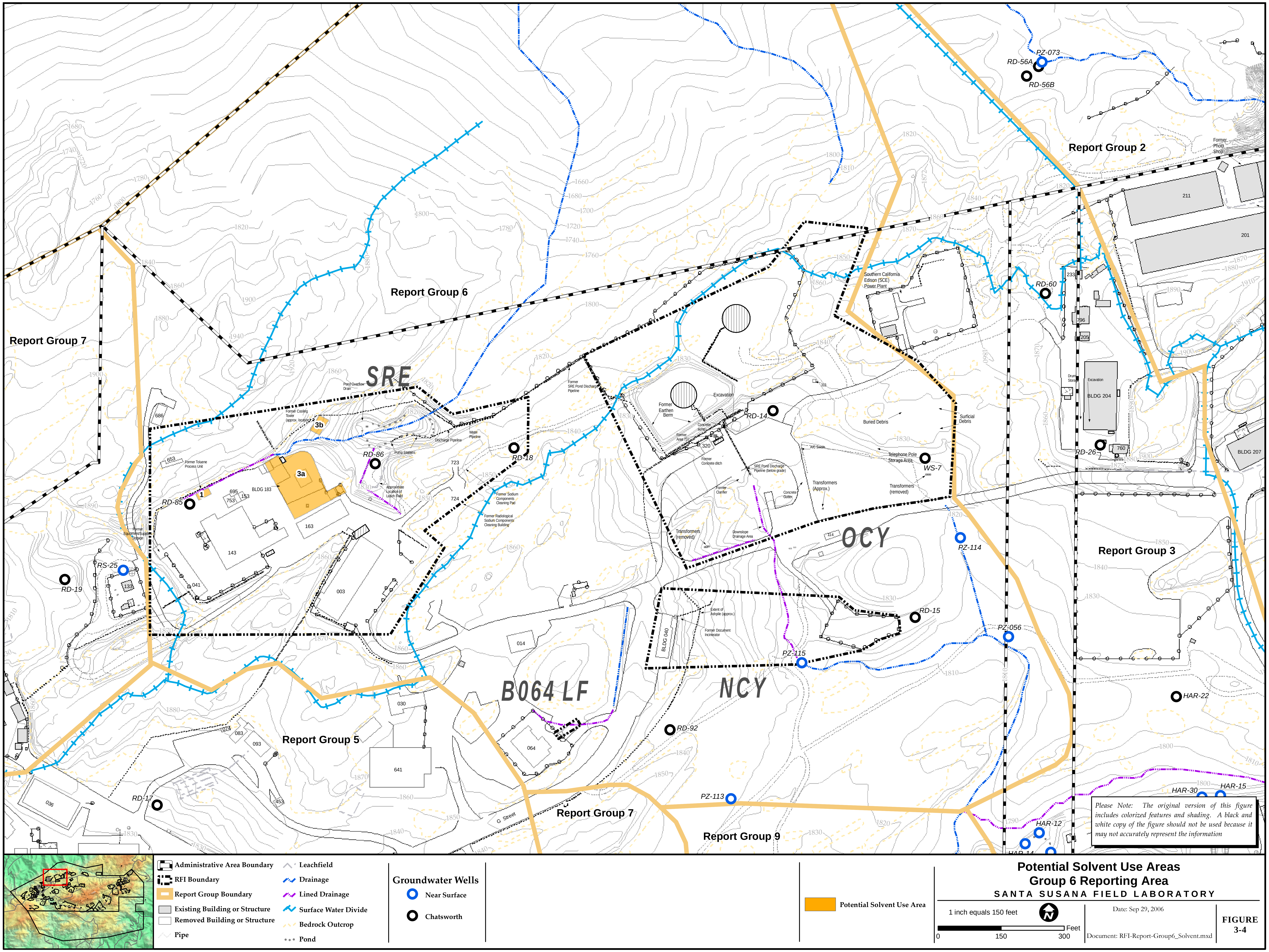
Solvent	Oil	Metal	Hydrazine	Screening	TPH Stain
Petroleum	Transformer	Debris	Perchlorate	Multiple Use	

Potential Chemical Use Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

1 inch equals 150 feet
0 150 300 Feet

Date: Sep 30, 2006
Document: RFI_Report-Group6_Chem_use.mxd

FIGURE 3-3

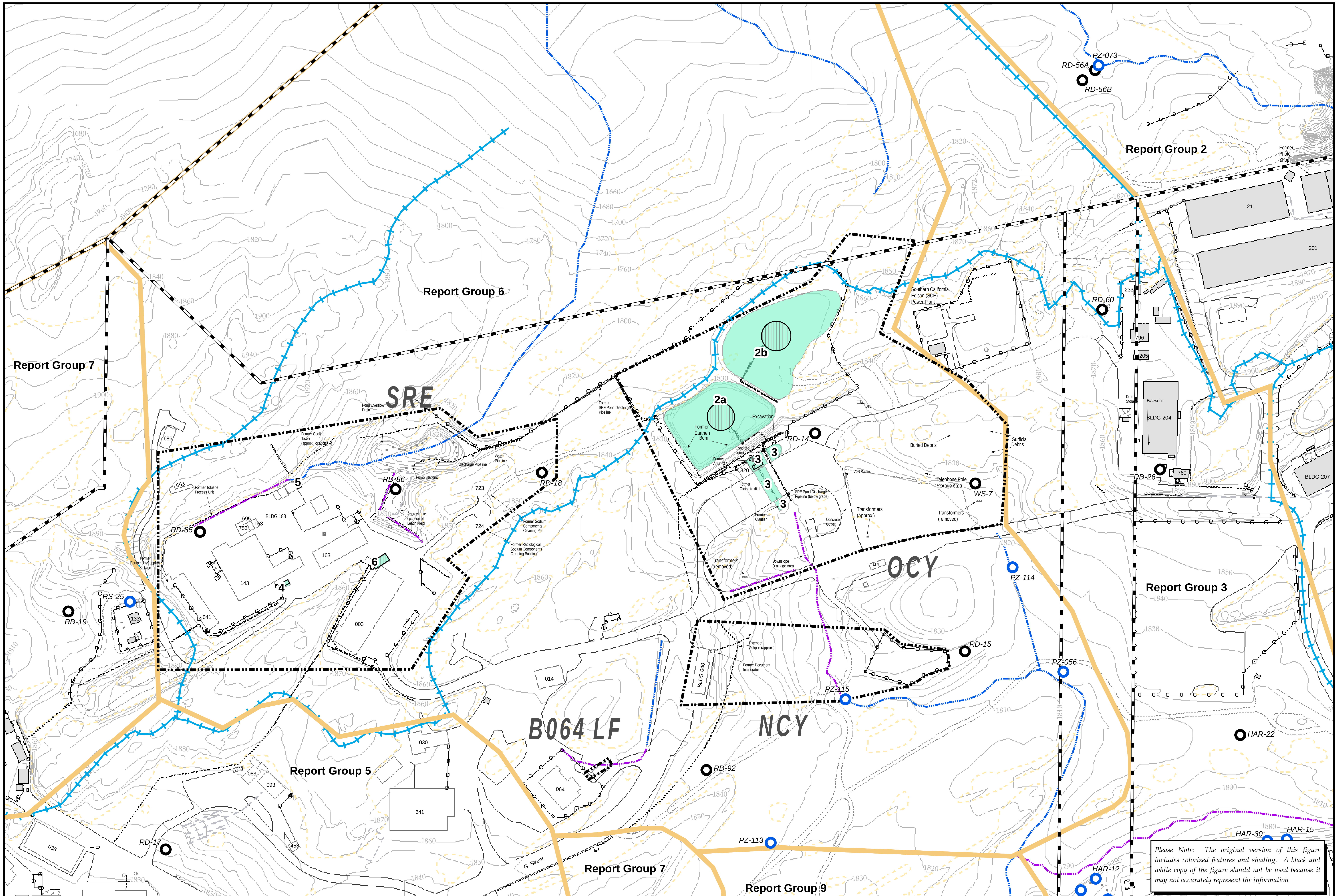


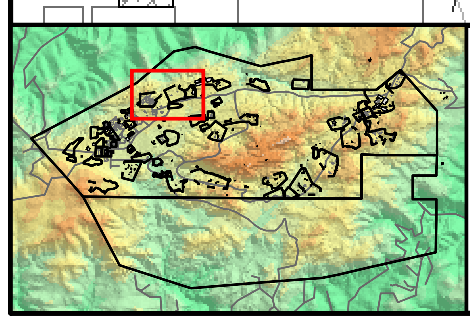
Potential Solvent Use Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

Date: Sep 29, 2006

Document: RFI-Report-Group6_Solvent.mxd

FIGURE 3-4





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

Groundwater Wells

- Near Surface
- Chatsworth

- Potential Petroleum Hydrocarbon Use Areas

Potential Petroleum Fuels Use Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

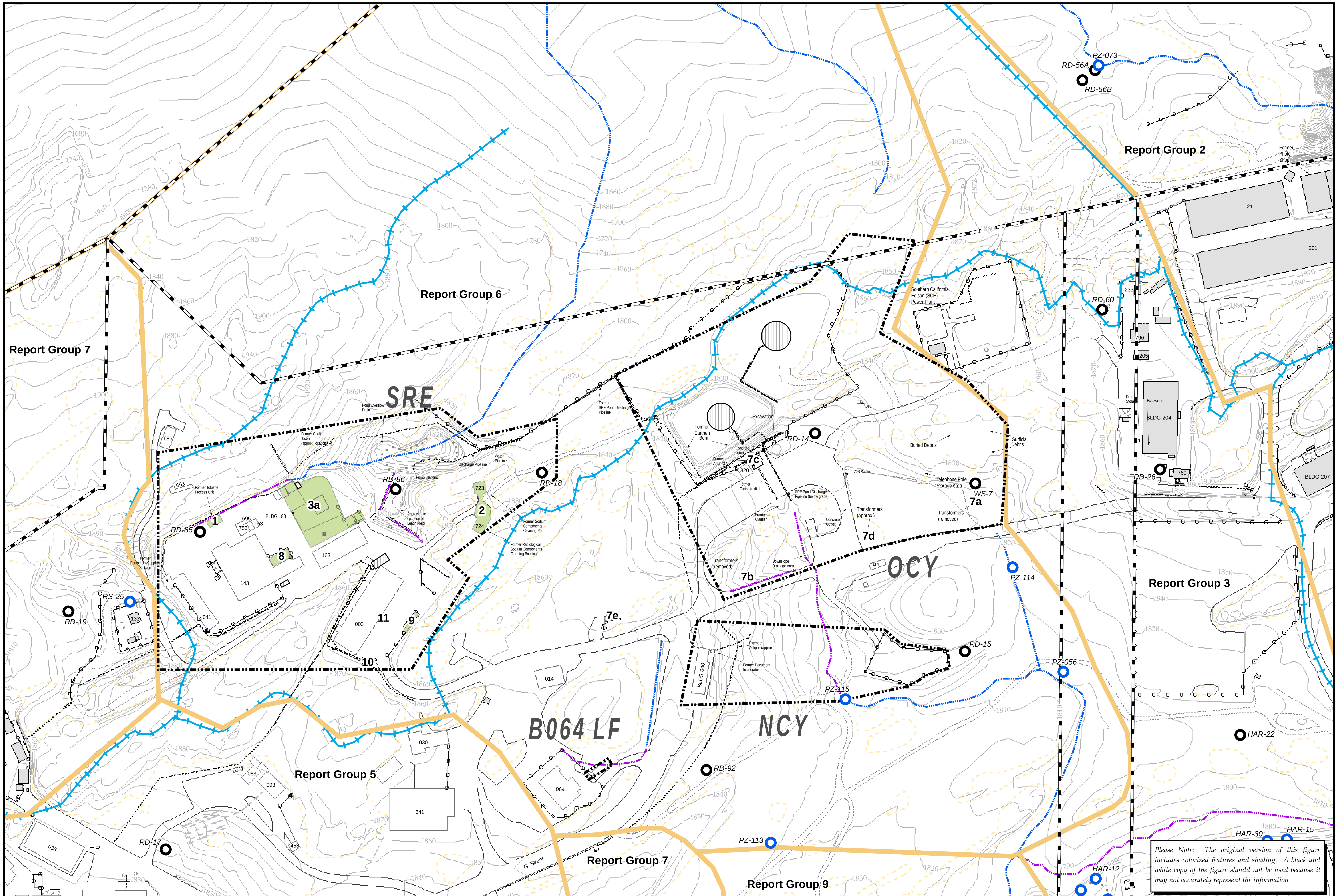
1 inch equals 150 feet

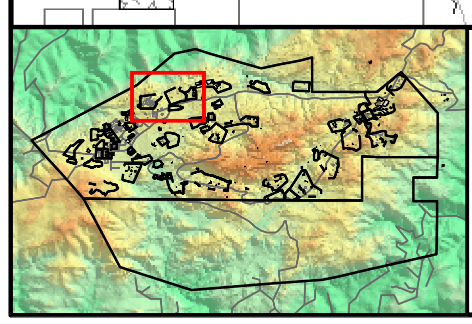
0 150 300 Feet

Date: Sep 29, 2006

Document: RFI-Report-Group6_Petroleum.mxd

FIGURE 3-5





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

Groundwater Wells
Near Surface
Chatsworth

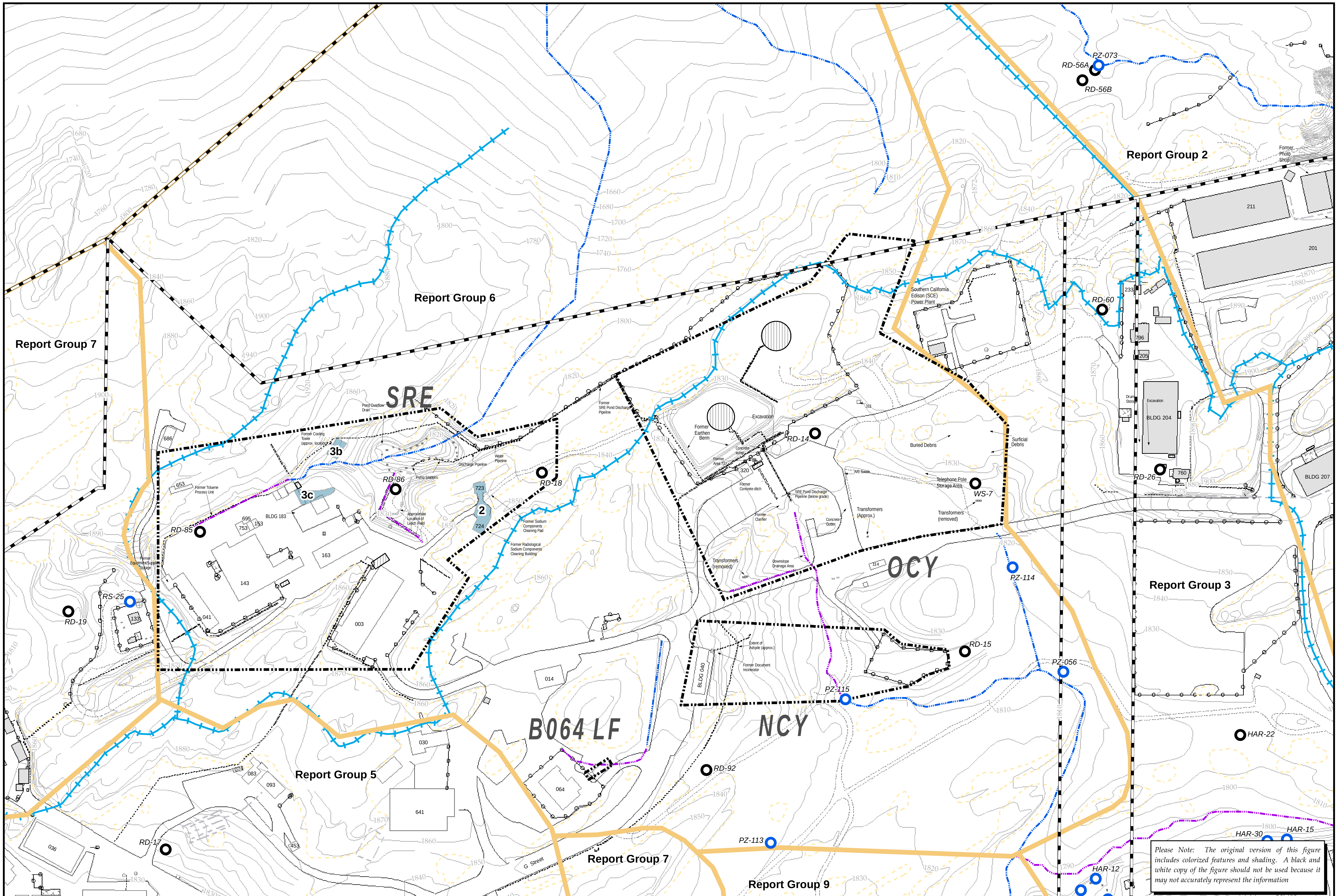
Potential Oil-related Materials Use Area

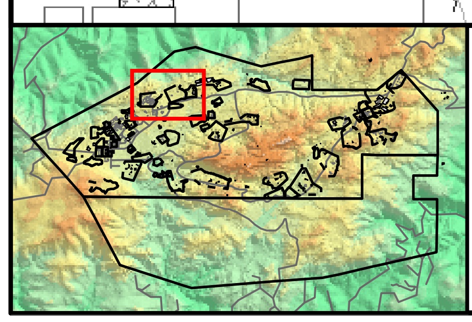
Potential Oil-related Materials Use Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

1 inch equals 150 feet
0 150 300 Feet

Date: Sep 29, 2006
Document: RFI-Report-Group6_OilRelated.mxd

FIGURE 3-6





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

Groundwater Wells
Near Surface
Chatsworth

Potential Metals Waste Area

Potential Metals Impact Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

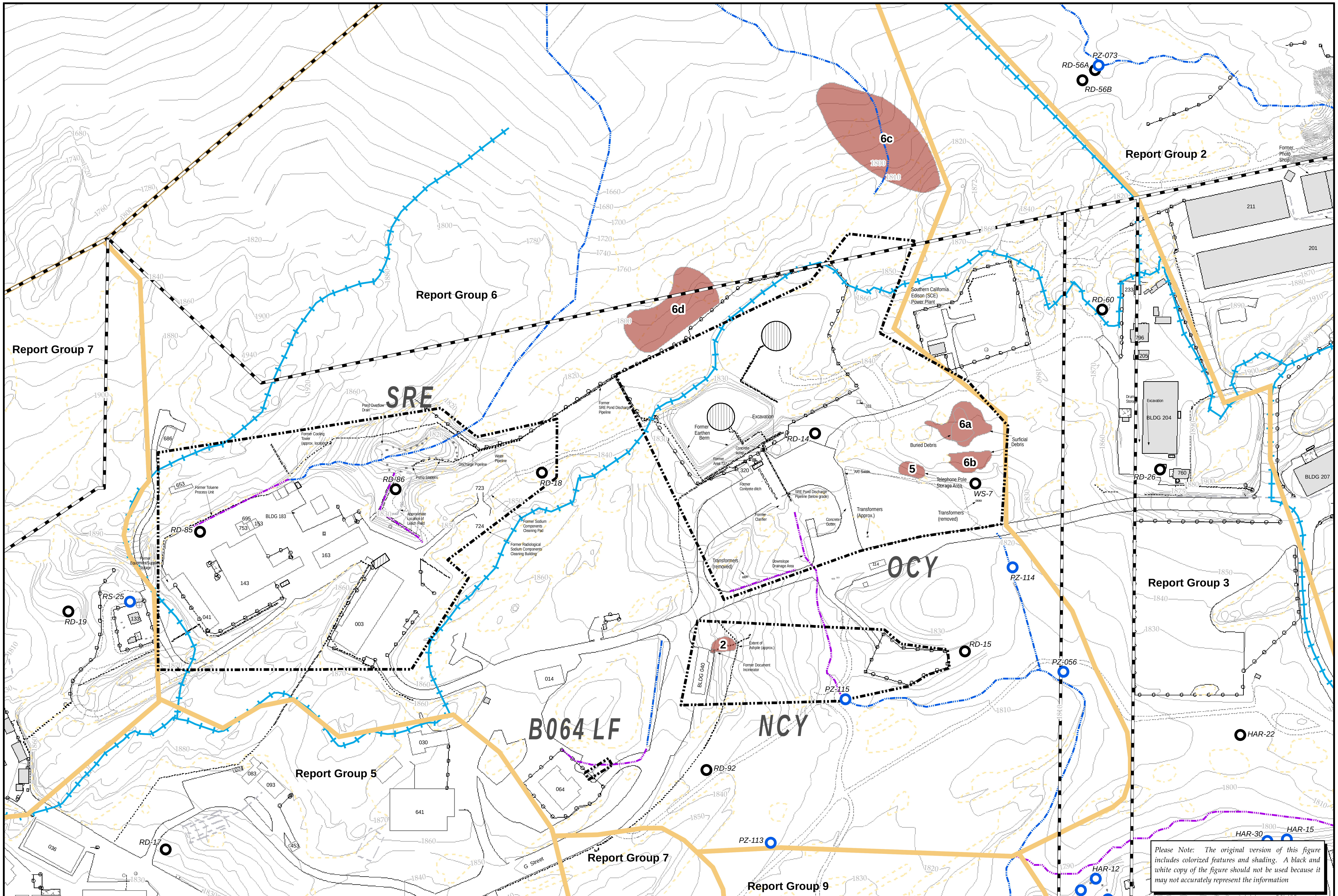
1 inch equals 150 feet

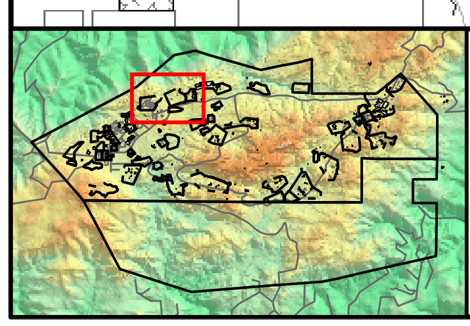
0 150 300 Feet

Date: Sep 29, 2006

Document: RFI-Report-Group6_MetalWaste.mxd

FIGURE 3-7





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

Groundwater Wells

Near Surface

Chatsworth

Potential Debris Area

Potential Debris Areas
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

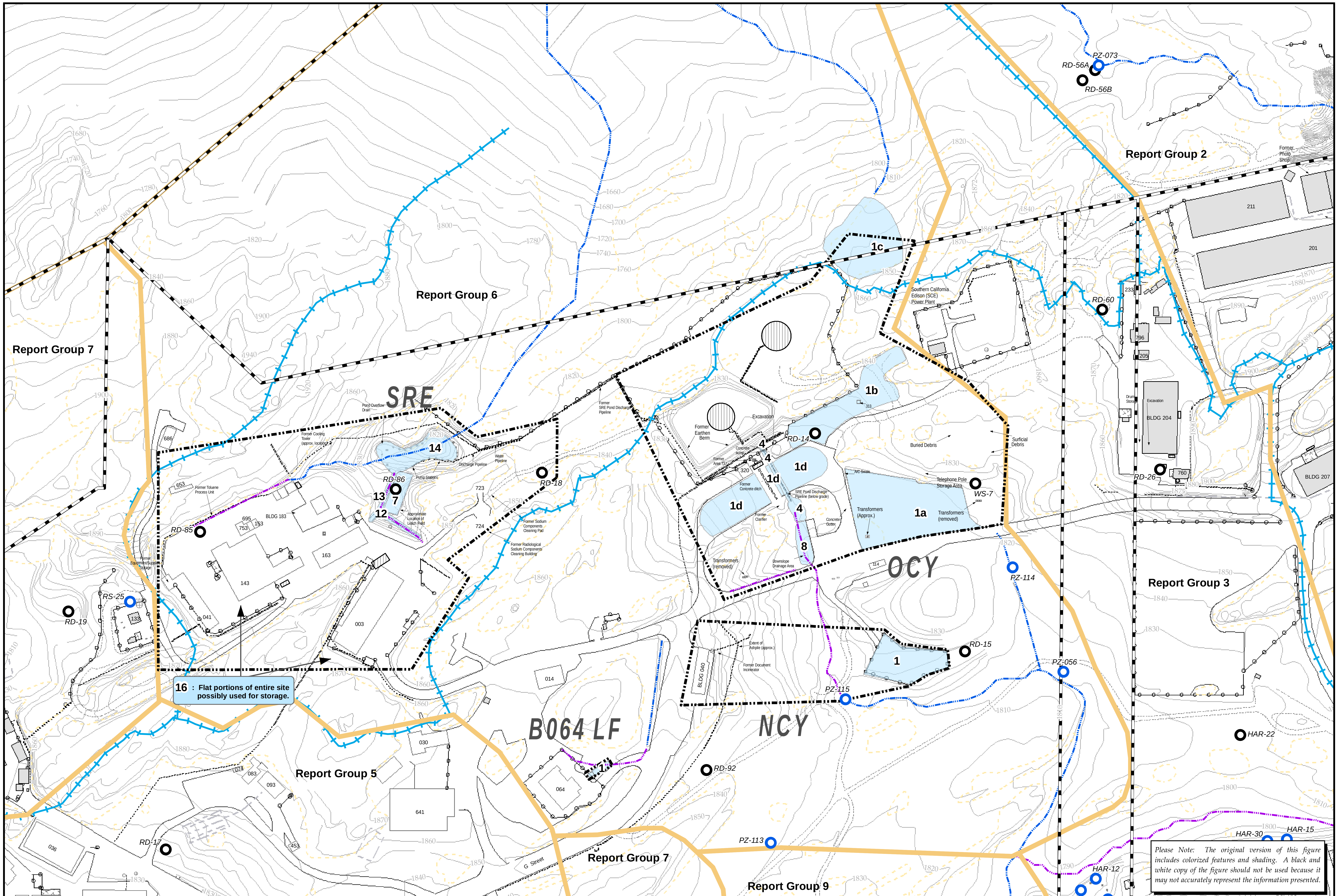
1 inch equals 150 feet

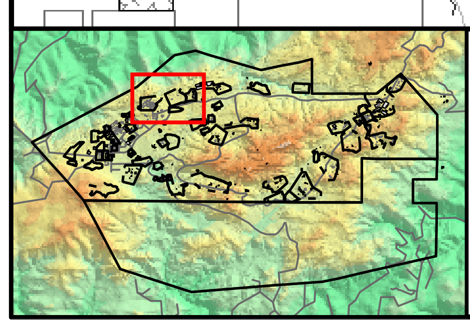
0 150 300 Feet

Date: Sep 29, 2006

Document: RFI-Report-Group6_Debris.mxd

FIGURE 3-8





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

Groundwater Wells
Near Surface
Chatsworth

Area Screened for Potential Chemical Use

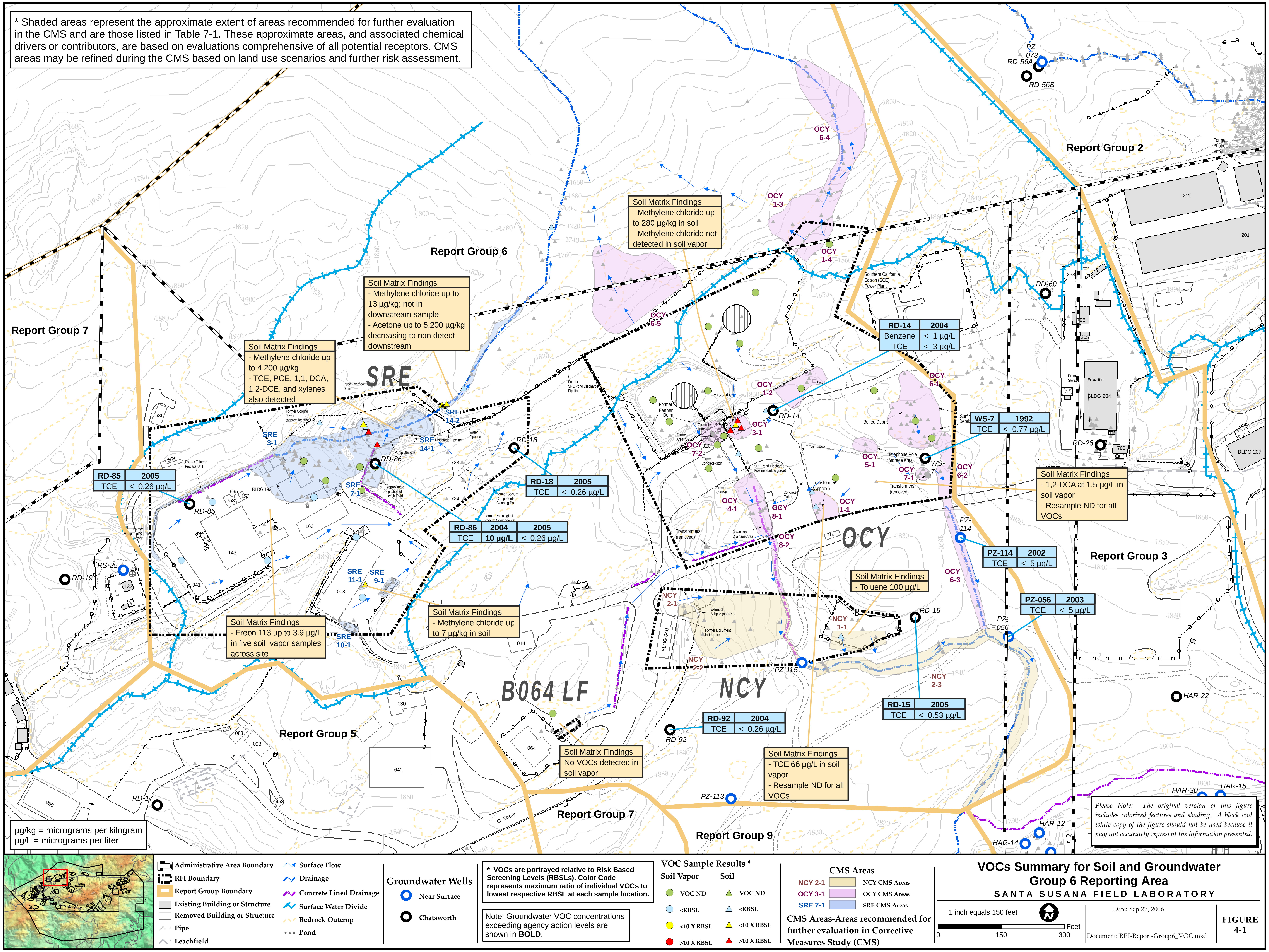
Areas Screened for Potential Chemical Use
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY

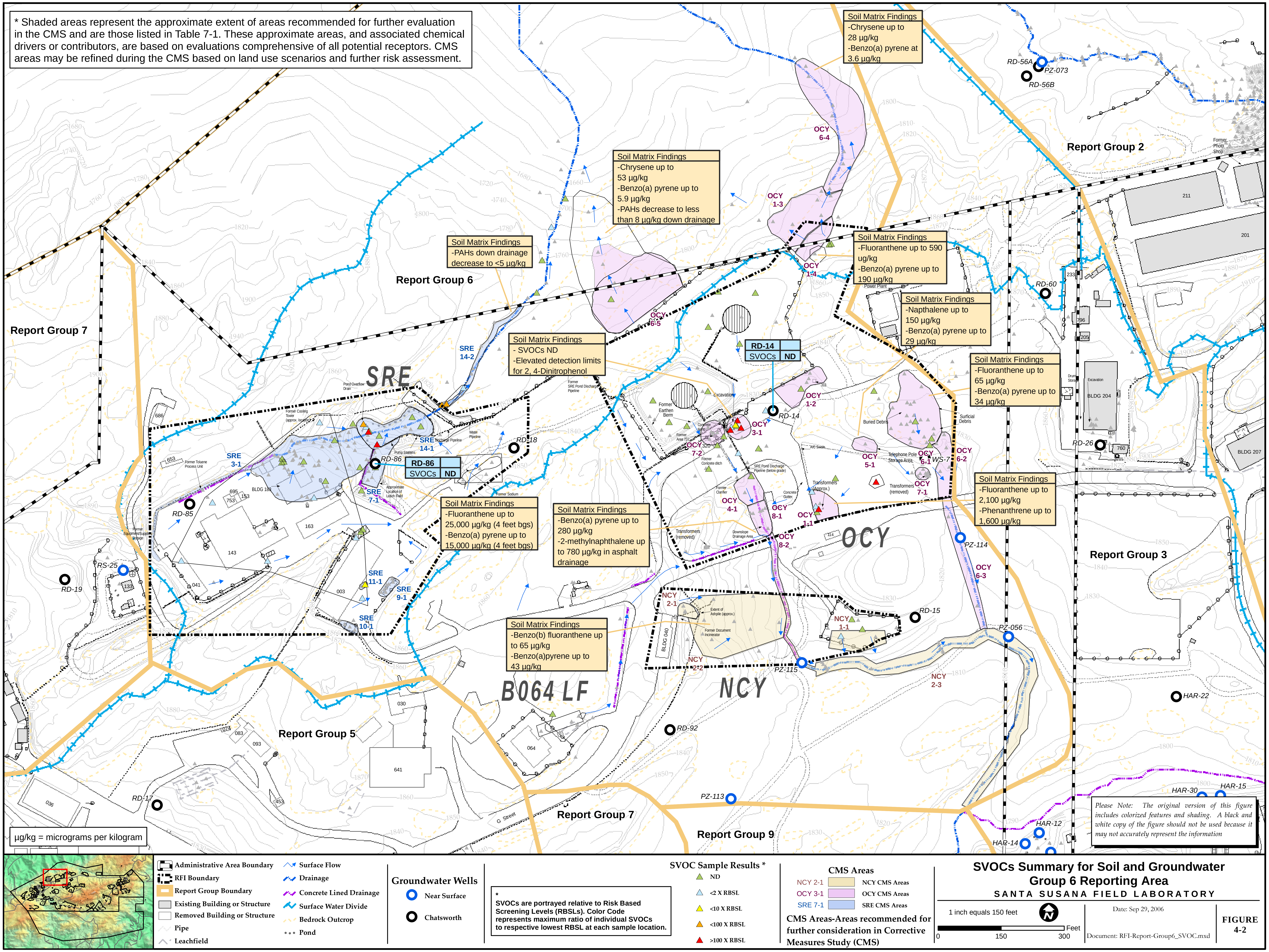
1 inch equals 150 feet
0 150 300 Feet

Date: Sep 30, 2006

Document: RFI-Report-Group6_Screening.mxd

FIGURE
3-9

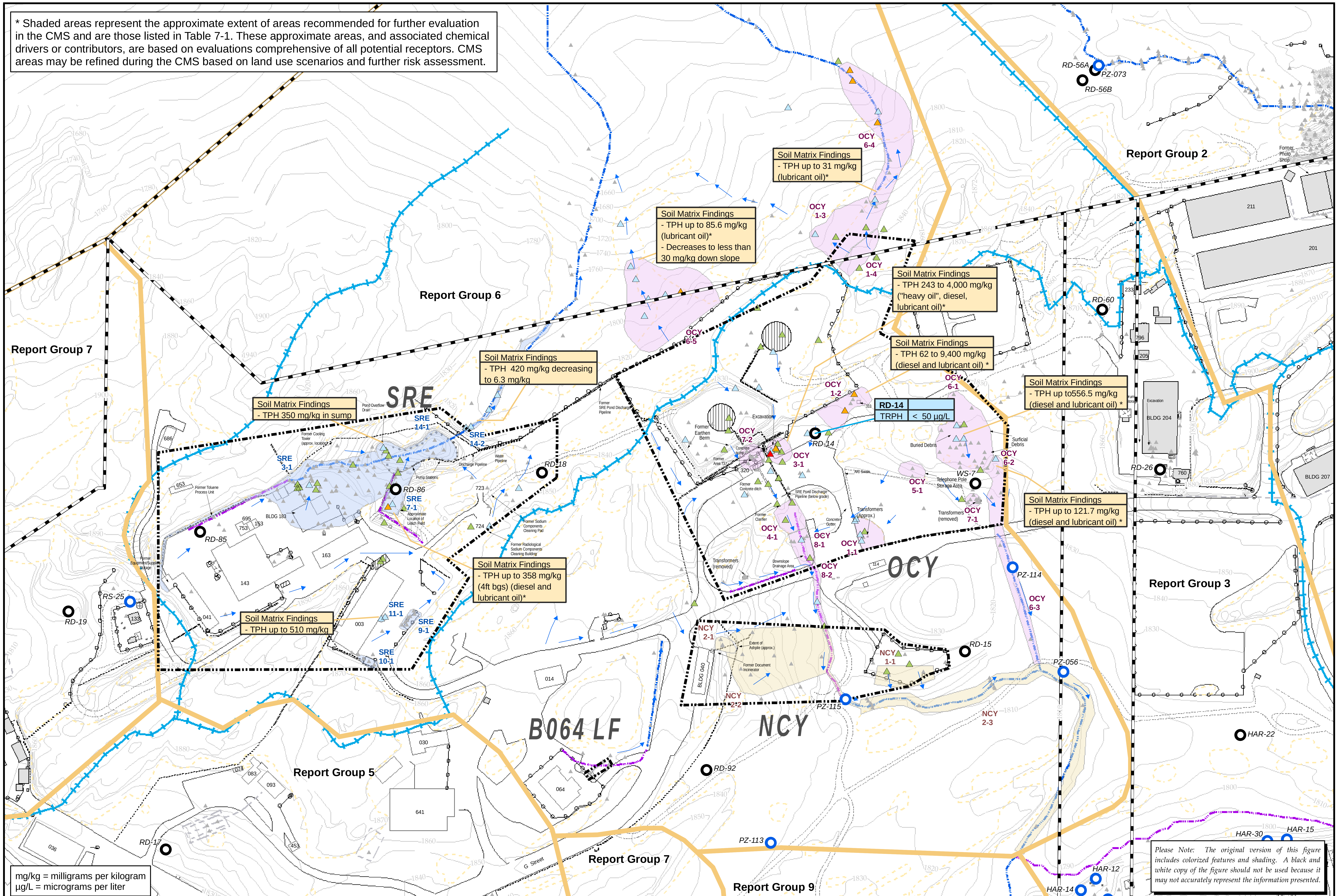

* Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.
Report Group 2
Report Group 3
Report Group 5
Report Group 6
Report Group 7
Report Group 9
SRE
OCY
NCY
B064 LF
Soil Matrix Findings
- Methylene chloride up to 280 µg/kg in soil
- Methylene chloride not detected in soil vapor
Soil Matrix Findings
- Methylene chloride up to 13 µg/kg; not in downstream sample
- Acetone up to 5,200 µg/kg decreasing to non detect downstream
Soil Matrix Findings
- Methylene chloride up to 4,200 µg/kg
- TCE, PCE, 1,1, DCA, 1,2-DCE, and xylenes also detected
Soil Matrix Findings
- 1,2-DCA at 1.5 µg/L in soil vapor
- Resample ND for all VOCs
Soil Matrix Findings
- Toluene 100 µg/L
Soil Matrix Findings
- Methylene chloride up to 7 µg/kg in soil
Soil Matrix Findings
- Freon 113 up to 3.9 µg/L in five soil vapor samples across site
Soil Matrix Findings
No VOCs detected in soil vapor
Soil Matrix Findings
- TCE 66 µg/L in soil vapor
- Resample ND for all VOCs
RD-14 2004 Benzene < 1 µg/L TCE < 3 µg/L
WS-7 1992 TCE < 0.77 µg/L
RD-85 2005 TCE < 0.26 µg/L
RD-18 2005 TCE < 0.26 µg/L
RD-86 2004 2005 TCE 10 µg/L < 0.26 µg/L
PZ-114 2002 TCE < 5 µg/L
PZ-056 2003 TCE < 5 µg/L
RD-15 2005 TCE < 0.53 µg/L
RD-92 2004 TCE < 0.26 µg/L
OCY 6-4
OCY 1-3
OCY 1-4
OCY 6-5
OCY 1-2
OCY 3-1
OCY 7-2
OCY 6-1
OCY 5-1
OCY 7-1
OCY 6-2
OCY 4-1
OCY 8-1
OCY 1-1
OCY 8-2
OCY 6-3
NCY 2-1
NCY 1-1
NCY 2-2
NCY 2-3
SRE 14-2
SRE 3-1
SRE 14-1
SRE 7-1
SRE 11-1
SRE 9-1
SRE 10-1
RD-56A
RD-56B
PZ-073
RD-60
RD-26
RD-14
RD-18
RD-86
RD-85
RD-19
RS-25
RD-15
PZ-115
PZ-113
RD-92
RD-17
HAR-22
HAR-30
HAR-15
HAR-12
HAR-14
Southern California Edison (SCE) Power Plant
Excavation
Former Earthen Berm
Buried Debris
Telephone Pole Storage Area
Transformers (removed)
Transformers (Approx.)
Downslope Drainage Area
Former Clarifier
Former Cooling Tower
Pump Stations
Former Toluene Process Unit
Extent of Asphalt (approx.)
Former Document Incinerator
BLDG 204
BLDG 207
BLDG 183
BLDG 040
G Street
µg/kg = micrograms per kilogram
µg/L = micrograms per liter
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
RFI Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leachfield
Surface Flow
Drainage
Concrete Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond
Groundwater Wells
Near Surface
Chatsworth
* VOCs are portrayed relative to Risk Based Screening Levels (RBSLs). Color Code represents maximum ratio of individual VOCs to lowest respective RBSL at each sample location.
Note: Groundwater VOC concentrations exceeding agency action levels are shown in BOLD.
VOC Sample Results *
Soil Vapor
Soil
VOC ND
<RBSL
<10 X RBSL
>10 X RBSL
CMS Areas
NCY 2-1 NCY CMS Areas
OCY 3-1 OCY CMS Areas
SRE 7-1 SRE CMS Areas
CMS Areas-Areas recommended for further evaluation in Corrective Measures Study (CMS)
VOCs Summary for Soil and Groundwater
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY
1 inch equals 150 feet
0 150 300 Feet
Date: Sep 27, 2006
Document: RFI-Report-Group6_VOC.mxd
FIGURE 4-1



SVOCs Summary for Soil and Groundwater Group 6 Reporting Area

SANTA SUSANA FIELD LABORATORY

FIGURE 4-2



Administrative Area Boundary
RFI Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leachfield
Surface Flow
Drainage
Concrete Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond

Groundwater Wells
Near Surface
Chatsworth

*
TPH are portrayed relative to Risk Based Screening Levels (RBSLs) for gasoline range hydrocarbons and combined diesel-kerosene-lubricant oil range hydrocarbons. RBSLs for TPH ranges are based on extrapolated benzene and benzo(a)pyrene concentrations respectively. Color code represents maximum ratio of individual TPH concentrations for these two ranges to respective lowest RBSL at each sample location.

TPH Sample Results *
ND
<RBSL
<2 X RBSL
<10 X RBSL
>10 X RBSL

CMS Areas
NCY 2-1 — NCY CMS Areas
OCY 3-1 — OCY CMS Areas
SRE 7-1 — SRE CMS Areas

CMS Areas-Areas recommended for further consideration in Corrective Measures Study (CMS)

TPH Summary for Soil and Groundwater Group 6 Reporting Area

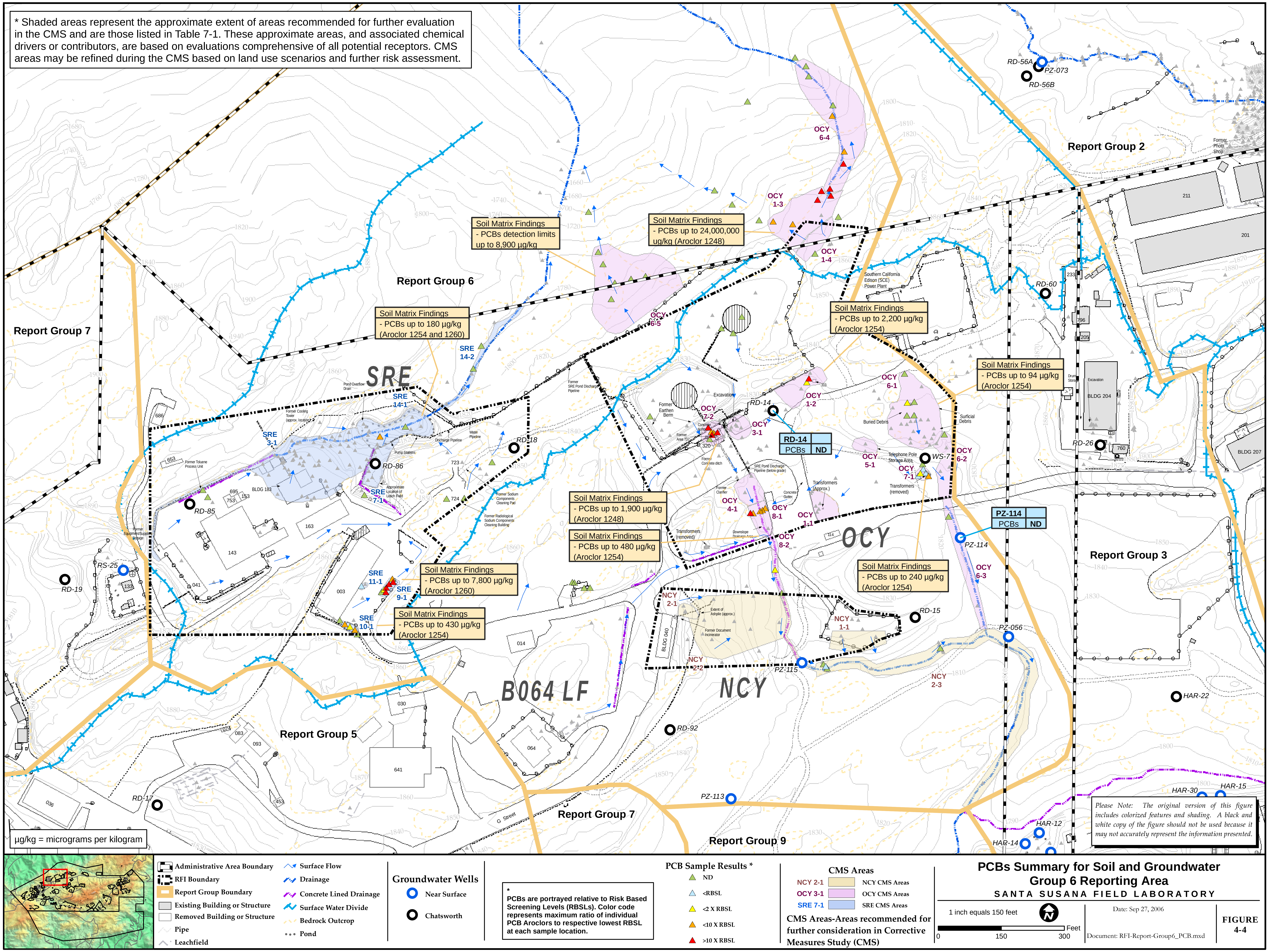
SANTA SUSANA FIELD LABORATORY

1 inch equals 150 feet
0 150 300 Feet

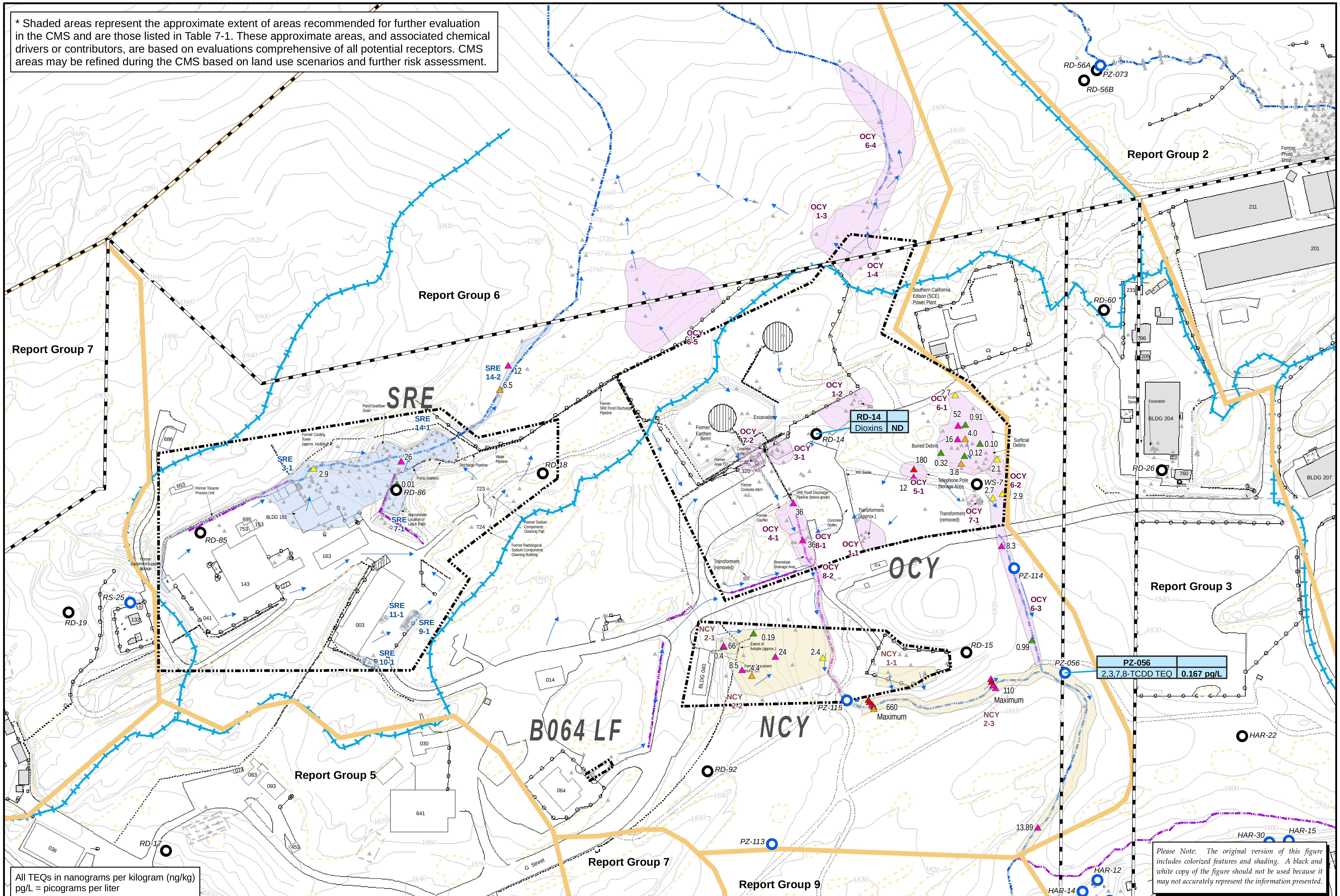
Date: Sep 30, 2006

Document: RFI-Report-Group6_TPH.mxd

FIGURE 4-3



* Shaded areas represent the approximate extent of areas recommended for further evaluation in the CMS and are those listed in Table 7-1. These approximate areas, and associated chemical drivers or contributors, are based on evaluations comprehensive of all potential receptors. CMS areas may be refined during the CMS based on land use scenarios and further risk assessment.
Report Group 2
Report Group 3
Report Group 5
Report Group 6
Report Group 7
Report Group 9
SRE
OCY
NCY
B064 LF
Soil Matrix Findings - PCBs detection limits up to 8,900 µg/kg
Soil Matrix Findings - PCBs up to 24,000,000 ug/kg (Aroclor 1248)
Soil Matrix Findings - PCBs up to 180 µg/kg (Aroclor 1254 and 1260)
Soil Matrix Findings - PCBs up to 2,200 µg/kg (Aroclor 1254)
Soil Matrix Findings - PCBs up to 94 µg/kg (Aroclor 1254)
Soil Matrix Findings - PCBs up to 1,900 µg/kg (Aroclor 1248)
Soil Matrix Findings - PCBs up to 480 µg/kg (Aroclor 1254)
Soil Matrix Findings - PCBs up to 240 µg/kg (Aroclor 1254)
Soil Matrix Findings - PCBs up to 7,800 µg/kg (Aroclor 1260)
Soil Matrix Findings - PCBs up to 430 µg/kg (Aroclor 1254)
RD-14 PCBs ND
PZ-114 PCBs ND
RD-56A
RD-56B
PZ-073
RD-60
RD-26
WS-7
PZ-056
RD-15
PZ-115
HAR-22
RD-92
PZ-113
HAR-30
HAR-15
HAR-12
HAR-14
RD-17
RD-19
RS-25
RD-85
RD-86
RD-18
OCY 6-4
OCY 1-3
OCY 1-4
OCY 6-5
OCY 6-1
OCY 1-2
OCY 7-2
OCY 3-1
OCY 5-1
OCY 7-1
OCY 6-2
OCY 4-1
OCY 8-1
OCY 1-1
OCY 8-2
OCY 6-3
SRE 14-2
SRE 14-1
SRE 3-1
SRE 7-1
SRE 11-1
SRE 9-1
SRE 10-1
NCY 2-1
NCY 1-1
NCY 2-2
NCY 2-3
µg/kg = micrograms per kilogram
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
RFI Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leachfield
Surface Flow
Drainage
Concrete Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond
Groundwater Wells
Near Surface
Chatsworth
* PCBs are portrayed relative to Risk Based Screening Levels (RBSLs). Color code represents maximum ratio of individual PCB Aroclors to respective lowest RBSL at each sample location.
PCB Sample Results *
ND
<RBSL
<2 X RBSL
<10 X RBSL
>10 X RBSL
CMS Areas
NCY 2-1 NCY CMS Areas
OCY 3-1 OCY CMS Areas
SRE 7-1 SRE CMS Areas
CMS Areas-Areas recommended for further consideration in Corrective Measures Study (CMS)
PCBs Summary for Soil and Groundwater
Group 6 Reporting Area
SANTA SUSANA FIELD LABORATORY
1 inch equals 150 feet
0 150 300 Feet
Date: Sep 27, 2006
Document: RFI-Report-Group6_PCB.mxd
FIGURE 4-4



Administrative Area Boundary
RFI Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leachfield
Surface Flow
Drainage
Concrete Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond

Groundwater Wells
Near Surface
Chatsworth

*
2,3,7,8 TCDD Toxicity Equivalency Quotients (TEQs) are displayed relative to background, and human health (residential) and ecological Risk Based Screening Levels (RBSLs). The maximum TEQ is shown for each sample location.

Dioxin Sample Results (TEQs)*
<Background
<Eco RBSL
<Res RBSL
<10 X Res RBSL
>10 X Res RBSL

CMS Areas
NCY 2-1 — NCY CMS Areas
OCY 3-1 — OCY CMS Areas
SRE 7-1 — SRE CMS Areas
CMS Areas-Areas recommended for further consideration in Corrective Measures Study (CMS)

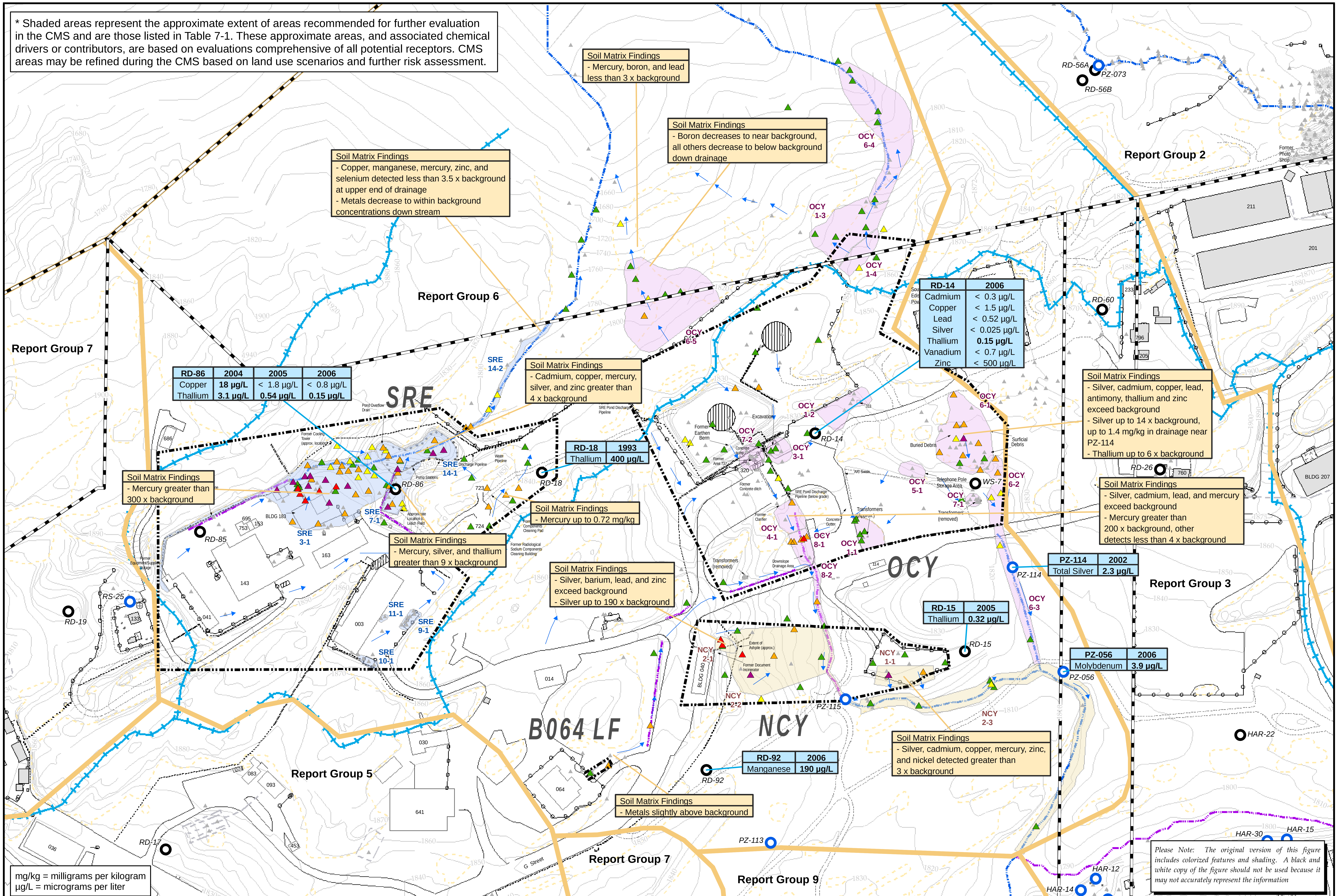
Dioxins Summary for Soil and Groundwater Group 6 Reporting Area

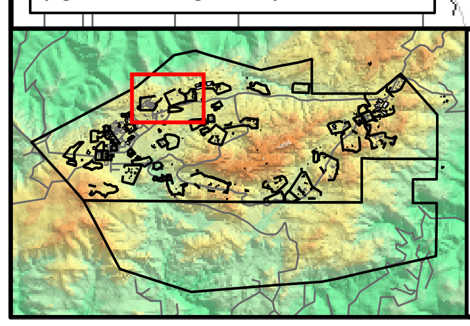
SANTA SUSANA FIELD LABORATORY

1 inch equals 150 feet
0 150 300 Feet

Date: Sep 28, 2006
Document: RFI-Report-Group6_Dioxin.mxd

FIGURE 4-5





Administrative Area Boundary
RFI Boundary
Report Group Boundary
Existing Building or Structure
Removed Building or Structure
Pipe
Leachfield
Surface Flow
Drainage
Concrete Lined Drainage
Surface Water Divide
Bedrock Outcrop
Pond

Groundwater Wells
Near Surface
Chatsworth

* Metals are portrayed relative to DTSC approved soil background concentrations. Color code represents maximum ratio at each sample location of individual metals to respective background concentration.

Note: Groundwater metals concentrations shown in **BOLD** exceed respective groundwater comparison concentrations.

Metals Sample Results *
<Background
<10 X Background
<100 X Background
<1,000 X Background
>1,000 X Background

CMS Areas
NCY 2-1 — NCY CMS Areas
OCY 3-1 — OCY CMS Areas
SRE 7-1 — SRE CMS Areas

CMS Areas-Areas recommended for further consideration in Corrective Measures Study (CMS)

Metals Summary for Soil and Groundwater Group 6 Reporting Area

SANTA SUSANA FIELD LABORATORY

1 inch equals 150 feet
0 150 300 Feet

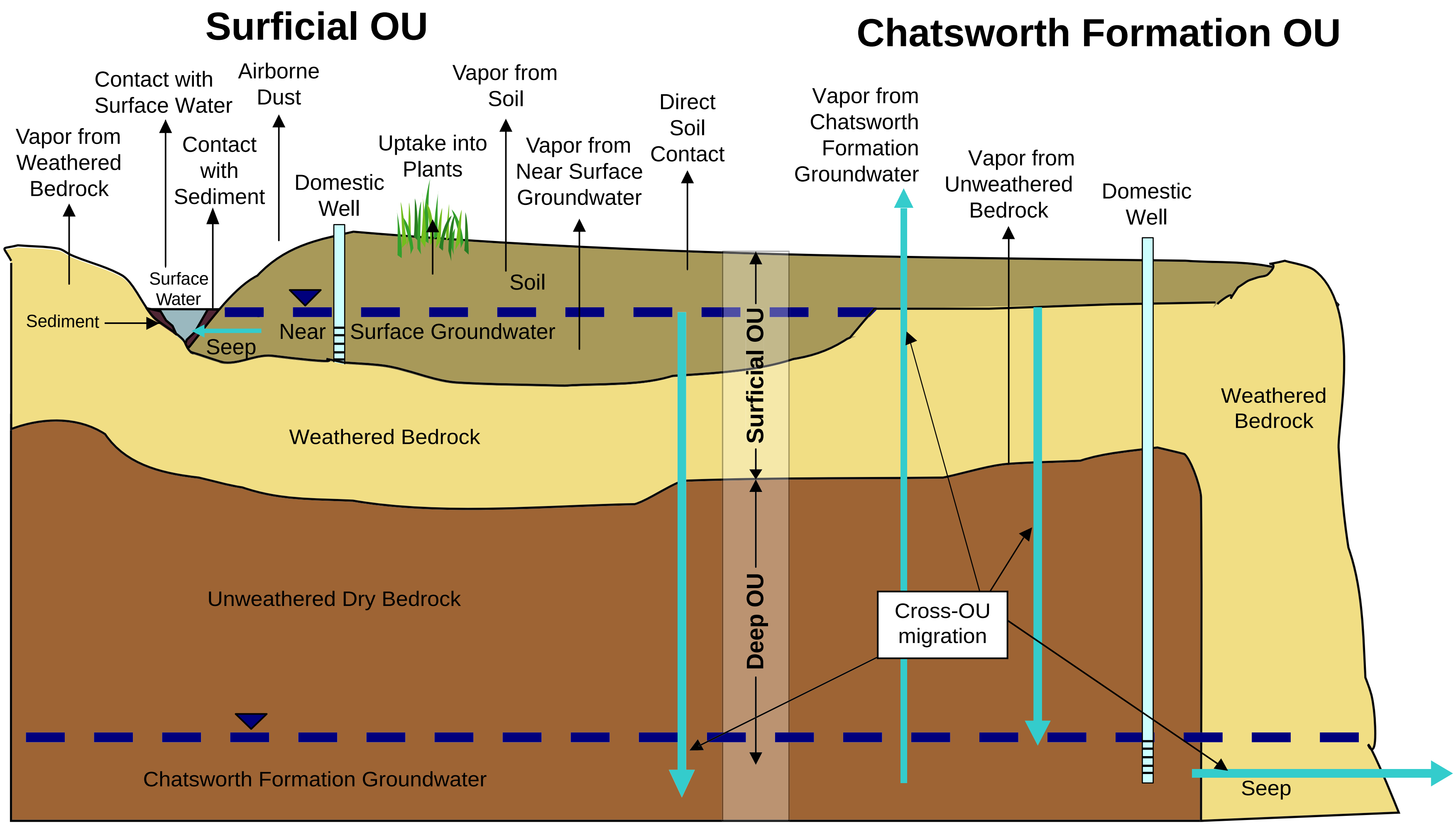
Date: Sep 28, 2006
Document: RFI-Report-Group6_Metal.mxd

FIGURE 4-6

Representative Ecological Receptors:
- Generic aquatic species (aquatic primary/secondary consumer)
- Great blue heron (aquatic tertiary consumer)
- Deer mouse (terrestrial primary/secondary consumer)
- Thrush (terrestrial primary/secondary consumer)
- Mule deer (terrestrial primary consumer)
- Red-tailed hawk (terrestrial secondary/tertiary consumer)
- Bobcat (terrestrial secondary/tertiary consumer)

Worker Receptor:
- Inhalation of dust (Surficial OU)
- Inhalation of vapors from soil and groundwater (Surficial OU and CFOU)
- Dermal contact with soil (Surficial OU)
- Ingestion of soil (Surficial OU)
- Dermal contact with surface water and sediment (Surficial OU)
- Ingestion of surface water and sediment (Surficial OU)
- Inhalation of vapors from bedrock

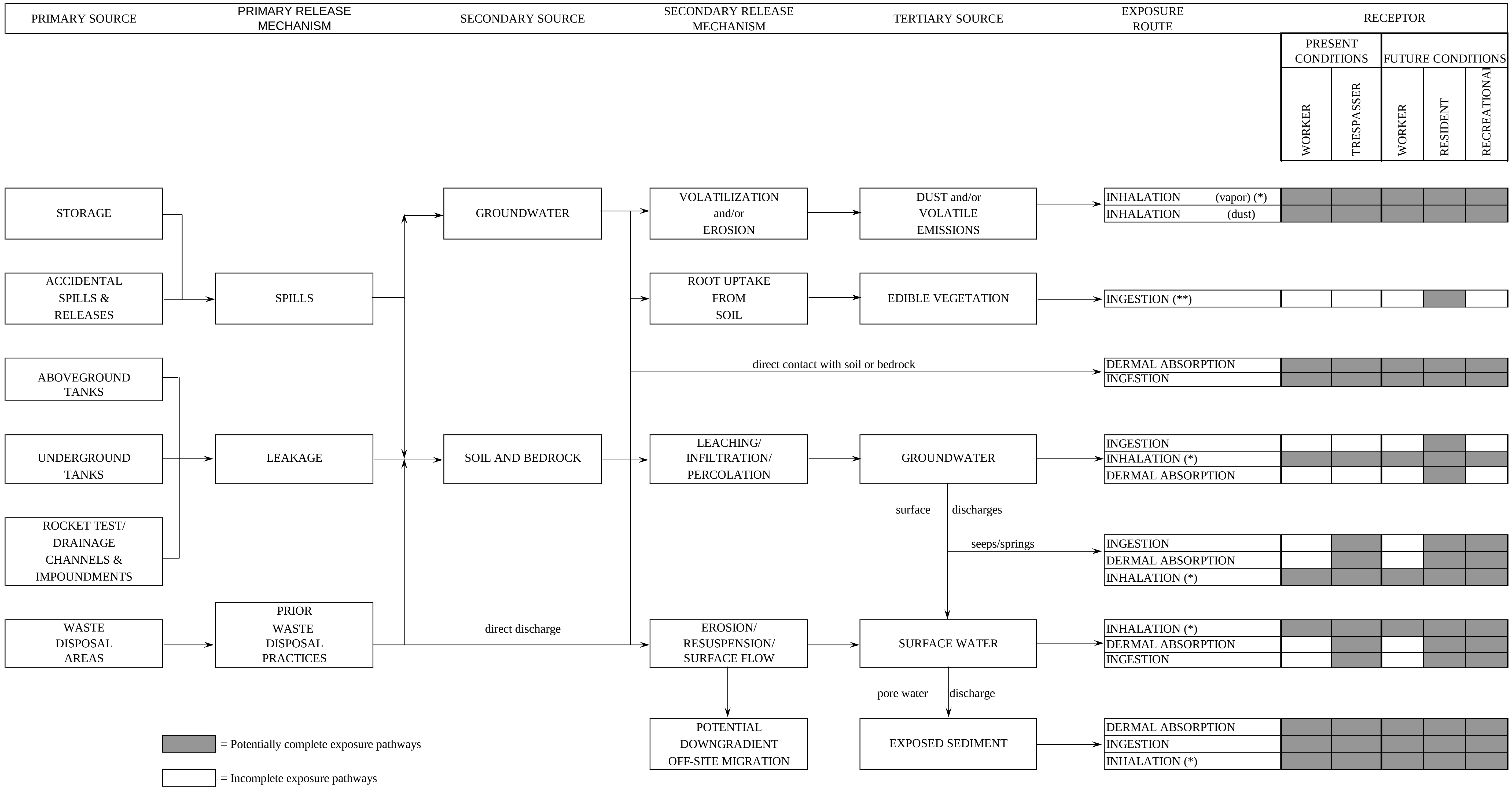
Future Residential Receptor:
- Inhalation of dust (Surficial OU)
- Inhalation of vapors from soil and groundwater (Surficial OU and CFOU)
- Ingestion of plants (Surficial OU)
- Dermal contact with soil (Surficial OU)
- Ingestion of soil (Surficial OU)
- Dermal contact with surface water and sediment (Surficial OU)
- Ingestion of surface water and sediment (Surficial OU)
- Ingestion of groundwater (Surficial OU and CFOU)
- Inhalation of vapors during domestic use (Surficial OU and CFOU)
- Dermal contact with groundwater (Surficial OU and CFOU)
- Inhalation of vapors from bedrock



MWH

Santa Susana Field Laboratory (SSFL)
Illustrated Conceptual Site Model of Human Health and Ecological Exposures

FIGURE 5-1



Notes:

See Figure 6-3 for a generalized Conceptual Site Model of ecological exposures. See Appendix C, Attachments C1 through C4 for RFI site-specific Conceptual Site Models.

As described in the SRAM (MWH 2005), note that risk estimates for the potential future recreational user (recreator) are used as surrogate risk estimates for the trespasser.

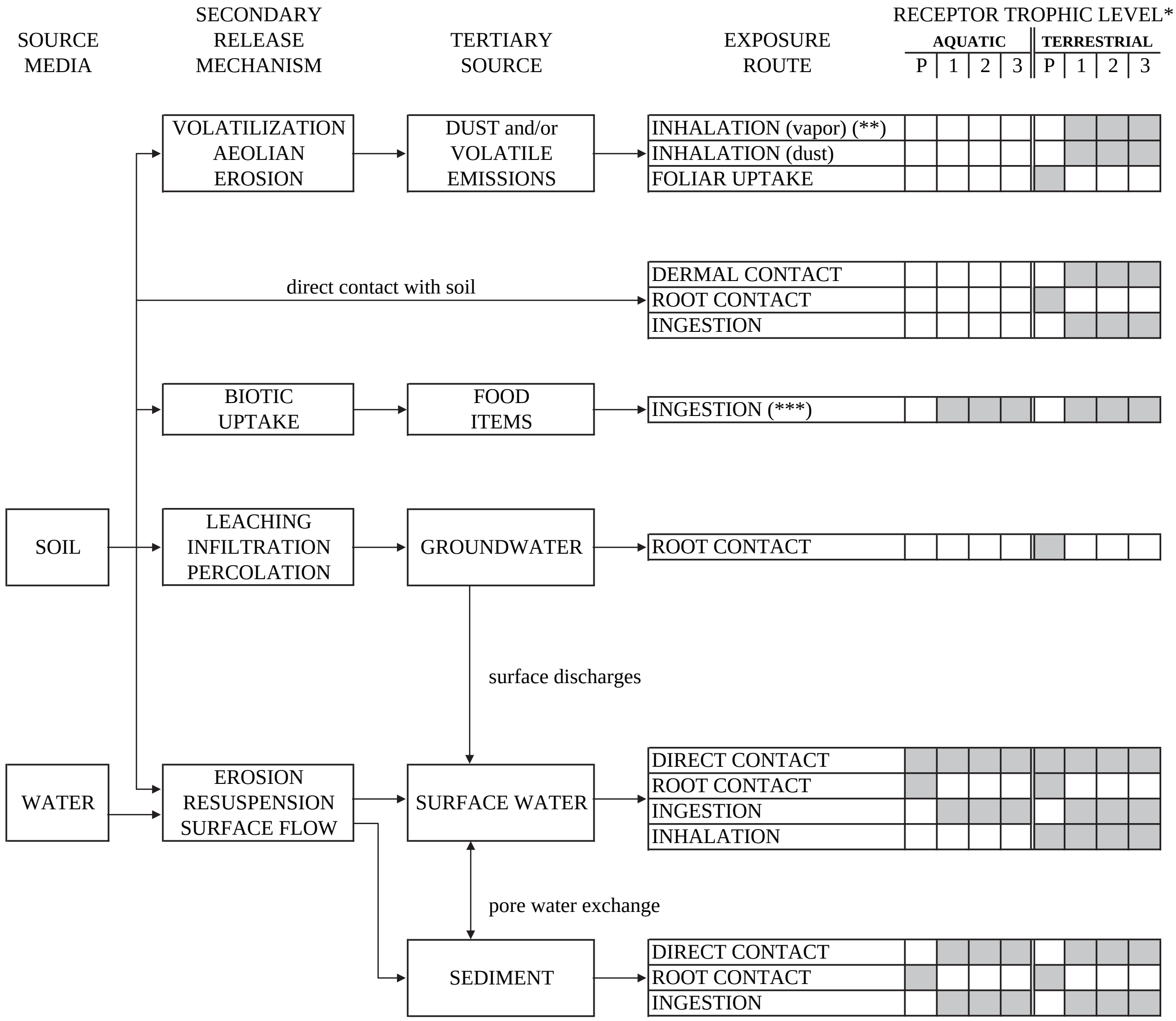
(*) Exposure limited to volatile compounds as defined in the text; residential and worker receptors include both indoor and outdoor air exposure to volatiles; nonresidental and nonworker receptors include only outdoor air exposure. For residents, inhalation of volatiles from shallow groundwater includes pathways associated with both domestic use and migration to indoor air, whereas, nonresidential exposure includes only migration to indoor and outdoor air for workers and only outdoor air for recreators. Exposure to fugitive dust is limited to non-volatile organic compounds.

(**) Exposure limited to bioaccumulatable compounds as described in the text.

MWH

Santa Susana Field Laboratory (SSFL)
Generalized Conceptual Site Model of Human Health Exposures

FIGURE 6-1



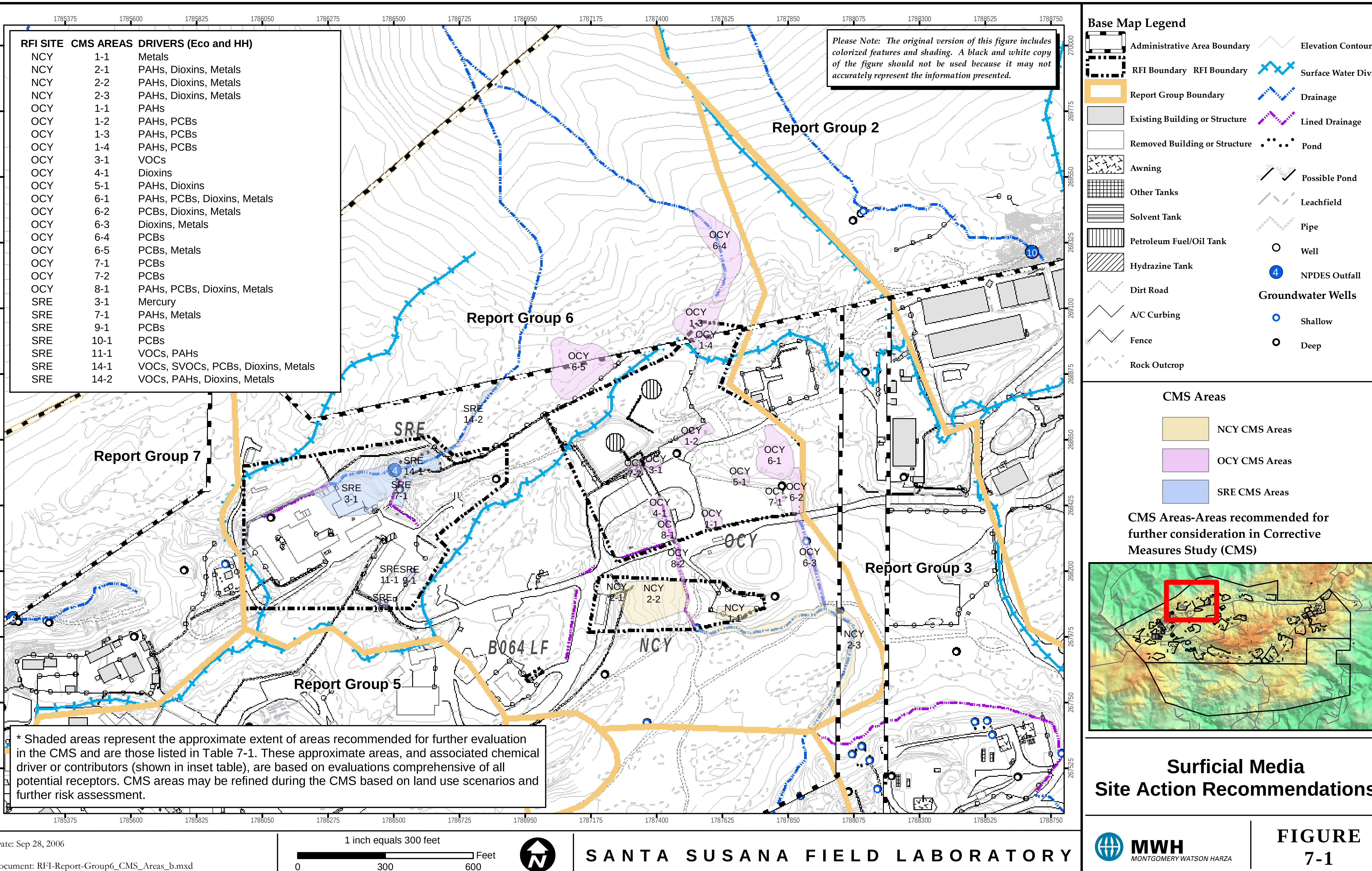
Notes:

See Figure 6-2 for a generalized Conceptual Site Model of human health exposures. See Appendix C, Attachments C1 through C4 for RFI site-specific Conceptual Site Models.

(*) Trophic Level: P= Primary producers (e.g., plants); 1=1st consumer (e.g., invertebrates); 2=2nd consumer (e.g., wading birds); 3=3rd consumer (e.g., fish-eating birds)

(**) Exposures limited to volatile compounds as defined in the text.

(***) Exposures limited to bioaccumulatable compounds as described in the text.



RFI SITE	CMS AREAS	DRIVERS (Eco and HH)
NCY	1-1	Metals
NCY	2-1	PAHs, Dioxins, Metals
NCY	2-2	PAHs, Dioxins, Metals
NCY	2-3	PAHs, Dioxins, Metals
OCY	1-1	PAHs
OCY	1-2	PAHs, PCBs
OCY	1-3	PAHs, PCBs
OCY	1-4	PAHs, PCBs
OCY	3-1	VOCs
OCY	4-1	Dioxins
OCY	5-1	PAHs, Dioxins
OCY	6-1	PAHs, PCBs, Dioxins, Metals
OCY	6-2	PCBs, Dioxins, Metals
OCY	6-3	Dioxins, Metals
OCY	6-4	PCBs
OCY	6-5	PCBs, Metals
OCY	7-1	PCBs
OCY	7-2	PCBs
OCY	8-1	PAHs, PCBs, Dioxins, Metals
SRE	3-1	Mercury
SRE	7-1	PAHs, Metals
SRE	9-1	PCBs
SRE	10-1	PCBs
SRE	11-1	VOCs, PAHs
SRE	14-1	VOCs, SVOCs, PCBs, Dioxins, Metals
SRE	14-2	VOCs, PAHs, Dioxins, Metals

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

Surficial Media Site Action Recommendations

SANTA SUSANA FIELD LABORATORY

MWH MONTGOMERY WATSON HARZA

FIGURE 7-1

Date: Sep 28, 2006

Document: RFI-Report-Group6_CMS_Areas_b.mxd