FINAL
GEOPHYSICAL INVESTIGATION REPORT

AREA IV RADIOLOGICAL STUDY
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

U.S. EPA Contract Number: EP-S7-05-05
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Prepared for:

U.S. Environmental Protection Agency Region 9
75 Hawthorne Street
San Francisco, California 94105

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December 02, 2011

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LIST OF ACRONYMS AND ABBREVIATIONS

AOI	areas of interest
AST	aboveground storage tank
bgs	below ground surface
CVM	cesium vapor magnetometer
DOE	Department of Energy
DTSC	Department of Toxic Substance Control
DVL	digital video logger
EM	electromagnetic method
ETEC	Energy Technology Engineering Center
FDEM	frequency-domain electromagnetic method
GPR	ground penetrating radar
GPS	global positioning system
HGL	HydroGeoLogic, Inc.
HSA	Historical Site Assessment
I	in phase
ICCA	Identified Chemical Contamination Area
mS/m	milliSiemens per meter
NASA	National Aeronautics and Space Administration
NBZ	Northern Buffer Zone
PPM	proton procession magnetometer
QA	quality assurance
QC	quality control
Q	quadrature
RMHF	Radioactive Materials Handling Facility
SNAP	Systems for Nuclear Auxiliary Power
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory

TFM	total field magnetometry
TM	Technical Memorandum
TOI	targets of interest
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank

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1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) is conducting an extensive radiological characterization study of the Santa Susana Field Laboratory (SSFL) at Area IV and the Northern Buffer Zone (NBZ) located in Ventura County, California. This work is being executed under U.S. Environmental Protection Agency (USEPA) Region 7 Architect and Engineering Services Contract EP-S7-05-05, Task Order 038. The technical lead on the project is USEPA Region 9.

In support of USEPA's overall radiological characterization study, a geophysical investigation was conducted to survey and map possible burial areas. This geophysical investigation report describes the methodology, field procedures, and final data results of geophysical surveys conducted at Area IV, in the following subareas (in surveyed order): 5C, 5B, 5A, 5D-North, 8-North, 6, 7, 5D-South, and 3, and in the NBZ.

1.1 INVESTIGATION OBJECTIVE

The objective of this investigation was to use surface geophysical methods to survey areas of interest (AOI) in Area IV and the NBZ of SSFL as defined in the Geophysical Investigation Plan (HGL, 2010c) to identify and locate areas of potential buried materials that may contain radiological contamination referred to as targets of interest (TOI). The findings of the geophysical survey were used in conjunction with information in the historical site assessments (HSA) and aerial photographs to locate and approximate the dimensions of the TOI which were verified as a geophysical anomaly. This objective was met by using three different geophysical instruments to obtain high quality, reliable geophysical data, then digitally mapping the three datasets using a geo-referenced database.

This information was used as one of the lines of evidence to identify targeted locations for soil sampling. Sample locations were described and mapped in the Field Sampling Plan Addendums for each subarea, and presented for stakeholder concurrence.

1.2 SITE SETTING AND BACKGROUND

The following subsections describe the physical attributes of the SSFL site and provide a brief overview of the site history obtained from documents describing previous investigations.

1.2.1 Geology and Geomorphology

The physical setting of the SSFL site in terms of localized topography and earth materials at SSFL are discussed in the following subsections.

1.2.1.1 Topography and Surface Conditions

The SSFL is located on a ridge within the Transverse Ranges physiographic province. The facility is about 850 feet above the valleys to the north and south. While the laboratories and other facilities within Area IV are generally located on relatively flat ground, local relief can be up to 600 feet. In the Area IV Study Area, the highest elevation (2,150 feet above mean sea level) is along the southern boundary (Figure 1a). Along the northwest boundary, the land slopes steeply away to undeveloped land. The relatively flat area in the southern part of Area IV is called "Burro Flats."

Surface water drainage in the northern portion of the Area IV Study Area and the NBZ flows north into Meier Canyon, which is a tributary to the Arroyo Simi, flowing westward and terminating in the Pacific Ocean. Drainage of the majority of Area IV flows to the southeast into the Bell Creek drainage system as suggested by the location of the northeast-southwest trending drainage divide (Figure 1c). Bell Creek is the headwater and tributary of the Los Angeles River which flows south and eastward terminating in the Pacific Ocean.

Given the topographic divide and topographical rises to the east and west of Area IV, there is no drainage directly to the west or east from Area IV (U.S. Geological Survey, 1952).

Surface drainage within Area IV Study Area is through manmade and natural ditches and swales that lead to natural streambeds. The drainage from some operational areas is directed through various settling and process ponds. The locations of surface drainage features are presented on Figure 1c.

1.2.1.2 Soils

The parent material of the soil in the Area IV Study Area consists of weathered bedrock, colluviums and alluvium derived from the Chatsworth Formation. According to the Natural Resources Conservation Service, approximately 40 percent of the Area IV Study Area is classified as sedimentary rock outcrop. The two predominant soil types in Area IV are a sandy loam of the Saugus series and a loam of the Zamora series. The Saugus series soils consists of deep, well drained soils that usually forms on dissected terraces and foothills and are moderately permeable. The sandy loam of the Saugus series usually has slopes of 5 to 30 percent. The Zamora series soils are typically well drained loam that form on nearly level grade or on strongly sloping fans and terraces. The Zamora series in Area IV has slopes that range from 2 to 15 percent (U.S. Department of Agriculture, 2003).

1.2.1.3 Geology

The SSFL is located within the Transverse Ranges physiographic province, approximately 30 miles north of downtown Los Angeles (Baily and Jahns, 1954). Two geologic formations underlie Area IV within the SSFL: the Cretaceous Chatsworth Formation and the Tertiary Santa Susana Formation. The Chatsworth Formation underlies approximately 80 percent of Area IV. The following descriptions are derived from the Preliminary Geologic Map of the Los Angeles 30 feet by 60 feet Quadrangle, Southern California (Yerkes and Campbell, 2005). A geologic map of the area is presented as Figure 1d.

1.2.1.3.1 Chatsworth Formation

The Chatsworth Formation consists of three unnamed members. The members were deposited by turbidity currents in the deep ocean at depths ranging from 4,000 to 5,000 feet. Turbidity currents cause massive submarine landslides from the continental shelf into submarine canyons which are generally more than a half-mile wide and greater than ten miles in length. During periods without turbidity currents, silt and clay particles from runoff filtered to the ocean floor and formed the siltstone strata found in the formation.

Deposited in the late Cretaceous, the Chatsworth Formation is in excess of 6,000 feet thick. The uppermost member is a thick strata of light gray to brown sandstone, which is hard, coherent, arkosic, micaceous, primarily medium grained separated by thin partings of siltstone. The middle member is a gray conglomerate of cobbles of rounded, polished clasts of quartzite, porphyry and granitic rocks in hard sandstone matrix. The lower member is gray clay shale, crumbly with ellipsoidal fracture where weathered, and may include sandstone strata.

1.2.1.3.2 Santa Susana Formation

The Burro Flats Fault places the Chatsworth Formation in structural contact with the Santa Susana Formation in the Area IV Study Area. The Santa Susana Formation underlies the southwestern most portion of the Area IV Study Area (Figure 1d) and consists of four members. The unnamed uppermost layer of the Santa Susana Formation consists of gray micaceous claystone and siltstone with a limited number of thin sandstone beds. Below the uppermost layer lies a second unnamed layer that is made up of tan coherent fine grained sandstone, which locally contains thin shell-beds and calcareous concretions. Underlying this layer is the Las Virgenes Sandstone Member, which is composed of tan semi-friable bedded sandstone and is locally pebbly. The oldest member is the Simi Conglomerate Member. This member contains gray to brown cobble conglomerate with smooth cobbles of quartzite, metavolcanic and granitic rocks in sandstone matrix that locally includes thin lenses of red clay. The Santa Susana Formation was also formed by turbidity currents.

1.2.1.3.3 Geologic Structures at the Santa Susana Field Laboratory

The SSFL is located on the south flank of an approximately east-west striking, westward plunging syncline. There are three categories of geologic structures present in the SSFL faults/fault zones, deformation bands, and structures (Montgomery Watson Harza, 2007). The fault zones and deformation features displace primary geologic features, the former showing displacement of at least five feet and the later with minimal observed displacement (less than 6 inches). Mapped faults in the SSFL are presented on Figure 1d. The Burro Flats Fault places the Chatsworth Formation in structural contact with the Santa Susana Formation in the southwest portion of the Area IV Study Area.

Fractures and joints are widespread in the Chatsworth Formation and these may be important conduits for groundwater and contaminant movement. Fractures are oriented parallel to bedding and dip 25 to 30 degrees to the northwest and strike N70°E. Steeply dipping joints are also present in the formation, and some cut across bedding planes. The openings are well interconnected vertically and horizontally (Cherry et al., 2007).

1.2.2 Historical information and Description of Subareas

1.2.2.1 History of SSFL

The SSFL is located in southeastern Ventura County, California, near Simi Valley (Figure 1a). The 2,850-acre site is approximately 30 miles northwest of downtown Los Angeles between the Simi and San Fernando valleys in the Simi Hills. The site is separated into four administrative areas. The Boeing Company owns all of Area I, except for 42 acres that are owned by the National Aeronautics and Space Administration (NASA). Area II is owned by NASA and operated by The Boeing Company; and The Boeing Company owns and operates Areas III and IV. Areas I, II, and III were used by predecessors of The Boeing Company, NASA, and the Department of Defense for rocket engine and laser testing. Chemical contamination resulting from those activities is the responsibility of The Boeing Company and NASA and is not part of the scope of this project. A 90-acre portion of Area IV is leased by the U.S. Department of Energy (DOE) and is the subject of this radiological and geophysical study.

Until its closure, DOE was responsible for operation of the Energy Technology Engineering Center (ETEC) located in Area IV. As the ETEC did not have specific boundaries within Area IV, it represented a group of facilities owned by DOE and used for nuclear research and other experimental activities. From the mid-1950s until the mid-1990s, DOE and its predecessor agencies were engaged in or sponsored nuclear operations including the development, fabrication, disassembly, and examination of nuclear reactors, reactor fuel, and other radioactive materials. Associated experiments included large-scale sodium metal testing for fast breeder reactor components. Nuclear operations at ETEC included 10 nuclear research reactors, seven critical facilities, the Hot Laboratory, the Nuclear Materials Development Facility, the Radioactive Materials Handling Facility (RMHF), and various test and radioactive material storage areas.

All nuclear research in Area IV was terminated in 1988, when DOE shifted its focus at SSFL from research to decontamination and decommissioning activities. Decontamination and decommissioning of the sodium test facilities started in 1996, when DOE determined that the entire ETEC facility was surplus to its mission and began formal cleanup and closure of its facilities in Area IV in preparation for returning the property to the Boeing Company.

1.2.2.2 Area IV Subareas

Area IV, the portion of the site under investigation, is approximately 290 acres in size. Surface elevations range from approximately 2,160 feet above sea level in the southwestern part of Area IV to approximately 1,725 feet above sea level near the northwestern part of Area IV. Area IV is bounded by undeveloped land to the north, west, and south; and to the east by SSFL Area III (USEPA, 2010). A general description of each subarea and their former operations follows.

Subarea 5C

Subarea 5C encompasses approximately 21.9 acres. The area is flat, with drainage generally to the southeast.

There was one retention pond in this subarea used for alcohol retention. Radiological operations in the Subarea 5C were related to the Systems for Nuclear Auxiliary Power (SNAP) and SNAP 8 programs as well as to the Advanced Epithermal Thorium Reactor, and the Fast Critical Experiment Laboratory. During the peak of operations, Subarea 5C comprised 23 sites, most of which were buildings. Of the 23 sites, one was a reactor (Building 4059), one was a criticality test facility (Building 4100) and others housed operations involving radioactive materials. Only six buildings remain in Subarea 5C (HGL, 2010b).

Subarea 5B

Subarea 5B encompasses approximately 23.2 acres of flat land. Drainage is generally to the south.

A bermed ponding area was located at the intersection between G and 17th Street. This ponding area retained water during the mid- to late-1960s. Radiological operations in Subarea 5B related to the SNAP and SNAP 8 programs. During the peak of operations, Subarea 5B comprised 46 primary sites, most of which were buildings, and 22 associated sites, such as electrical substations, power supplies, electrical equipment pads, and time clocks. Of the 46 sites, one was a reactor building (Building 4010), two were criticality test facilities (Buildings 4012 and 4019), and others housed operations involving radioactive materials. Only four buildings remain in Subarea 5B (HGL, 2010a).

Subarea 5A

Subarea 5A encompasses approximately 38.4 acres of flat land. Drainage is generally to the southeast.

Radiological operations in this subarea area related to the SNAP and SNAP 8 programs as well as to the Advanced Epithermal Thorium Reactor and the Fast Critical Experiment Laboratory. During the peak of operations, Subarea 5A comprised 27 sites, most of which were buildings. Of the 27 sites, three were reactor buildings and 14 housed operations possibly involving radioactive materials. Only two buildings and a parking lot remain in Subarea 5A (HGL, 2011e).

Subarea 5D-North

Subarea 5D-North encompasses approximately 71.5 acres. Though the area is generally flat, drainage from roadways is diverted through ditches and other surface drainages to the R-2A pond located within Area II of the SSFL.

Primary radiological operations in the Subarea 5D-North area related to the SNAP programs as well as to the Hot Laboratory and the Nuclear Material Development Laboratory. The majority of radiological operations in Subarea 5D-North occurred in the Hot Laboratory or the

Nuclear Material Development Laboratory. During the peak of operations, Subarea 5D-North comprised 21 sites, 20 buildings and one site consisting of aboveground storage tanks (AST). One site was a critical facility and six housed operations possibly involving radioactive materials, including the Hot Laboratory and the Nuclear Material Development Laboratory. Only one building and two ASTs remain in Subarea 5D (HGL, 2011c).

Subarea 8-North

Subarea 8-North encompasses approximately 108.8 acres. About half the area is flat, and the other half is characterized by undeveloped, rocky land. The drainage direction is generally to the north and northeast.

There were three unlined retention ponds and a concrete-lined pit in this subarea that were associated with liquid waste disposal. Additionally, this subarea included a landfill formerly used for disposal of construction debris. Primary radiological operations were related to the two critical test facilities located in Building 4009 and the waste disposal operations at the former Sodium Disposal Facility, Building 4886. During the peak of operations, Subarea 8-North comprised eight sites, three of which were buildings. Only one building remains in Subarea 8-North (HGL, 2011d).

Subarea 6

Subarea 6 is approximately 57 acres that encompasses areas graded flat for construction with large bedrock outcrops dividing the graded areas. The direction of surface drainage varies depending on the location within the subarea.

The majority of operations in Subarea 6 were to support operations associated with the Sodium Reactor Experiment (SRE). The SRE served as both a nuclear power plant and a reactor systems experiment. There was one retention pond that received effluent from the SRE. During the peak of operations, Subarea 6 comprised 38 sites, 22 were buildings. The SRE was contained in Building 4143 and other buildings involved operations that included radioactive materials. Other features included fenced areas, concrete pads, storage yards, oil storage tanks, and parking lots. No buildings remain in Subarea 6 (HGL, 2011b).

Subarea 7

Subarea 7 encompasses approximately 16 acres of land along the west-central edge of Area IV. The terrain is rough and drainage is generally to the northwest.

Radiological operations in Subarea 7 were related primarily to the Shield Test Reactor, the RMHF, and the Interim Storage Facility. Most of the buildings in Subarea 7 were part of the RMHF complex and were enclosed by a fence, this facility is still active. The Interim Storage Facility was a below-grade structure that stored used radioactive fuel elements. Subarea 7 comprised 18 sites, most of which were buildings. Of the 18 sites, one contained the Shield Test Reactor and 13 housed operations involving radioactive materials. Only four buildings have been demolished in Subarea 7 (HGL, 2011a).

Subarea 5D-South

Subarea 5D-South encompasses approximately 46 acres of moderately sloping land to the north and south with a low lying flat area in the center. The subarea is poorly drained and generally ponds in the low lying flat area.

This area includes two water storage tanks (Tank 4701 and 4702) and the Area IV borrow pit; there were no buildings in this area. The former borrow pit is in a low lying area that retains moisture and sediment. The tanks are still standing and are located on the ridgeline along the southern edge of Area IV (HGL, 2011c).

Subarea 3

Subarea 3 encompasses 0.887 acres of land gently sloping to the south. Drainage in this subarea is generally to the southwest.

The Southern California Edison substation area is located at the east end of C Street, near the eastern boundary of Area IV. It comprises a small rectangular building, transformers, switching equipment, protection and control equipment, and a fenced area of land surrounding these facilities. The portion of Subarea 3 surveyed encompasses a small field sloping to the south just south of the Southern California Edison. Field observations indicated two moderate sized debris fields divided by a small gully (HGL, 2011a).

NBZ

The NBZ is a 175-acre parcel of land that abuts the SSFL property. The NBZ is a naturally vegetated area containing drainage channels that transport surface water from the SSFL down slope to surrounding populated areas. The NBZ northeast area comprises land and drainage channels located north of Area IV extending west to east between the SRE complex and Area I. The NBZ northwest area comprises land and drainage channels located north of Area IV extending west to east between the southwest corner of Subarea 8-North and the SRE complex.

In 1998 it was discovered that radioactive and chemical contamination that had migrated from the SSFL into the NBZ. No known radiological operations were conducted in the NBZ. Additionally there were no buildings constructed in the NBZ (HGL, 2011a).

Subarea 8-South

Geophysical data was not collected in Subarea 8-South as no AOI were identified in the Geophysical Investigation Plan. Due to observed ground scarring in Subarea 8-South a geophysical visual reconnaissance was conducted using a Schonstedt flux gate magnetometer. No ferrous materials or AOI were identified.

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2.0 PROJECT DISCUSSION

This section details the geographic extent and the required preparation and procedures of the investigation.

2.1 AREAS OF INTEREST

The AOI were identified primarily through aerial photographic interpretation. As the investigation progressed, geophysical AOI were expanded and modified as additional information was obtained from HSA TMs and the ongoing gamma radiation survey. The AOI covered portions of the subareas listed below in the order they were surveyed:

- Subarea 5C,
- Subarea 5B,
- Subarea 5A,
- Subarea 5D-North,
- Subarea 8-North,
- Subarea 6,
- Subarea 7,
- Subarea 5D-South,
- Subarea 3, and
- NBZ.

Figure 1b presents the AOI that were surveyed within each of the subareas inside Area IV as well as the NBZ. A summary of the planned versus the actual areas surveyed within each subarea is provided in Table 2.1 along with a brief description of the survey area. It should be noted that in most cases, the actual area surveyed exceeded these areas due to terrain features that precluded the use of surface geophysical methods, ad hoc areas identified by further scrutinizing historical information, or from site observation and data interpretation.

Geophysical data was not collected in Subarea 8-South as no AOI were identified in the Geophysical Investigation Plan. Due to observed ground scarring in Subarea 8-South a geophysical visual reconnaissance was conducted using a Schonstedt flux gate magnetometer. No ferrous materials AOI were identified.

Data collected from surveying the AOI was processed and geophysical anomalies were identified. These geophysical anomalies were used to map the location and approximate dimensions of TOI.

2.2 GEOPHYSICAL ANOMALIES

Geophysical anomalies were identified from instrument responses seen in the processed data collected from surveying the AOI throughout Area IV and the NBZ of SSFL. Geophysical anomaly identification and verification is discussed in Section 3.5 Map groups 2 through 12 present the processed data results and the delineation of geophysical anomalies for each subarea, these figures are discussed in more detail in Section 4.0.

2.3 TARGETS OF INTEREST

TOI are features within the AOI that may contain radiological contamination. The location and approximate dimensions of TOI were verified and mapped as geophysical anomalies.

2.3.1 Use of Aerial Photography for Identifying Targets of Interest

Aerial photographic analysis performed by the USEPA (USEPA, 2010) was used to define the investigation boundaries of AOI identified in the Geophysical Investigation Plan (HGL, 2010c). The photographic analysis was later used to aid in identifying geophysical anomalies interpreted as TOI. The photographic analysis involved visual examination and comparison of many components of the photographic image to identify TOI for each of the subareas in the Area IV Study Area such as:

- Building foundations
- Cleared areas
- Debris fields
- Depressions
- Disturbed ground
- Excavations
- Fill areas
- Ground scars
- Impoundments
- Mounded material
- Open storage areas
- Processing areas
- Stains
- Solid waste
- Tonal variations in surface images
- Trenches
- Waste disposal areas

2.3.2 Use of Past Facility Operations History for Identifying Targets of Interest

HSA Technical Memorandums (TM) were prepared by HGL that summarized facility operations history for each subarea. The information in the HSA TMs was used to help evaluate geophysical anomalies to verify TOI. This was achieved by researching facility operational history and evaluating surface drainage patterns; locations of leach fields and disposal areas; and locations of underground utilities such as in-use or abandoned in place sewage lines and septic systems that were identified from the HSA TMs.

2.4 SITE PREPARATION

Various site preparation activities were required for geophysical surveying. Fieldwork was conducted in a manner that minimized damage to the ground surface, native plants, nesting birds and sites identified as archeologically significant. Measures implemented to manage

vegetation, and protect natural and cultural resources were conducted in accordance with the Site Management Plan (HGL, 2010d).

2.4.1 Protection of Natural and Cultural Resources

Consistent with environmental protection and as required by law natural and cultural resources were protected to minimize impact. The subsections below describe the procedures used for this process.

2.4.1.1 Natural Resources

Before initiating any site activities a Biological Monitor inspected each area and flagged any endangered or threatened species and habitats that needed to be avoided. The protection measures that were implemented during the execution of field activities at SSFL area described below.

An information sheet was provided for each listed species in the Biological Assessment prepared by the USEPA and the Biological Opinion issued by the U.S. Fish and Wildlife Service. Any additional species determined to be at risk from site activities was included. The following is a list of plant and animal species that were flagged and avoided:

- Braunton's milk-vetch (*Astragalus brauntonii*)
- Lyon's pentachaeta (*Pentachaeta lyonii*)
- Spreading navarretia (*Navarretia fossalis*)
- California Orcutt Grass (*Orcuttia californica*)
- Conejo dudleya (*Dudleya abramsii* ssp. *parva* [=> *Dudleya parva*])
- Santa Monica Mountains dudleya (*Dudleya cymosa* ssp. *ovatifolia* [inclusive of *Dudleya*
- *cymosa* ssp. *agourensis*])
- Marcescent dudleya (*Dudleya cymosa* ssp. *marcescens*)
- Coastal California gnatcatcher (*Polioptila californica* ssp. *californica*)
- Least Bell's vireo (*Vireo bellii* ssp. *pusillus*)
- California red-legged frog (*Rana aurora* ssp. *draytonii* [=> *Rana draytonii*])
- Quino checkerspot butterfly (*Euphydryas editha* ssp. *quino*)
- Riverside fairy shrimp (*Streptocephalus woottonii*)
- Vernal pool fairy shrimp (*Branchinecta lynchi*)
- San Fernando Valley spineflower (*Chorizanthe paryii* var. *fernandina*)
- Santa Susana tarplant (*Deinandra minthornii*)

Throughout the year various birds were nesting on site. The nesting bird areas were identified, flagged and continually examined by the Biological Monitor. Site activities were required to avoid these areas until the Biological Monitor confirmed that the chicks had left the nest.

2.4.1.2 Cultural Resources

Before initiating any site activities a Cultural Resources Monitor and Native American Monitor inspected each site for known and unknown cultural resources that may potentially have been adversely affected by site activities.

Cultural resources included:

- Archaeological deposits - soils that contained material evidence of human activity including the remains of houses, hearths, cemeteries, and other features,
- Artifacts - objects made by people such as whole or broken grinding stones, bowls and tools of various kinds,
- Rock paintings and carvings that are tied to the landscape, all of which provide information about the culture of the people who made and used them,
- Cultural resources also included certain plants and sacred sites (natural features of the landscape that are recognized in local traditions and places with religious significance).

To mitigate the potential for disturbing cultural resources within Area IV of the SSFL, a records search was conducted to identify all archaeological sites that have been recorded through previous surveys. Fieldwork was designed so as to avoid all known and previously identified cultural resources. The measures that were taken by USEPA to protect cultural resources during execution of the proposed action were derived from the Draft Cultural Resources Management Plan prepared for the SSFL site by NASA in February 2010; the Draft Cultural Resources Clearance Survey prepared by the DOE in November 2009; and from consultations held between USEPA, the State Historic Preservation Office, and Tribal Representatives on December 2 and 3, 2009. The DOE conducted an additional survey within the Northern Undeveloped Lands of the SSFL in the spring of 2010. The additional archaeological sites and cultural resources identified in this or subsequent surveys were integrated into the Cultural Resources Protection Measures.

Identification, avoidance, and protection measures were taken during the execution of field activities at the SSFL site to protect Cultural Resources in accordance with all applicable laws, regulations, and policies as follows:

- HGL and subcontractor field personnel received training for identifying cultural features, archaeological sites, and artifacts. This training was jointly conducted by the Cultural Resource Specialist and a local Tribal Representative before work began.
- Cultural resources protection measures were applied during all ground disturbing field activities. All known cultural resources, as identified through previous surveys, as well as all archeological sites and artifacts discovered through the course of this undertaking were avoided. If potential artifacts were identified, the field crew left them in place and notified a Cultural Resources Monitor and Native American Advisor/Consultant immediately.

2.4.2 Vegetation Clearance

Geophysical field activities at SSFL required that vegetation within the study area be cut or trimmed to allow safe access for equipment and provide clearance for operation of geophysical instruments at optimum levels of sensitivity. It was necessary to trim or cut vegetation within the study area to a height of approximately 6 inches. Before field geophysical surveying

commenced, a vegetation clearing crew went through and cleared vegetation in areas not identified as protected and not flagged for avoidance by the biological and cultural monitors.

2.5 SEQUENCING OF FIELD EFFORTS

The investigation tasks were conducted in the following sequence: survey preparation, data collection, and anomaly identification as detailed below:

- Survey preparation included the following tasks:
  - field reconnaissance,
  - monitoring of environmental and cultural resources,
  - vegetation clearing,
  - defining and mapping survey grids, and
  - staking of grids in the field.
- Data collection included field surveying using three separate technologies integrated with global positioning system (GPS) using a crew of one field geophysicist and a field assistant per instrument.
- Anomaly identification included data processing, digital mapping, documentation research, and field ground truthing. The interpretation of the survey results within each of the subareas, as they were completed, was presented at the scheduled stakeholders meetings.

Table 2.2 summarizes the chronological order of surveys by subarea.

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3.0 TECHNICAL APPROACH

The geophysical investigation involved using three investigation methods. These were the frequency-domain electromagnetic method (FDEM), total field magnetometry (TFM), and ground penetrating radar (GPR). FDEM and TFM were applied in all AOI. GPR was applied in limited locations and where the survey results using the FDEM or TFM show a geophysical anomaly that required further resolution in accordance with the Geophysical Investigation Plan (HGL, 2010c). These technologies were chosen because they provided the best non-invasive means to map the wide range of TOI located in each AOI.

3.1 GEOPHYSICAL INVESTIGATION METHODOLOGY

3.1.1 Total Field Magnetometry

The TFM system, the Geometrics G858 Cesium vapor magnetometer (CVM) for field measurements and the G856 proton procession magnetometer (PPM) for base station correction, provided corrected total magnetic field measurements useful for mapping a wide range of ferrous metal objects at shallow to moderately deep depths, including small to large size buried containers, underground storage tanks (UST), steel and cast iron utility lines, and demolition debris. It was also capable of mapping subtle changes in the magnetic properties of soil, which corroborated with terrain conductivity in mapping disturbed areas, such as burial trenches.

During the TFM survey the instrument measured at one point in space a combination of the earth's magnetic field and a magnetic field caused by the presence of a ferrous object or material. Subtle variations in the measured field were often caused by the natural distribution of iron oxides within the rock and soil. More significant changes in the magnetic field intensity were caused by the presence of buried metals composed of iron, steel and other alloys containing ferrous materials. The response of the CVM was a function of the object's depth and mass.

The changes in intensity of the field produced a definable and mappable signature, or footprint, called a magnetic anomaly. The magnetic anomaly signature was a combination of the earth's (ambient) field and the magnetic field of the ferrous object or material. The effect of the earth's field, which varies in time, was removed from the measured response. This correction was monitored by the PPM base station, and later subtracted the data from the data collected by the CVM.

3.1.2 Frequency Domain Electromagnetic Method

The FDEM system, the Geonics EM-31 standard and EM-31 short, provided terrain conductivity measurements useful for mapping shallow waste disposal trenches, fill areas, drainage, abandoned/unmapped utility lines, as well as larger metallic objects such as USTs and drums.

The EM-31 was composed of two coils, a transmitter and receiver coil, separated by a fixed distance. The transmitter coil transmitted an alternating electromagnetic signal into the

subsurface whose magnetic field component induced current flow, called eddy currents, into the ground. The strength of the eddy currents was directly proportional to the electrical properties of subsurface materials. The eddy currents in turn created a secondary magnetic field which was detected by the receiver coil. The receiver coil transmitted readings to an internal data logger, where readings were displayed and recorded. The recorded signal consisted of two components, the in phase (I) and quadrature (Q). The EM-31 instrument displays the Q component in units of milliSiemens per meter (mS/m), and the I component in parts per thousand.

- The Q component is a measure of the average bulk terrain conductivity sampled over a volume of earth to a maximum depth proportional to the coil spacing and transmission frequency of the instrument.
- The I component is a measure of the "quality" of the conductive materials within the volume investigated. It is nulled over areas representing normal ranges of terrain conductivity, over areas of buried metallic material - particularly ferrous metal - the readings can either dip in the positive range or negative range.

Because the system transmitted at specific frequencies, the induced secondary field was also at that same frequency. A reference signal provided the amplitude of the transmitted signal, the difference between the measured and reference amplitudes was taken as the response due to the secondary, induced field.

3.1.3 Ground Penetrating Radar

The GPR system, the Sensors and Software Noggin 250, provided high resolution imaging (profiling and plan view) of the subsurface. The GPR system was useful as a follow up tool for better target discrimination and higher resolution of burial areas and trenches identified with the other two technologies, especially in areas of high cultural interferences. GPR can locate utility lines, USTs, containers (including non-metallic), and can map the edges of burial trenches to a high resolution.

GPR methodology was a specialized electromagnetic method (EM) geophysical technique that employs the use of a pulsed, high frequency signal (radio wave) that was transmitted into the ground by an antenna that acts as both as transmitter and receiver (transceiver). The GPR transceiver generated pulses of electromagnetic waves that reflected off materials with differing dielectric properties. The pulsed wave was reflected back to the transceiver and recorded by the instruments digital video logger (DVL). As the antenna was moved along the surface, a profile record of the subsurface was produced, providing a very descriptive, understandable view showing soil and rock interfaces resembling a seismic record. The profile record had the dimensions of length in feet versus time in nanoseconds. The recorded time was the duration of the pulsed signal from transmission to reception, so it was representative of a two-way path. The two-way travel time was converted mathematically into depth below ground surface (bgs).

3.2 GEOSPATIAL POSITIONING AND NAVIGATION

GPS navigation devices were used for data collection with the EM-31 and the CVM. GPS was used to map the corners of GPR grids, but was not used during the collection of data. More information concerning geospatial portioning and navigation is given in the sub-sections to follow.

3.2.1 Global Positioning System Navigation Devices

For geospatial positioning and navigation, four different trimble GPS navigation devices were used. The AG-114 and AG-132 were used with the EM-31 and CVM for sub-meter differential accuracy. The handheld GeoXH and Real Time Kinematic were used for grid setup, surface material identification, and ground truthing with position accuracies ranging from sub-meter to sub-decimeter respectively. GPR grid corners were mapped using available GPS Navigation Devices, then geo-referenced on data presentation maps.

3.2.2 Geodetic Datum

The geodetic datum used for all the geophysical field work was the California State Plane Coordinate System, North American Datum 1983 Zone 5, converted from the World Geodetic System 84 geographic (north latitude, west longitude) datum.

3.3 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) and quality control (QC) processes were integrated into daily procedures to ensure that the data collected was consistently of good quality and conformed to quality standards. Data quality consistency was monitored throughout the investigation by practicing standard instrument check procedures and operational techniques as described in Section 3.3.3 below. These QA procedures were conducted each workday throughout the geophysical investigation to:

- Ensure data fidelity and utility of selected technologies.
- Ensure the repeatability and reliability of the data.
- Demonstrate the effectiveness and limitations of using geophysical methods to identify and locate potential buried material.
- Test the limitations and capabilities of the instruments (such as instrument target response versus background, effective line spacing, etc.) and verify that the equipment was working properly.

In addition, data was inspected and evaluated on a daily basis by the Lead Project Geophysicist to ensure that QC standards were met and if not, to determine corrective actions.

3.3.1 Site Seeding and Anomaly Reacquisition

A small plot in SSFL Area IV, Subarea 5C (Figure 1b), was seeded with metallic objects to serve as a blind test of the EM-31, CVM and GPR in real site conditions. The seeded area was constructed by digging five holes that were filled with various metal objects. The location

of this area is shown in Map Group 2 and Figure 12a. Table 3.1 lists the buried items found in each target hole, location in the seeded area and the soil overburden.

3.3.2 Quality Assurance/Quality Control Evaluation Area

A QA/QC evaluation area was constructed in Subarea 5D-North (Figure 1b) in an undisturbed area free of buried metal and cultural interferences, to ensure future background readings. The QA/QC evaluation area consisted of an instrument check base station and two evaluation test strips (a baseline and seeded line). This area was used to perform daily checks of the EM-31 and CVM before and after operations.

The two evaluation test strips, the baseline and the seeded line, were constructed as 100 foot northwest to southeast trending lines along an equal elevation of the natural slope. In the construction of the baseline test strip the soil and ground conditions were not changed so as to emulate background conditions. The seeded line consisted of three target areas where clusters of three 1-gallon steel paint cans were buried along a linear transect at depths of 4, 18, and 36 inches bgs.

The instrument check base station was constructed as an 8-foot by 8-foot area about 15 feet north of the evaluation test strips with the four cardinal directions marked by stakes in the corners. The soil and ground conditions were not changed during the construction of the instrument check base station.

Each morning, before commencing geophysical surveys, the EM-31 and CVM were evaluated in the QA/QC evaluation area instrument check station (static test) and evaluation test strips (baseline and seeded line tests).

- Static test – A three minute stationary test conducted in the instrument check base station with the EM-31 or CVM recording data. During the static test, the operator performed a shake test and cable pull test to simulate possible survey conditions.
- Baseline test – A motion test conducted over the baseline evaluation test strip with the EM-31 or CVM recording data.
- Seeded line test – A motion test conducted over the seeded line evaluation test strip with the EM-31 or CVM recording data.

For QC purposes, the data from the evaluation surveys was reviewed during collection and after collection. EM-31 and CVM surveys within Area IV and the NBZ were conducted after the daily QA/QC evaluations indicated that the equipment functioned properly and target detection capabilities were consistent with project standards. At the end of each day after the completion of surveying the EM-31 and CVM were again evaluated in the QA/QC evaluation area to verify that the equipment continued to function properly and to note any deviations in the equipment capabilities from the earlier tests. Any deviations, equipment issues and actions taken were noted in the logbook.

3.3.3 Daily Instrument Check Procedures

The EM-31, CVM, PPM, and GPR instruments are not radiation or chemical detectors; therefore, no calibration against a known standard was required before field operations. However, instrument functional tests and quality check procedures as recommended by the manufacturer and in accordance with standard practices were followed to ensure good and reliable data quality. These functional and quality checks are detailed below.

EM-31 Standard and EM-31 short

Prior to each day's activities, during midday function test and at the completion of each day's activities various functional tests and nulling of the I component were conducted in the QA/QC evaluation area at the instrument check base station. The following observed values were recorded in the logbook:

- Battery Check – Recorded at the beginning of the day prior to connecting the receiver. For proper function of the EM-31 the batteries should be higher than 4.7 volts. Generally the batteries were changed when the levels were below 5 volts.
- Zero In Test – Recorded at the beginning of the day prior to connecting the receiver. The Q interval was required to be between -1.000 and 1.000. If value deviated the instrument was adjusted. Generally the Q interval was between -0.750 and 0.250.
- Nulling – Recorded at the beginning and end of day. The I component was adjusted as close to 0.000 as possible, generally between -0.003 and 0.003. The I component continued to be checked and adjusted throughout each day.
- Phase test – Recorded at the beginning of the day and during the midday function test. The Q value was required to be 0.100 between two coarse adjustment settings. Generally the Q value was adjusted to meet this standard.
- Sensitivity test – Recorded at the beginning of the day and during the midday function test. The difference in the Q values while equipment was set to COMP was recorded generally between 79 and 81.
- Q and I values – Recorded at the beginning and end of daily operations. The Q and I values were recorded while the EM-31 was in a North-South orientation and in an east-west orientation.
- GPS acquisition – Before operating geophysical equipment, the GPS signal was checked to ensure that the GPS was collecting data properly.

CVM

During the operation of the CVM various function were monitored to ensure proper data acquisition. After connecting the sensors and GPS and before operating the CVM the following functions were checked.

- Battery check – Battery packs were checked at the beginning of the day to ensure that they were fully charged.

- Signal strength check – Before operating the CVM, the sensors signal strengths were required to warm up to at least 25 percent of full signal strength or higher for proper data acquisition.
- GPS acquisition check – Before operating the CVM, the GPS chat mode was checked to determine that it was receiving a signal and functioning properly.

PPM

The PPM base station was setup at the beginning of each day, then the following information was recorded and functional tests were performed:

- Synchronization of instrument time clocks – The instrument times on the CVM and the PPM were synchronized to the second. The Julian day and time were recorded.
- Battery check – The battery voltage was recorded to ensure it was above 8.0 volts for proper function. Generally the batteries were replaced when the voltage was below 8.5 volts.
- Reading check – A discrete reading of the ambient magnetic field was recorded.
- Tuning – The instrument was tuned to 47,500 nanoTesla ambient field, and maintained between 4.0 and 8.0 signal strength.
- Time – The real time and the time on the PPM was recorded.

These values were also recorded at a midday base station check and at the end of the day before taking down the base station.

3.3.4 Daily Data Review

All geophysical instrument data and GPS data was recorded in either an external or internal data logger. All data streams from the EM-31, CVM, PPM, and GPR were monitored throughout the day while surveying. At the end of each day, the data were downloaded to a computer and reviewed for quality and GPS positioning by the Lead Project Geophysicist. Issues with the QA/QC data and/or the survey data were noted and if the day's data was compromised, areas were flagged for re-survey or corrective processing, or the equipment was decommissioned for repairs or replacement.

3.4 FIELD DATA COLLECTION PROCEDURES

The field data collection procedures were carried out in accordance with the Geophysical Investigation Plan (HGL, 2010c) to ensure complete and high quality data collection. The SSFL geophysical investigation team employed FDEM, TFM, and GPR. These technologies were chosen because they provided the best non-invasive means to map the wide range of TOI.

The following subsections explain in greater detail the procedures used while surveying the SSFL site.

3.4.1 Site Reconnaissance

Field reconnaissance was performed in areas, particularly the NBZ, that did not have defined investigation boundaries. A walkover was conducted to identify notable features such as mounding or a hummocky appearance suggesting ground disturbance, and scanning with the Schonstedt magnetic locator. Any buried ferrous material and physiographic features were noted and the location marked with a GPS. This information was used to help define AOI boundaries for surface geophysical survey.

3.4.2 Grid Layout

The objective of the geophysical investigation was to accurately locate and record the location of geophysical anomalies. To accomplish this task, the AOIs identified in the Geophysical Investigation Plan were divided into 100-foot by 100-foot grids. Each corner was staked with a uniquely numbered survey stake that was used to identify each geophysical survey grid. Each grid designation was determined by the stake number of the southwest corner. The GPR grids were of various sizes depending on the size of the geophysical anomaly. While surveying, the north and south ends of each grid were marked using 100-foot measuring tapes. Data was collected in north-south traverse lines, and initiated in the southwest corner of each grid where possible. Any deviations in the survey design were noted in the logbook.

3.4.3 Data Acquisition

3.4.3.1 G858 CVM Rover and G856 PPM Base Magnetometers

The PPM base station data was collected in automatic mode reading the total magnetic field every 10 seconds. The PPM base station was set up near the QA/QC area in a location that was relatively free of cultural noise (i.e. not near roads or pedestrian paths). The sensor was attached to a pole at a height of 6 feet facing north. The base station readings were recorded prior to starting data collection, in the middle of the day and at the end of the day before taking down the base station, to ensure the PPM was working properly throughout the day. All data was stored in the G856 internal logger attached to the sensor and downloaded at the end of the day to the data management files.

The CVM was set to record the total magnetic field at an interval of 10 cycles per second coupled with the AG-132 GPS unit and the G858 internal data logger. Data was recorded in the G858 internal data logger and downloaded at the end of each day. Each grid was divided into 10-foot-spaced lines with cones marking the end point of each individual line as it was surveyed. The CVM was traversed across the grid along the line, turned around, and traversed the adjoining line in the opposite direction. The CVM was carrying two sensors mounted in parallel recording data simultaneously. This configuration allowed two lines to be collected each traverse, for an effective line spacing of 5 feet. This process was continued until the grid was completely surveyed.

The CVM was transported to each survey area and assembled on the tailgate of a field truck. As the operator donned the instrument, the field assistant checked that the sensors were in the proper orientation. The CVM was carried by an operator who removed all metal prior to

running equipment. While the instrument was warming up the operator checked the battery levels, GPS data stream and the sensor signal strength. The sensors were orientated perpendicular to the ground at a height of approximately 3 feet above ground surface. During survey operations the data stream and GPS signal were monitored on the liquid crystal display of the G858 by the operator to ensure proper operation and data acquisition.

3.4.3.2 EM-31 Standard and EM-31 Short Terrain Conductivity Instruments

The EM-31 was set to record the terrain conductivity at an interval of five cycles per second coupled with the AG-114 GPS unit. Data was recorded using a data logging program on an Allegro handheld personal computer, that was connected to the AG-114 and the EM-31, and downloaded at the end of the day. Each grid was divided into 5 foot wide lines with cones marking the end point of each individual line as it was surveyed. The EM-31 was traversed across the grid along the line, turned around, and traversed the adjoining line in the opposite direction. This process was continued until the grid was completely surveyed.

The EM-31 was transported to each survey area and assembled on the tailgate of a field truck. As the operator donned the instrument the field assistant ensured that the coils were in the proper orientation. The EM-31 was carried by an operator that removed all metal prior to running equipment. Before commencing the survey, the operator checked the GPS data stream and performed a field function test to ensure the EM-31 was functioning properly. The coils were maintained at a height of approximately 3 feet above ground surface and oriented parallel to the ground. During survey operations the data stream and GPS signal were monitored on the liquid crystal display of the Allegro by the operator to ensure proper operation and data acquisition.

At SSFL both the EM-31 standard and EM-31 short were used to measure the terrain conductivity. Ultimately the majority of the site was surveyed using the EM-31 short because of the steep terrain and cultural interference from surface metals, as was proposed in the Geophysical Investigation Plan (HGL, 2010c).

3.4.3.3 Noggin 250 Smart Cart Ground Penetrating Radar

The GPR was coupled with an odometer and data was recorded at a rate of 1 cycle per 2 inches. Data was recorded using a DVL and downloaded at the end of the day. Each grid was divided into 2-foot-spaced lines with cones marking the end point of each individual line as it was surveyed. The GPR was traversed across the grid along the line, turned around, and traversed the adjoining line in the opposite direction. This process was continued until the grid was completely surveyed. The GPS coordinates of each corner of the GPR grids were recorded in the logbook.

The GPR was transported assembled to each survey area and the battery attached after removing the instrument for the bed of a field truck. The GPR and DVL were mounted on a Sensors and Software Smart Cart for operation. The GPR was operated by pushing the cart over relatively flat terrain. When a small obstacle or uneven terrain was encountered in the lane the field assistant would aid the operator in moving the cart over the obstacle or terrain.

During survey operations the line length and the data cross-section were monitored on the on the DVL by the operator to ensure proper operation and data acquisition.

3.5 ANOMALY IDENTIFICATION PROCEDURES

The following subsections describe the process by which anomalies were identified for suggested intrusive investigation.

3.5.1 Instrument Response

Instrument response over a small target, such as a buried steel drum, produced a definable and mappable signature, or footprint, called an anomaly. The anomaly footprint differed between instruments, and depended on other factors such as a depth bgs of the target, object size, and orientation. The first step in anomaly identification was recognizing these response signatures and flagging them for further screening.

3.5.1.1 Natural Features

Natural features, such as rock and soil lithology, topography, and drainage pathways were discerned through geophysical methods, particularly FDEM. For this environmental investigation, some natural features were important to delineate since they may have identified pathways for contamination. These areas were identified as "anomalies" for suggested target sampling, so understanding the geology and hydrology of the investigation area was essential as part of the screening process.

3.5.1.2 Anthropogenic Features

Anthropogenic, or features of human origin or influence, were distinguished from natural geologic changes by taking several factors into consideration:

- First, the anomaly footprint, as defined above, was inspected. In most cases buried ferrous materials can be readily identified because the anomaly footprint will show a clearly high amplitude, usually orders of magnitude stronger, relative to the background field. For larger anomalies, such as waste burials, the instrument responses tend to transition more abruptly, defining a boundary more clearly than natural features and the interior response may have a multi-peaked, broken appearance. If ferrous metal is present, there may be many high amplitude magnetometer response peaks.
- Second, particularly for terrain conductivity, the geometry of the anomaly was inspected. Rectangular shapes might indicate burial trenches or building footprints and linear features of a characteristic signature may indicate pipelines. Understanding the site history is essential for this type of interpretation.
- Third, historical site aerial photographs were compared to the data maps and correlations were drawn between the mapped data and features such as disturbed or scarred areas identified on the photographs.
- Last, applicable data was compared to background trends caused by lateral changes in geology and geomorphology. Unusually high and abrupt lateral amplitude changes of response, particularly in terrain conductivity, which is not characteristic of the

background data, might suggest an anthropogenic origin even if no other lines of evidence exist.

3.5.2 Ground Truthing

Ground truthing is the process by which an instrument response is verified or eliminated based on field observations (such as the presence of surface metal, geologic features, or other debris) and/or anomaly reacquisition using the same or a different instrument. In cases of suspected buried metal, the anomaly location was reacquired using a GPS system, and if needed verified as buried metal with a Schonstedt magnetic locator. For example, for EM-31 terrain conductivity anomalies, careful site observation descriptors were typically used to interpret and describe the nature of the anomaly, such as low lying flat area, hummocky, drainage area, or nothing remarkable on surface.

3.5.2.1 Surface Metal and Cultural Mapping

Prior to the anomaly identification process, all surface metal and cultural interferences, such as scrap metal, fence lines, above ground pipes and tanks, manholes, and sign posts were mapped using a GPS unit with at least sub-meter accuracy. These locations as well as descriptions were incorporated into an Oasis Montaj database and overlaid on the data maps to isolate them from subsurface metal.

At times, surface metal provided a good marker as to where containers and other subsurface metal may have been disposed. The data in these areas was carefully reviewed for evidence of subsurface metal in addition to the observed surface metal and some areas were scanned with a magnetic locator for field verification.

3.5.2.2 Anomaly Verification

The above mentioned processes were used to verify and interpret defined anomalies. Once an anomaly was verified, its boundaries, type, and location were defined using symbols and filled polygons as discussed in Section 4.0. These were digitized by the HGL geographic information system staff, and then assigned numbers for final presentation. The digitized maps were presented for stakeholder concurrence.

4.0 INVESTIGATION RESULTS

Investigation results are presented in the following subsections. Please refer to the geophysical data maps and anomaly identification maps presented in Figures 2 through 12 while reading this section. Raw data is provided in Appendix B as an electronic copy.

The data are presented in color fill isopleth maps presented as Map Groups 2 through 11. Subfigures denoted a through d within each Map Group show different datasets as varying color fill schemes. An explanation of the meaning of these color fill schemes is summarized below.

- **a Subfigures** show the terrain conductivity data (Figures 2a - 11a) with a color scheme ranging from dark blues for lower terrain conductivities (approximately less than 10 mS/m) to reds (approximately greater than 60 mS/m), with the color scheme varying between the EM-31 standard, used in Subareas 5C, 5B, and 5A, and the EM-31 short, used in parts of Subarea 5A, and in Subareas 5D-North, 6, 7, 8, 5D-South, and the NBZ. In general, lower conductivity values (blues) represent areas of shallow or at the surface bedrock or looser, porous fill material, medium values (green to yellow) represent thicker, naturally occurring soils, and higher terrain conductivity values (shades of deep yellow and orange), are areas of very thick soils, fill areas of dense silts and clays, and drainage pathways. Abrupt changes, often of high amplitude peaks ($>$100 mS/m) either in the positive or negative range, represent areas of buried metal.
- **b Subfigures** show the corrected total field magnetometer data (Figures 2b – 11b) with a color scheme similar in appearance to the EM-31 data, but the magnetometer data is dipolar, and hence produces complex anomalies, with multiple low (blue color) and high (yellow to red) alternating peaks over areas of buried metal. Broad areas of more subtle color changes were caused by geologic and soil features, but could also indicate a contrast in fill material, so were used in interpretation.
- **c Subfigures** show the analytic signal data (Figures 2c – 11c) greatly simplifying the buried ferrous metal interpretation by mathematically converting the bipolar peaks of the corrected total field data into a single peak. The analytic signal conversion essentially flattens background readings (represented in uniform shades of green), and highlights buried metal areas (represented in shades of deep yellow to red), making the interpretation self explanatory.
- **d Subfigures** show the GPR data (Figures 2d – 11d), collected over isolated grids in areas of special interest, is presented as "depth slices." A depth slice represents a plan view of reflected radar energy patterns of subsurface materials at a specific depth range. No or little reflected radar energy (essentially "background") is represented in blue. Reflected radar energy of increasing intensity is represented in yellow to red in the approximate shape of the subsurface object. The depth slices shown are approximately in the range of 1 to 3 feet bgs. Also used in the interpretation were GPR cross sections representing one line of data from the surface to approximately 3 feet bgs. An example over a waste burial area (anomaly 7 A20) in Subarea 7 is shown as Figure 7d.

Map Group 12 (Figures 12a through 12j) are the anomaly maps as interpreted from the color fill isopleth data. EM-31 anomalies are presented in red coloring, CVM anomalies are presented in blue coloring, and GPR anomalies are presented in green coloring. Larger anomalies representing burial areas, disturbed areas, larger metallic objects such as USTs, leach fields and important natural features such as drainage pathways and basins are presented as hachure-filled polygons with "A" preceding the anomaly number. Boundaries of fill areas, or any extended area with many event-related anomalies are presented as unfilled polygons with dashed borders with an "A" preceding the anomaly number. Point-source anomalies (representing a single buried small target or clusters of targets) are presented as bold open circulars with "P" preceding the anomaly number. Linear anomalies representing unmapped utilities and other lengthy targets such as buried building girders, footings, and narrow drainage pathways are presented as dashed lines with "L" preceding the anomaly number. (Note: not every point-source anomaly is discussed in the text, but they are listed in the tables of Appendix A. Most are likely inconsequential scrap metal or, as ground truthing has suggested, magnetite concrete debris used commonly in the walls of some of the buildings for shielding. They are significant in some areas as they provide good markers to estimate excavation and fill boundaries.)

Summary tables of the anomalies discussed in the following subsections are provided in Appendix A.

Due the large number of TOI in each subarea a unique naming convention was implemented to subdivide the subareas into smaller groupings of geophysical anomalies for ease of presentation and explanation. Generally these groupings were associated with former buildings or historical activities.

4.1 SUBAREA 5C

The anomalies identified in Subarea 5C are described below. The anomalies were divided into the following areas and are designated A through H respectively on Anomaly Map Figure 12a:

A) Building 4015 Fill Area,
B) Site 4538 Area,
C) Building 4066 Area,
D) Building 4059 Area,
E) Building 4626 Area,
F) Building 4100 Open Storage/Fill Area,
G) Sodium Pump Test Facility Area, and
H) Northeast of 4015 Fill Area.

AREA A: BUILDING 4015 FILL AREA

Area A is located east of 22nd Street between G Street and J Street, a graded area of shallow bedrock and fill material. This area consists of Building 4015 and Fill Area 10 which was

built on top of a former parking lot. There were no massive ferrous metal burials identified within Area A.

- Minor and scattered buried metal were identified with various point source anomalies (5C P1-P24). Note that the anomaly identified as P25 is actually the seeded area used as a blind field test.
- The seeded area used for QA/QC anomaly reacquisition was identified by all three instruments as anomaly 5C P25.
- A rough approximation of Fill Area 10 (5C A1) boundaries was delineated by the distribution of scattered subsurface ferrous materials as compared to historical information.
- There is a small burial area (5C A4, A9) mapped by EM-31 and CVM responses. Ground truthing showed a partially buried cable at the EM-31 anomaly (5C A9) but other sources are likely at the CVM anomaly (5C A4) location.
- The EM-31 anomaly of high terrain conductivity (5C A15) was interpreted as a general trend of terrain conductivity between the fill material to the east and soils to the west. There are also cultural interferences from surface metal, so the anomaly is not well defined.

AREA B: SITE 4538 AREA

Area B is located at the intersection of 20th and G Street, a flat vegetated area, formerly a parking lot. There were no massive ferrous metal burials identified in this area. CVM responses were largely due to subsurface utilities.

- The west side of this area showed a high terrain conductivity trend interpreted to map compacted fill and soil where building pads were constructed. There were lower terrain conductivity responses on the east side suggesting native soil.
- There were small and large EM-31 anomalies (5C A6, A10) of high terrain conductivity identified at the Building 4487 footprint likely due to moisture retention. These could be caused by seepage from abandoned service lines.
- The GPR data was interpreted to map the footings of Building 4487 as shown by the green dashed U-shaped linear anomalies (5C L19).
- Linear CVM and EM-31 anomalies map unmarked service lines to former buildings.

AREA C: BUILDING 4066 AREA

Area C is located at the intersection of 20th and F Street, a flat graded area formerly Building 4066 laboratory and support buildings. There were no massive ferrous metal burials identified in this area. CVM responses are largely due to subsurface utilities, mapped and unmapped.

- Linear EM-31 (5C L1, L2, L16-L18) and CVM anomalies (5C L11, L12,) in this area identified unmapped service lines to former buildings in this area.

AREA D: BUILDING 4059 AREA

Area D is located at the end of 20th Street, in a flat, graded open field. This area represents excavation activities associated with the Building 4059 and Building 4459 demolition, and a large excavated area identified from aerial photographs.

- A rough approximation of the fill area boundaries (5C A12) was delineated by the distribution of scattered subsurface ferrous materials (5C P37-P48). This interpretation was consistent with historical information.
- The boundaries of the building footprints and fill area (5C A11) were approximated by the EM-31 terrain conductivity responses nominally above background (Figure 2a). This was not originally defined as an anomaly, because the bulk of the fill material interpreted to be important for sampling was defined by the CVM responses.

AREA E: BUILDING 4626 AREA

Area E is located near east of 20th Street north of F Street, in a flat graded area with various existing buildings surrounding the area. There were no massive ferrous metal burials interpreted in this area. CVM responses were largely due to subsurface utilities and vertical piping.

- The linear EM-31 and CVM anomalies (5C L13-L15) were interpreted as unmapped service lines to former buildings in this area.

AREA F: BUILDING 4100 OPEN STORAGE/FILL AREA

Area F is located east of 24th Street. Site observations indicated that the area is a flat graded area of shallow bedrock, bedrock outcropping, and fill material. There were no massive ferrous metal burials identified in this area.

- A rough approximation of fill area (5C A3) boundaries was delineated by the distribution of scattered subsurface ferrous materials (5C P26-P36) that corresponds to historical information.
- To the east of 24th Street were two circular shaped EM-31 anomalies (P A7, A8) of lower terrain conductivity (Figure 2d). These were interpreted as the footprints of a remediation area. GPR profiling confirmed that there were excavation and filling activities in this area.

AREA G: SODIUM PUMP TEST FACILITY AREA

Area G is located between 22nd and 24th Street north of G Street. Only three small areas were surveyed around the standing building as shown on Figure 12a with all three technologies. The CVM data and EM-31 data indicated only mapped utilities due to a high degree of surface metal interferences.

- The GPR data resolved some unmapped service lines and piping structures as shown by the GPR linear anomalies (5C L20, L21, L23), and a larger metallic object that straddles the side of the building (5C A14), apparently a part of the piping system.
- The GPR data apparently resolved a footprint of an old road between 22nd Street and 24rd Street possibly "23rd Street" as shown by subtle north-south trending linear features (5C L24, L25). The edges are shown by dashed green lines.
- The GPR data and CVM data resolved an apparent ferrous object (5C A5, A13). The GPR data did not confirm it to be a UST, but the anomaly is a near surface feature that may indicate excavation to uncover or place this object. There were also a number of uninterpreted point source ferrous objects under the asphalt (5C P51-P53) resolved.

AREA H: NORTHEAST OF 4015 FILL AREA

Area H is a small area located south of the intersection of 20th and G Street, in an open field adjacent to an intermittent stream and a lined channel. The area was surveyed due to evidence of ground scarring.

- The CVM data identified an elongated mounded feature of multiple target, buried ferrous metal (5C A2). This interpretation was supported by ground truthing.

4.2 SUBAREA 5B

The anomalies identified in Subarea 5B are described below. The anomalies were divided into the following areas and are designated A through E respectively on Anomaly Map Figure 12b:

A) Building 4013 Area,
B) Building 4025 Area,
C) Building 4356 Processing Area 1,
D) Building 4011 Area, and
E) South Fill Area 11

AREA A: BUILDING 4013 (SNAP) AREA

Area A is located at the north end of Subarea 5B, in a flat graded area situated at the top of a 40-foot drop into rugged terrain. The area consists of a demolition and excavation area.

- The large oblong EM-31 anomaly (5B A6) of high terrain conductivity correlated to a materials stockpile suggesting compacted material remnants.
- A massive linear anomaly (5B L14) was interpreted as a large pipe segment or steel structure.
- The CVM anomalies (5B A13-A15) and EM-31 anomaly (5B A1) may have identified a septic/leach field area but the exact location is unknown.

AREA B: BUILDING 4025 SMALL COMPONENT TEST LOOP BUILDING AREA

Area B is located at the northeast end of Subarea 5B, in a flat raised area. There were no burial areas defined in this area.

- Linear anomalies (5B L15-L18, L24) were interpreted as unmapped piping/utilities.

AREA C: BUILDING 4356 PROCESSING AREA 1

Area C is a broad flat area located to the west of 17th Street. It is a graded area of backfill, demolition debris, and abandoned service lines.

- The EM-31 and CVM anomalies (5B A7, A9) were interpreted as demolition backfill of Building 4356.
- Linear anomalies (5B L2-L13, L25-L28) delineated unmapped utilities and storm drains.
- EM-31, and CVM, anomalies (5B A3, A4) were interpreted as massive demolition debris and buried metal in the Buildings 4334 and 4335 areas. This interpretation was further evidenced by GPR data.
- The EM-31 and CVM anomalies located a massive ferrous metal object (5D A19, A20, P3) near former Building 4226. This object could be a small UST, but there is no conclusive evidence.
- EM-31 anomaly (5D A17) likely delineated the remnants of the former leach field.

AREA D: BUILDING 4011 AREA

Area D is bordered by G Street to the southeast. It is a flat area with standing buildings and drainage that flows to the southwest of Building 4011.

- EM-31 and CVM anomalies (5B A11, A12) showed lateral contrasts in soil properties just south of the former spill area, suggesting a contaminant pathway.
- Northeast of Building 4011, in a culturally noisy area, a point-source anomaly was identified (5B P6) with nothing significant discerned.

AREA E: SOUTH FILL AREA 11

Area E is the location of the former south Fill Area 11 southeast of G Street. It is relatively flat to the south west, and somewhat hummocky, rocky, and wooded to the northeast. There were no former buildings in this area.

- The fill area remnants were delineated both from CVM data and EM-31 data (5B A5, A10, A16). There is substantial buried ferrous materials indicated by anomalies (5B A5, A10), and scattered point-source anomalies (5B P1, P2, P5, P7, P9) of ferrous materials.
- The EM-31 and CVM anomalies (5B A8, A24) suggested a possible leach field, or drainage accumulation area.

- The EM-31 anomalies (5B A21, A22) were interpreted as the light-toned mounded material remnants as seen in historical photographs. Ground truthing confirmed small mounds of sandy material.
- The linear anomalies (5B L19-L23) delineated unmapped or mis-mapped utilities.

4.3 SUBAREA 5A

The anomalies identified in Subarea 5A are described below. The anomalies were divided into the following areas and are designated A through H respectively on Anomaly Map Figure 12c:

A) Coal Storage Area,
B) Debris Field Area,
C) Building 4049 Area,
D) 4536 Parking Lot Area,
E) Building 4029 Area,
F) SNAP Environmental Test Facility Area,
G) Leach Field Area, and
H) Building 4641 and 4064 Storage Areas.

AREA A: COAL STORAGE AREA

Area A is a small, flat triangular patch on the corner of G and 17th Streets. It is the site of a former coal storage facility.

- The southeast linear anomalies (5A L1, L2) defined footings of an old coal bin.
- The northwest linear anomaly (5A L3) appeared to be an unmapped utility line.
- The EM-31 anomaly (5A A32) was interpreted to indicate excavation and backfilling from the demolition process.

AREA B: DEBRIS FIELD AREA

Area B is just to the southeast of Area A across G Street. It is a hummocky and rocky area to the east, with obvious signs of ground disturbances.

- This was a debris area. The boundaries were approximately defined by anomalies (5A A19-A21, 5A A24-A28) and (5A A39-A44).
- The EM-31 anomaly (5A A20) suggested excavation activities.
- Ground truthing suggested that materials were covered with soil rather than buried in a trench.

AREA C: BUILDING 4049 AREA

Area C is a flat, paved area at the southeast corner of G and 17th Streets. It consists of remnants of old concrete structures and process remnants with no evidence of massive burials.

- Linear anomalies (5A L7, L8) delineated the likely location of drain lines that connected two removed radioactive materials storage tanks. The GPR anomaly (5A A13) identified to the west of the "drain lines" might be related to this system.
- Linear anomalies (5A L9, L10) delineated the possible location of drain lines from trenches which could not be identified from historical search.

AREA D: 4536 PARKING LOT AREA

Area D is an elevated flat area located on the corner of 12th and G Streets. It was a former parking lot and open storage area with no major buildings. No major burial areas were identified.

- The EM-31 anomalies to the north (5A 23, 29, 30) suggested disturbed areas (possibly backfilled) with no direct evidence of buried materials.
- The EM-31 anomaly to the south (5A A22) appeared to be a natural feature, but correlated with a light colored feature from historical photos. There was no direct evidence of buried material. The GPR anomaly directly to the north (5A-A10), was interpreted as compacted soil due to excavation activities.
- Point source anomalies (5A P1-P9) identified small amounts of buried ferrous material scattered throughout this area.
- A more substantial CVM anomaly (5A A33) was indentified in this area. Its footprint suggests it may be magnetite concrete debris.

AREA E: BUILDING 4029 AREA

Area E is a gently sloping, somewhat rocky and woody area, with no former buildings, just to the southwest of current Building 4029. There were no burial areas defined in this area.

- The EM-31 anomaly (5A A31) of high terrain conductivity correlated with a dark spot in historical photos and what appeared to be ponded water.

AREA F: SNAP ENVIRONMENTAL TEST FACILITY AREA

Area F is a mostly paved area to the west in the vicinity of standing buildings and structures. It is mostly open fields of varying topography to the east at the location of former buildings. There were no burial areas defined in this area.

- Several linear anomalies (5A L18-L20) delineated unmapped utility pipes.
- The linear anomaly (5A L21) delineated a utility pipe near Buildings 4027 and 4625. All utilities were supposed to have been removed during demolition according to historical documents (HGL, 2011e).
- Linear anomaly (5A L22) possibly delineated the 3-inch cast iron drain line near Building 4023 that ran through the vault and was part of the liquid waste hold up system.

- GPR anomaly (5A A11) was interpreted as process related, and is significant because it straddles the former location of the waste hold-up tanks just to the north. The smaller portion of the anomaly at the west end correlates to a valve pit from schematic drawings, and the wider portion at the east end may be a concrete slab remaining from the removal of the tanks. The linear feature was interpreted as a section of pipe that may be process related. These features may also be related to the storm drainage system.
- GPR anomaly (5A A12) correlated with what appears to be a concrete slab in schematic drawings.

AREA G: LEACH FIELD AREA

Area G was surveyed at a special request and lies outside the AOI. It was the location of a former septic and leach field system.

- The EM-31 data identified the apparent targeted leach field (5A A1) and what is interpreted as terra cotta lines (5A L28, L29) that are broken up towards the northeast (5A L30-L33). To the northeast of anomaly (5A A1) are some likely insignificant terrain conductivity anomalies. Anomalies (5A 5, 5A 8 and 5A 9) are likely responses from a utility line in the area, and the others are likely changes in soil density due to fill and compaction (5A A2-A7).

AREA H: BUILDING 4641 AND 4046 STORAGE AREAS

Area H is of varying topography and rocky and wooded in areas, located to the northwest of G Street. It is the site of former buildings used for storage and shows evidence of massive ferrous metal burials.

- The L-shaped linear anomaly (5A L16-L17) correlated to the west side and south side of Building 4641, which was used for shipping radioactive and non-radioactive materials and for storage. This was interpreted to be demolition remains. Building 4641 might have been used to store "mixed fission material" in 55-gallon steel drums. Some buried metal was identified by CVM anomalies in this area (5A A34-A38).
- Linear anomalies (5A L11-L15) were interpreted as remnants of utilities connecting to buildings in the area.
- The EM-31, GPR, and CVM anomalies (5A A48, L27, A45) were interpreted to delineate a massive ferrous material burial area. Ferrous material may include pipe remnants, slag materials on surface, metallic debris (probably from demolition), other buried metal as confirmed with GPR, and containers. This area was used as open storage.
- Additional buried metal areas were identified by anomalies (5A 14-18).
- The EM-31 anomalies (5A A46, A47) of high terrain conductivity to the southeast were interpreted as drainage pathways.

4.4 SUBAREA 5D-NORTH

The anomalies identified in Subarea 5D-North are described below. The anomalies were divided into the following areas and are designated A through D, respectively, on Anomaly Map Figure 12d:

A) Pond Dredge Area,
B) Rockwell International Hot Laboratory Area,
C) SNAP Critical Facility Area, and
D) Building 4353 Area.

AREA A: POND DREDGE AREA

Area A is a large, hummocky area of poor drainage. It is located just to the southeast of H Street. There is much evidence of ground disturbances and buried material in this area.

- The EM-31 and CVM anomalies (5DN A2-A5 A22-A29) located in the center of the area were interpreted to be remnants of Fill Area 14. Ground truthing showed mounded and scattered buried materials, including metal (5DN P2-P9, P35-P37). Fill Area 14 boundaries are approximated by EM-31 and CVM anomalies (5DN A14, A15) which were delineated from the distribution of instrument responses.
- The small EM-31 and CVM anomalies (5DN A1, A7, A8) identified mounded and buried materials of concentrated ferrous metal, possibly containers. This interpretation was verified with the GPR.
- The elongated EM-31 anomaly (5DN A18) was interpreted to be a disturbed area within Fill Area 14.
- The EM-31 linear anomalies (5DN L8, L9, L12) were interpreted to be important drainage pathways.
- The EM-31 linear anomaly (5DN L17) was interpreted as the remnants of a linear ground scar feature identified by historical aerial photography.
- To the east of Fill Area 14, a circular excavated debris field and fill area was identified by site inspection and geophysical data. The boundaries of this area were defined by the EM-31 anomaly (5DN A16). There were observed surface metal, demolition debris, verified buried metal (5DN A11, A9, A12) and numerous point source anomalies (5DN P17-P34) of ferrous (blue) and non-ferrous (red) materials in this area.
- To the west of the debris field (5DN A16), two isolated anomalies were identified. These were (5DN A6) containing ferrous materials, and a mounded area (5DN A32) of non-ferrous material.

AREA B: ROCKWELL INTERNATIONAL HOT LABORATORY AREA

Area B is a small, graded flat area off of G and H Streets at the former location of the Hot Laboratory. There is evidence of demolition debris, but no massive burials.

- The EM-31 anomaly (5DN A17) identified a low saturated area that correlated with Outside Storage Area 16.
- The CVM anomaly (5DN A30) identified scattered ferrous materials at the location of the Building 4020 demolition excavation. These were interpreted as magnetite/concrete debris used for radiation shielding in the walls of the building. Other point sources which may be the same material, or scrap metal included anomalies 5DN P39, P50, P56.
- Ground truthing of the smaller EM-31 anomalies (5DN A19-A21) indicated low areas of sediment and drainage accumulation.
- The linear anomalies (5DN L2-L7, L13, L18) delineated unmapped utilities and pipes.

AREA C: SNAP CRITICAL FACILITY AREA

Area C is a small, flat open field at the former location of the SNAP critical facility to the south of G Street. No burial areas were identified.

- The point-source magnetometer anomalies (5DN P51) and linear EM-31 and CVM anomalies (5DN L19-L22) likely delineated unmapped utilities. Additional point source anomalies (5DN P54, P55, P57) were uninterpreted ferrous materials.

AREA D: BUILDING 4353 AREA

Area D is of somewhat varying topography that slopes to the southeast. It is located to the south of J Street. There is evidence of disturbed areas and buried ferrous materials in this area.

- CVM anomalies (5DN A31) identified mounded materials of buried ferrous metal.
- Point source CVM anomalies (5DN P41-P49, P52) identified scattered, buried ferrous material. These may be magnetite concrete debris or metal scrap.
- The linear U-shaped CVM anomaly (5DN L14) was interpreted as a structure remnant. This feature corresponded to an outside storage area identified from a 1959 aerial photograph.
- Ground truthing indicated that the L-shaped EM-31 anomaly (5DN A13) corresponded to a berm area used for erosion control. This area also correlates with an identified potential gamma radiation anomaly.

4.5 SUBAREA 8-NORTH

The anomalies identified in Subarea 8-North are described below. The anomalies were divided into the following areas and are designated A through E respectively on Anomaly Map Figure 12e:

A) Borrow Pit Area,

B) Empire State Atomic Development Associates, Inc. Area,

C) Former Sodium Disposal Facility Area,

D) Building 9 Area, and

E) Building 56 Landfill Area.

AREA A: BORROW PIT AREA

Area A is located south of H Street, at the base of a steep slope, in hummocky terrain. This area was used to store truckloads of light toned mounded material in the 1980's (USEPA, 2010; HGL, 2011d).

- Disturbed areas, where excavation and fill activities apparently occurred, were indicated by anomalies (8N A29, A37, A38, A39, A110,A119, A120).
- A few remnants of truck load sized mounds were still evident topographically and from geophysical anomalies (8N A39, A41, A42, A111).
- Geophysical anomalies (8N A30-A40, A112-A114, P65-P74) indicated that ferrous materials were also disposed in this area. CVM anomalies (8N A112, A113) were identified at the west side the cut and fill area (8N A110). These are near a two sigma radiation response.
- A relatively narrow linear anomaly of high terrain conductivity (8N L7) was identified along a sloped area. Since this anomaly trends in the direction of site drainage, it is likely a drainage/deposition feature.
- Another linear feature (8N L6) was identified with the CVM. This was interpreted as a pipe section.

AREA B: EMPIRE STATE ATOMIC DEVELOPMENT ASSOCIATION AREA

Area B is located south of the Arness Fire Road at the base of a steep slope. Areas of mounded soil and materials were observed.

- Mounded materials were identified topographically and by the EM-31 anomaly (8N A50).
- Unmapped utility lines are indicated by EM-31 and CVM linear anomalies (8N L8-L10).
- EM-31 anomaly (8N A51) on edge of concrete pad was identified as an apparent vent pipe to a UST. This interpretation was not verified.

AREA C: FORMER SODIUM DISPOSAL FACILITY AREA

Area C is located in the northwest corner of Area IV. The terrain varies from a gradual slope on the south side to slightly rugged with bedrock outcropping on the north side. No metal burial areas were identified in this area.

- EM-31 anomalies were interpreted to identify the footprints of impoundment areas 77, 3, and 2 (8N A114, A115, A123), Waste Disposal Area 1 (8N A116) and the light toned mounded material (8N A122) identified from historical aerial photography.

- The prominent total field CVM anomaly (8N A2) was interpreted as the location of a likely burn area identified by historical aerial photography.
- The subtle total field anomaly (8N A124) suggested the location of the dark toned material identified by historical aerial photography.
- The EM-31 anomaly (8N A129) was interpreted as fill material associated with Fill Area 1.
- The GPR anomaly (8N A128, and A130) suggested an area of subsidence in Fill Area 1 with possible associated buried metal (8N A127) but interferences from the developed outfall precludes further interpretation
- The EM-31anomaly (8N A126) identified the location of the pistol range pad.
- The linear anomalies (8N L14-L18) were interpreted as remnants of the former concrete ditch drainage system.

AREA D: BUILDING 4009 AREA

Area D is located at the terminus of G Street. Portions of the area are in a paved area surrounding Building 4009 while other portions are in slightly rugged terrain with outcropping bedrock.

- An apparent UST at the northeast side of Building 4009 was indicated by all three technologies (8N A52). This was the location of the contaminated waste holdup tank.
- The EM-31 anomaly (8N A 54) of high terrain conductivity near Building 4009 was uninterpreted.
- The EM-31 responses north of Building 4009 (8N A117) were interpreted as a known leachfield. The EM-31 anomaly (8N A55) was not interpreted, but may be associated with the leachfield and septic system.
- The EM-31 linear anomalies (8N L11, L12) were interpreted as effluent drainage from the leachfield to the north towards Fill Area 2.
- The EM-31 linear anomaly (8N L1) identified an unmapped utility line across the parking lot.
- EM-31 anomaly (8N A121) was interpreted to delineate the boundaries of Fill Area 2, and CVM anomalies (8N A17, A18) identified the location of buried metal associated with fill activities. The linear anomaly (8N L14) was interpreted as a pipe section.

AREA E: BUILDING 56 LANDFILL AREA

Area E is located in a north-south trending ravine of dense vegetation and rugged terrain near the northern border of Area IV. This landfill was a disposal area for non-radiological facilities according to historical documents. Metal and non-metal debris were observed on the surface and with geophysical equipment.

- The CVM and EM-31 anomalies (8N A3-A16, A22-A27, A 44-A49, A84) indicated areas of massive surface and subsurface ferrous metal and likely demolition debris in the landfill area and ravine.

- The small GPR anomaly (8N A1) west of well RD-74 at about 1.5 feet bgs suggested multiple sources of non-metallic debris.
- EM-31 anomalies (8N A20 and A21) were interpreted as disturbed areas with no buried ferrous metal.

4.6 SUBAREA 6

The anomalies identified in Subarea 6 are described below. The anomalies were divided into the following areas and are designated A through G, respectively, on Anomaly Map Figure 12f:

A) North of the SRE,
B) SRE,
C) Building 4003 and Laundry Buildings Area,
D) SRE Fuel Storage and Support,
E) Central Subarea 6,
F) Old Conservation Yard, and
G) New Conservation Yard.

AREA A: NORTH OF THE SODIUM REACTOR EXPERIMENT

Area A is located on the northern edge of Area IV on steep, rugged, vegetated terrain with shallow bedrock that outcrops throughout area. The area was used to support sodium reactor activities.

- The solid radioactive storage waste facility Building 4686 pad was identified using all three technologies (6 A31, A32, A34).
- EM-31 anomalies (6 A30, A33, L28) identified buried metal areas south of former Building 4653 in the former liquid waste tank area.
- There were several point-source CVM anomalies (P163-P166) identified in this area
- The CVM anomaly (6 A35) east of Tower 4703 was identified at a potential gamma radiation anomaly location. The potential gamma radiation anomaly was later determined to be a NORM and likely geologic in nature.

AREA B: SODIUM REACTOR EXPERIMENT

Area B is located at the end of E Street. The terrain on the west side is a flat graded area that is partially covered with a black tarp, on the east side the terrain is more rugged with bedrock outcrops throughout. The area consists of excavation and fill areas.

- CVM anomalies (6 A22, A26-A29, A51, A64), as well as numerous CVM point-source anomalies (see inset, Figure 12f) identified massive buried ferrous metal, presumed to be demolition debris, located both southwest of the tarp and beneath the tarp area.

- Several linear EM-31 and CVM anomalies (6 L13, L20, L21, L27, L30, L31, L39-L41) beneath the tarp suggested supply lines and possibly building girders from demolition, based on historical photographs.
- A large EM-31 anomaly of high terrain conductivity (6 A15) was identified at the Building 4143 area likely identifying an area of moisture retention where excavation could have occurred.
- Several GPR anomalies (6 A16, A17, A37, A39) were identified at shallow depths likely representing changes in soil density or compaction due to excavation activities.
- To the west of the SRE, a large elongated EM-31 anomaly and several smaller anomalies of high terrain conductivity (6 A56-A58, A63) identified a former leach field as well as septic tank excavation area (6 A55) on the southern end. Terrain conductivity peaks may represent residual leachate contamination.
- There is an elongated anomaly (6 A21) identified with the EM-31 and CVM that trends along the southeast area of the SRE that may mark the location of a cast iron sewer line. Several other linear features were identified which are interpreted as pipe scrap and abandoned service lines (6 L9-L12, L22-L25, L29)
- A CVM anomaly (6 A36) at the northeast edge of the SRE marks the location of demolition debris and in-situ footing remnants of the cooling tower.

AREA C: BUILDING 4003 AND LAUNDRY BUILDINGS AREA

Area C is located along the northeast side of E Street. The laundry buildings were located on top of a steep slope within bedrock outcrops. Building 4003 was located at the base of the slope from the laundry buildings in a flat graded area. Remnants of demolition debris and mounded materials were observed.

- An EM-31 anomaly of high terrain conductivity (6 A59) was identified in the Building 4003 area near a location called the "hot cell". Ground truthing showed a low lying area where moisture ponds during rains. This likely marks the area of demolition excavation with contrasting fill material.
- There were several linear anomalies (6 L2-L7, L14) identified by EM-31 and GPR data, locating abandoned service lines to former buildings.
- Linear anomalies (6 L8, L17) that cross in a V-shape between the cluster of former buildings in the laundry area were identified with the EM-31 and GPR, and not so clearly with the CVM.
- Many scattered point source CVM (ferrous) and EM-31 (non-ferrous) anomalies (see inset, Figure 12F) were identified throughout this area. Ground truthing of one of these anomalies (6 P2) uncovered a magnetite nodule. Magnetite was used for radiation shielding in concrete walls of some of the buildings. These anomalies are likely demolition debris consisting of concrete, magnetite nodules, and scrap metal.
- To the northeast of the former buildings in the laundry area, an elongated EM-31 anomaly of high terrain conductivity (6 A65) marked a drainage pathway and what appears to be old asphalt pavement. This area is a good candidate for a septic leach

field from the former buildings in the laundry area that has not been identified historically, but is likely to exist.

- To the east of the former buildings in the laundry area was a mounded area identified topographically. Responses from the EM-31 and GPR instruments (6 A66-A69) over this area indicate non-metallic materials of likely coarser material than the surrounding soil matrix.
- Just to the east of the mounded material area was demolition debris and partially in-situ structures remaining from Building 4783 identified by CVM and EM-31 anomalies (6 A14, A25).
- Throughout this area were located scattered point source CVM and EM-31 anomalies identifying ferrous and non-ferrous materials. A portion of these may be responses from magnetite nodules and concrete foundation materials.

AREA D: SRE FUEL STORAGE AND SUPPORT

Area D is located at the intersection of E, F and G Streets surrounding a large hill of bedrock. The terrain is a relatively flat, vegetated graded area. Past ground moving activities were visible on the surface as trenches and mounded materials.

- Several CVM, EM-31, and GPR anomalies (6 A40, A44-A50, P256-P257) clustered at the northwest end of the Building 4064 footprint were identified. These were likely caused by demolition debris. The GPR data indicated that there is approximately 1 to 2 feet of overburden over the buried materials. In addition, an elongated EM-31 anomaly of high terrain conductivity (6 A18) was identified extending to the southwest. This was interpreted to be drainage pathway.
- Anomalies (6 A41, A42, P130, P132, P258) were identified in a former open storage area and overlap an area of excavation to the east that may identify the location of a former leach field.
- There were EM-31 linear anomalies (6 L33,-L35) to the southeast and to the north of the building footprint. These were likely unmapped utilities such as supply lines.
- There were many point source CVM anomalies (6 P173-P179, P145-P149, P180, P182, P183, P185) clustered around the Building 4014 storage building footprint and east next to F Street. One of these anomalies (6 P175) was identified as a magnetite nodule commonly used for radiation shielding at the site.
- There were linear EM-31 anomalies (6 L15, L16) that abutted the Building 4014 footprint to the north. These were likely remnants from the building footings.

AREA E: CENTRAL SUBAREA 6

Area E is located between the Old Conservation Yard and the SRE Complex on the north end of Area IV. The terrain is uneven and very rugged with steep slopes, bedrock outcrops and dense vegetation. Central Subarea 6 was devoid of buildings with very few anomalies identified.

- Ground truthing of the EM-31 linear anomaly (6 L42-L43) revealed mounded materials of asphalt and concrete debris bordering to the south. The nature of these linear features was unknown, but resembled pipe signatures.
- There were a few point source CVM anomalies (6 P50, P51, P168, P169, P172, P265) of subsurface ferrous materials and some surface scrap metal was observed.

AREA F: OLD CONSERVATION YARD

Area F is located north of F Street on the eastern border of Area IV in relatively flat, graded terrain. The Old Conservation Yard is bordered with bedrock outcrops on the east and steep slopes to the north with open fields on the west. The Old Conservation Yard was used for open storage of salvageable material from 1955 to 1977.

- The most striking feature was a fan shaped EM-31 anomaly of high terrain conductivity (6 A60, A61) that extends to the south to E Street. This was identified on the anomaly map as an unfilled polygon with dashed boundaries that is split in the middle by a linear feature. Historical aerial photographs show a paved area with the same shape. The EM-31 responses are apparently from compacted soil and padding material used for construction.
- Within the northeastern portion of the above mentioned anomaly two EM-31 anomalies were identified. The smaller anomaly (6 A52) to the west corresponds to an identified chemical contamination area (ICCA) known as "Central Transformer" (USEPA, 2010; HGL 2011b). The nature of the eastern, larger anomaly (6 A53) is unknown.
- The linear EM-31 anomaly (6 L45-L47) that divided the former paved area discussed above is an abandoned steel pipeline that is exposed at the surface at a few locations to the south, and branches out toward E Street.
- There were small GPR anomalies (6 A1-A7) scattered about this area. Most of these were likely biologically disturbed zones and not buried materials.
- Several anomalies were identified near the footprints of ASTs 4732 and 4731. Remnants of the berm surrounding Tank 4732 were evident from a U-shaped high terrain conductivity anomaly (6 A20) as well as fill material from the tanks demolition (6 A19). To the north of the tanks were two elongated EM-31 anomalies that suggest excavation (6 A24) and stockpiling (6 A23) of materials, as evidenced by ground truthing observations.
- Two GPR anomalies (6 A8, A9) were identified in the vicinity of the ASTs. These anomalies were interpreted to be caused by changes in soil density due to excavation and backfilling.
- A cluster of point-source CVM anomalies (P156-P162, P144) suggesting a burial area was identified at the location of an ICCA known as the "Northern Bench Area" (HGL, 2011b).
- Scattered point-source anomalies (6 P154, P236-P241) of buried ferrous materials were identified in a field just to the east of the Area IV access road that leads from Building 204.

- The linear EM-31 anomaly (6 L32) crossing the road was interpreted to be a culvert or section of pipe.

AREA G: NEW CONSERVATION YARD

Area G is a small area south of F Street near an intermittent stream in a graded area that is relatively flat to the north and west and slightly sloping to the south and east. The New Conservation Yard was used for open storage of salvageable material including used equipment and drums after the old salvage yard ceased operations.

- The most significant anomaly was (6 A71) at the southern portion of the fenced in area. This EM-31 anomaly suggested a change in subsurface materials and correlated to an ICCA known as "New Conservation Yard South" (USEPA, 2010; HGL 2011b). It should be noted that this area was difficult to define because of interferences from surface metal, especially the existing fence.
- A strong irregular polygon shaped EM-31 anomaly (6 A70) at the center of the surveyed area suggested a reinforced concrete structure, such as footings from a small building. This structure was also partially in the ICCA.
- The linear anomalies (6 L48-L51) were interpreted as unmapped utility or service lines.
- There were a few point-source anomalies (6 P41-P49, P291-P295) identifying isolated buried ferrous materials.

4.7 SUBAREA 7

The anomalies identified in Subarea 7 are described below. The anomalies were divided into the following areas and are designated A through C respectively on Anomaly Map Figure 12g:

A) Building 4028 Area,
B) Radioactive Material Handling Facility Leach Field Area, and
C) Building 4133 Area.

AREA A: BUILDING 4028 AREA

Area A is located at the base of a steep slope near the northern border of Area IV. On the north side of the steep slope the terrain is uneven and highly vegetated with large piles of blasted bedrock. This area included anomalies northwest and in the immediate vicinity of Building 4028.

- A number of point-source CVM anomalies (7 P15-P19, P21-P25) were identified representing ferrous materials in the southwest portion of this area.
- There are three EM-31 anomalies that corresponded to a disturbed ground area identified by historical aerial photography. Anomaly (7 A4) was identified as piles of blasted out boulders. It was unremarkable otherwise. Anomaly (7 A3) was identified as mounded material and an apparent disturbed area next to a well. Anomalies (7 A1, A2, A8) were identified as an apparent cut and fill area.

- The elongated EM-31 anomaly (7 A9) corresponded to a grading slope to the north of Building 4012. It appeared to be a scattered debris field of general trash, apparently used for dumping solid waste.
- An EM-31 anomaly (7 A5) was identified just northeast of the retention pond (Building 4014). It corresponded to blast rock material and fill.

AREA B: RADIOACTIVE MATERIAL HANDLING FACILITY LEACH FIELD AREA

Area B is located north of the RMHF in an east west trending ravine. Area B is bounded on the north, south and east by steep slopes littered with blasted bedrock and various metallic and non-metallic debris and on the west by Outfall 3.

- An elongated EM-31 anomaly (7 A7) defined a wide drainage area to Outfall 3.
- EM-31 linear anomalies (7 L3-L8) were identified that mapped significant drainage pathways.
- The elongated EM-31 anomaly (7 A6) north of the RMHF caused by responses from fill material delineated the former leach field of Building 21. It was also the location of a 10 foot thick remediation cap covering residual radiological contamination of bedrock left from the leach field removal activities.(HGL, 2011a).
- Several point source CVM anomalies were identified (7 P35-P42). Some of these may be geologic in nature, particularly on the rocky slope north of the drainage identified as 7 L3.

AREA C: BUILDING 4133 AREA

Area C is located at the top of steep debris slopes east of the SRE complex. The terrain is stepped with relatively flat graded areas. This area included locations north and south of the Interim Storage Facility (Building 4654), and in the vicinity of Building 4133.

- There were two debris fields and burials identified by the EM-31 and CVM anomalies (7 A16-A19) Ground truthing by site observation and the Schonstedt magnetic locator showed metal and concrete scrap as well as buried and partially buried ferrous materials. There was also scattered buried metal and other ferrous material identified by point source anomalies (7 P33-P34).
- There were GPR anomalies (A10-A15) and a CVM anomaly (7 P3) at the location of the Interim Storage Facility interpreted to show remnants and debris of interim waste storage facility, and storage pad excavation. Linear anomalies (L1, L11) and point source anomaly (7 P1) identified unmapped utility/pipe lines in this area.
- An anomaly was identified with both GPR and CVM data (7 A20) immediately north of Building 4133. GPR data showed this to be a burial area measuring approximately 5 feet by 10 feet of concentrated ferrous material. Surface debris suggested it was largely magnetite concrete rubble but this does not rule out the possibility of buried containers. A GPR cross section of this area is shown as Figure 8e.

4.8 SUBAREA 5D-SOUTH

The anomalies identified in Subarea 5D-South are described below. The interpretation results are presented on Anomaly Map Figure 12h.

Subarea 5D-South encompasses the area known as the Area IV borrow pit. The southern portion of this area is relatively flat and poorly drained. The northern portion slopes moderately to the south. The geophysical data revealed no major burial area, only one point source anomaly of ferrous metal.

- The most striking feature was an EM-31 anomaly of high terrain conductivity (5DS A1) at the central portion of the surveyed area. This anomaly was interpreted to be an area of subsidence resulting from borrow activities where water tends to pond and sediment is accumulating from drainage.
- On a sloped area to the northwest an EM-31 anomaly (5DS A3, A4) was identified. It was interpreted to be a disturbed area where soil had been moved and backfilled.
- An oblong EM-31 anomaly (5DS A2) was identified to the west of the drainage basin. This anomaly corresponds to the remains of an open trench.
- To the northeast of the drainage basin linear EM-31 anomaly was identified (5DS L1). This is interpreted to represent a drainage pathway.

4.9 SUBAREA 3

The anomalies identified in Subarea 3 are described below. The interpretation results are presented on Anomaly Map Figure 12i.

Subarea 3 encompasses a small field sloping to the south just south of the Southern California Edison Substation. Field observations indicated two debris fields divided by a gully. These are designated DF-A and DF-B.

- All three technologies were useful in mapping the debris fields, and are shown as anomalies (3 A1-A3, A7) with point-source anomalies (3 P1-P33) of buried ferrous material indicated scattered around the area.
- Ground truthing using the Schonstedt magnetic locator and GPR indicated subsurface metal both at the DF-A and DF-B, and at the small CVM anomalies to the east of DF-B (3 A4, A6, A8, A10). The GPR anomaly (3 A5) is likely compacted soil/fill from former excavation activities during the debris disposal.
- Linear anomalies (3 L1. L3) likely identified pipe or demolition scrap.
- The EM-31 responses, particularly in DF-B (3 A7) suggested the boundaries of past excavations.
- A crushed empty 55-gallon drum was observed on the surface, suggesting the area may include buried containers.
- An EM-31 linear anomaly (3 L4) was identified at the southwest portion of the surveyed area and appears to be a segment of an unmapped utility line or culvert.

- Two small point source EM-31 anomalies (3 P24, P25) were identified at the south portion of the area. These corresponded to what appeared to be mounded material.
- EM-31 anomaly (3 A11) identified just south of DF-A was near the vicinity of an ICCA designated "Southeast Transformer."
- DF-A defined an ICCA designated the Eastern Debris Area. It extends into Subarea 6.

4.10 NORTHERN BUFFER ZONE

The anomalies identified in the NBZ are described below. The NBZ is divided into two areas, the NBZ-NW southwest of the SRE, and NBZ-NE northeast of the SRE. The interpretation results are presented on Anomaly Map Figure 12j.

4.10.1 Northern Buffer Zone-Northwest

AREA A: WELLS AREA

Area A is located just north of Subarea 8-North along fire roads. The terrain is fairly flat with some gradual slopes with dense vegetation. The geophysical data revealed no major ferrous metal burial areas.

- Only point source and small anomalies (NBZ NW P1-P8) were identified indicating buried ferrous materials, but likely no containers.

AREA B: AD HOC AREA

Area B area is located at the northern extreme of NBZ-NW bordering Subarea 7. The AD HOC AREA is in a moderate-sized field surrounded by bedrock outcrops.

- This area is a moderate sized field with scattered and sometimes dense CVM anomalies identified as anomaly (NBZ NW A1, A2)
- This area is interpreted to be disposal grounds for magnetite concrete debris as evidenced by several magnetite nodules found on the surface. There may be buried metal associated with this disposal as well.

4.10.2 Northern Buffer Zone-Northeast

AREA C: NORTHERN STORAGE PCB AREAS 1 AND 2

Area C is located north of Subarea 3 with steeply sloping terrain to the north and flat areas at the top of the slope to the south, bordered by large bedrock outcrops to the east and west. Metallic and non-metallic debris was observed on the surface.

- Substantial buried ferrous materials and debris fields were indicated by broad CVM anomalies and EM-31 anomalies (NBZ NE A1, A2, A6).
- Various point source anomalies (NBZ NE P1-P10) were scattered about the area.
- CVM and EM-31 anomalies at the debris fields on the western section of area indicated surface and buried material (NBZ NE A7-A11, P12-P13). Empty 55-gallon drums were observed.

- An EM-31 anomaly of high terrain conductivity (NBZ NE A12) at the southwestern end of this area is interpreted to be a drainage pathway from the debris fields.

AREA D: NORTH OF BUILDING 203 COMPLEX

Area D is located north of Area II at the top of steeply sloping terrain. The area is a relatively flat graded with large bedrock outcrops to the north and east and large slope to the west. No substantial burials were discovered in this area.

- Only point source and smaller CVM anomalies (NBZ NE P11, A3-A5) were scattered in portions of the area.
- Two of the CVM anomalies were light debris fields with small amounts of buried metal (NBZ NE A3, A4).

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this investigation was to use surface geophysical methods to survey defined AOI in Area IV and the NBZ as identified in the Geophysical Investigation Plan (HGL, 2010c) to identify and locate areas of potential buried materials that may contain radiological contamination referred to as TOI. This objective was met by using three different geophysical instruments to obtain high quality, reliable geophysical data, then digitally mapping the three datasets using a geo-referenced database.

The results of the geophysical investigation were used in conjunction with other data and information available for Area IV to identify targeted locations for Round 1 soil sampling. Soil sample locations were described and mapped in the Field Sampling Plan Addendum for each Subarea, and presented for stakeholder concurrence.

Based on the investigation findings, HGL recommends the following post investigation activities:

- Use the results of the geophysical survey to inform the locations of the Round 2 soil sampling and other intrusive activities.
- Expand the geophysical investigation in selected areas outside the AOIs in Area IV and the NBZ based on results from the soil investigation and radiological survey. For example, geophysical methods may be used to define the boundaries of an alleged disposal area suggested from soil borings.
- Perform an intrusive investigation in certain of the prioritized geophysical anomalies, which may include surface and subsurface sampling, and exploratory trenching. This investigation would include preparing a work plan, creating an addendum to the current site Health and Safety Plan, and soliciting subcontractor bids for exploratory trenching.
- Upon completion of other site investigations the best approach to remediation, if necessary, will be determined incorporating all lines of evidence.

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HydroGeoLogic, Inc., 2011d. Draft Technical Memorandum Subarea HSA-8, Historical Site Assessment Santa Susana Field Laboratory Site – Area IV Radiological Study Ventura County, California, prepared for United States Environmental Protection Agency. March, 2011.

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TABLES

Table 2.1
Areas of Interest Summary

Subarea	Subarea Size (acres)	Proposed AOI Coverage (acres)	EM31 Coverage (acres)	CVM Coverage (acres)	GPR Coverage (acres)
Subarea 5C	21.9	9.44	11.46	12.15	0.75
Subarea 5B	23.2	9.33	13.21	13.19	2.75
Subarea 5A	38.4	11.57	14.37	15.03	2.5
Subarea 5D-North	71.5	7.57	16.90	16.31	0.75
Subarea 8	108.8	8.07	11.54	10.67	1.5
Subarea 6	57	26.28	31.39	29.85	6.5
Subarea 7	16	10.63	12.07	10.56	0.25
Subarea 5D-South	46	4.36	5.51	5.68	0
Subarea 3	1.31	0.5	1.27	1.21	0.3
NBZ	175	13	15.53	14.86	0.1

Notes:

AOI – areas of interest
CVM – cesium vapor magnetometer
GPR – ground penetrating radar
NBZ – Northern Buffer Zone

Table 2.2
Chronological Order of Surveys by Subarea

Subarea	Survey Preparation	Data Collection	Anomaly Identification	Stake Holders Presentation
Subarea 5C	8/4/2010 to 8/12/2010	8/13/2010 to 9/15/2010	9/2/2010 to 9/20/2010	9/23/2010
Subarea 5B	8/31/2010 to 9/8/2010	9/9/2010 to 10/22/2010	9/22/2010 to 11/17/2010	11/19/2010
Subarea 5A	10/12/2010 to 10/25/2010	10/26/2010 to 1/18/2011	12/9/2010 to 1/18/2011	2/2/2011
Subarea 5D-North	12/15/2010 to 12/23/2010	1/4/2011 to 1/14/2011	1/13/2011 to 4/17/2011	4/20/2011
Subarea 8	1/18/2011 to 1/20/2011	1/20/2011 to 3/9/2011	2/7/2011 to 3/8/2011	3/16/2011
Subarea 6	2/4/2011 to 2/11/2011	2/9/2011 to 5/6/2011	3/31/2011 to 6/9/2011	6/15/2011
Subarea 7	4/7/2011 to 4/26/2011	4/7/2011 to 7/25/2011	5/26/2011 to 8/16/2011	8/17/2011
Subarea 5D-South	4/18/2011 to 5/12/2011	5/11/2011 to 5/27/2011	6/1/2011 to 7/12/2011	8/17/2011
Subarea 3	5/26/2011 to 6/13/2011	5/26/2011 to 7/20/2011	6/6/2011 to 7/28/2011	8/17/2011
Northern Buffer Zone northeast and northwest	4/25/2011 to 6/3/2011	6/8/2011 to 8/5/2011	6/14/2011 to 8/19/2011	To be determined

Table 3.1
Seeded Area Target Summary

Target Identification	Location	Buried Items	Overburden
1	Southwest	Five 1-gallon steel paint cans, two horizontal, three vertical	21 inches
2	Southeast	One 6 pound pipe buried almost vertically	11 inches
3	Northeast	A cage containing a paint can and a 10 pound weight	10 inches
4	Northwest	A 25 pound barbell weight, 11 inches in diameter.	21 inches
5	Center	Six pipe connectors	30 inches

FIGURES

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LIST OF FIGURES

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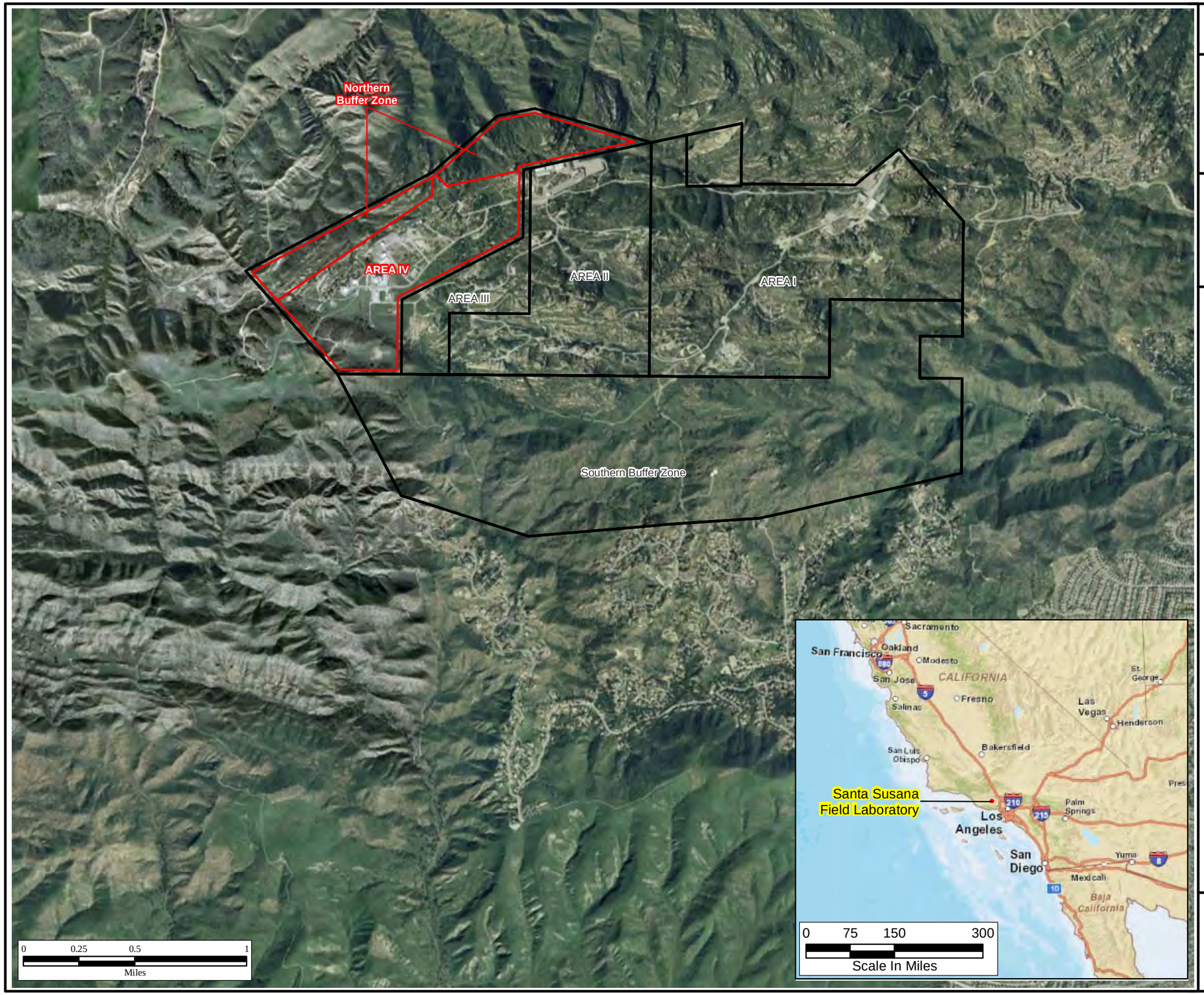
HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 1a
Site Location Map
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

EPA Study Area Boundary;
Area IV and Northern Buffer Zone

Santa Susana Field Laboratory
Property Boundary

N

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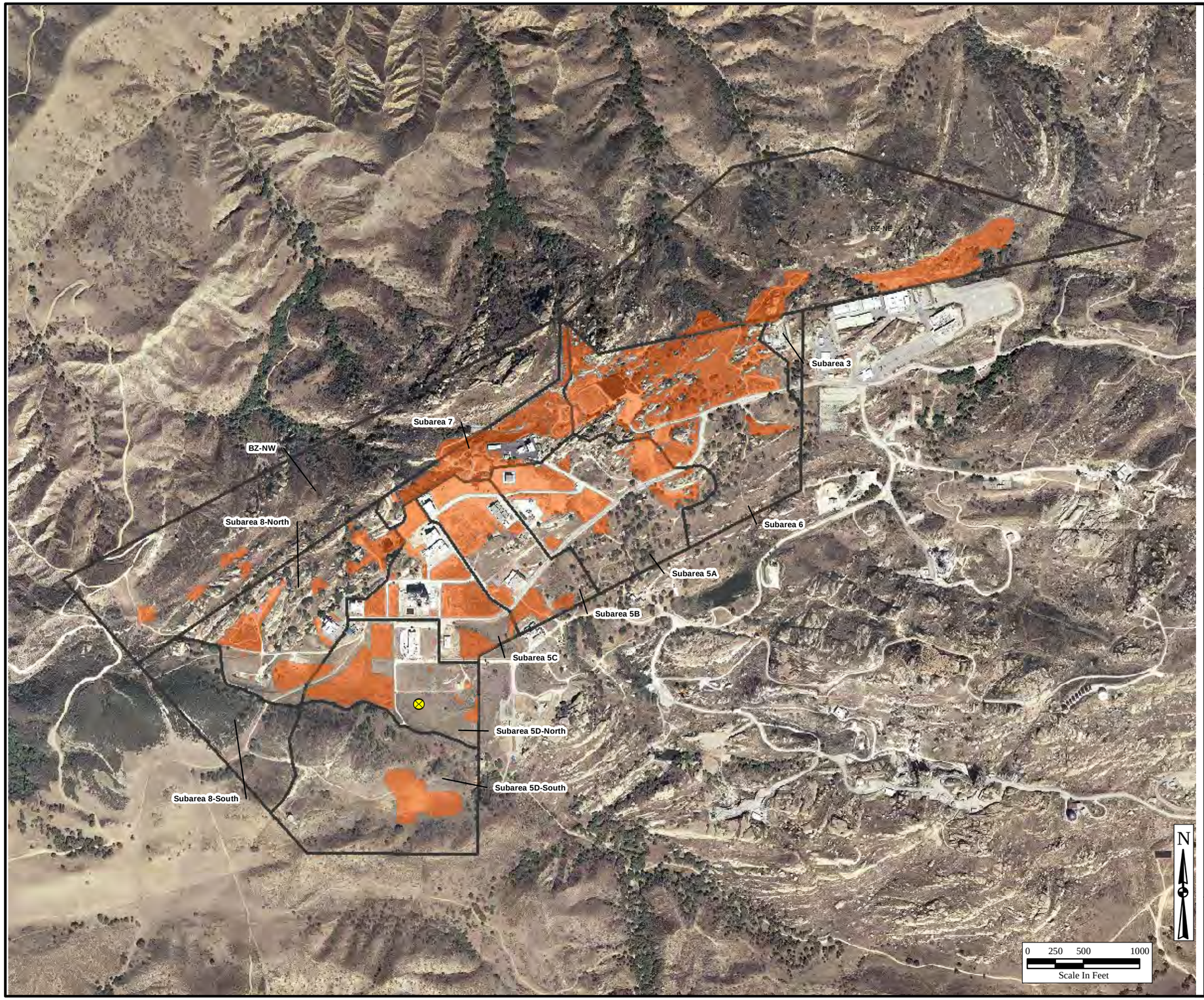
(1a)SiteMap.mxd
9/15/2011 sdrallos-kopecky
Source: CaSil, NAIP 2009; Boeing 2008

HGL HydroGeoLogic, Inc

Figure 1b
Investigation Areas
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Geophysical Investigation Areas
- Subareas
- QA/QC Evaluation Area

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(1b)InvestigationAreas.mxd
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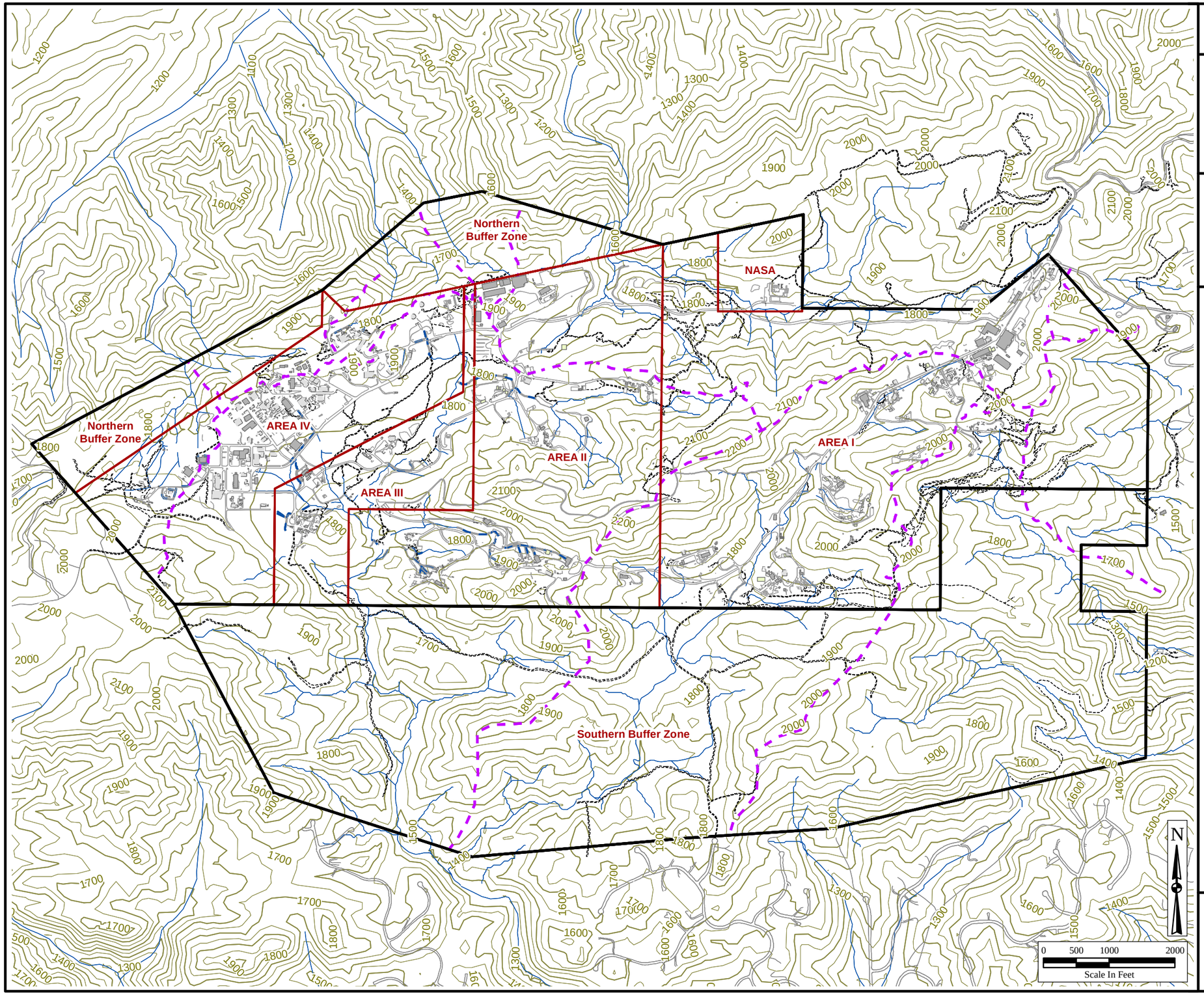
Source: HGL 2011, CIRGIS 2007, Boeing 2009

Figure 1c
Topographic Map
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Santa Susana Field Laboratory Property Boundary
- Santa Susana Field Laboratory Administrative Areas
- Drainage Divide

Buildings

- Demolished
- Existing
- Status Unknown

Hydrology

- Lined Channel
- Unlined Channel

Roads

- Off-site Roads
- Dirt Roads

Elevation Contours

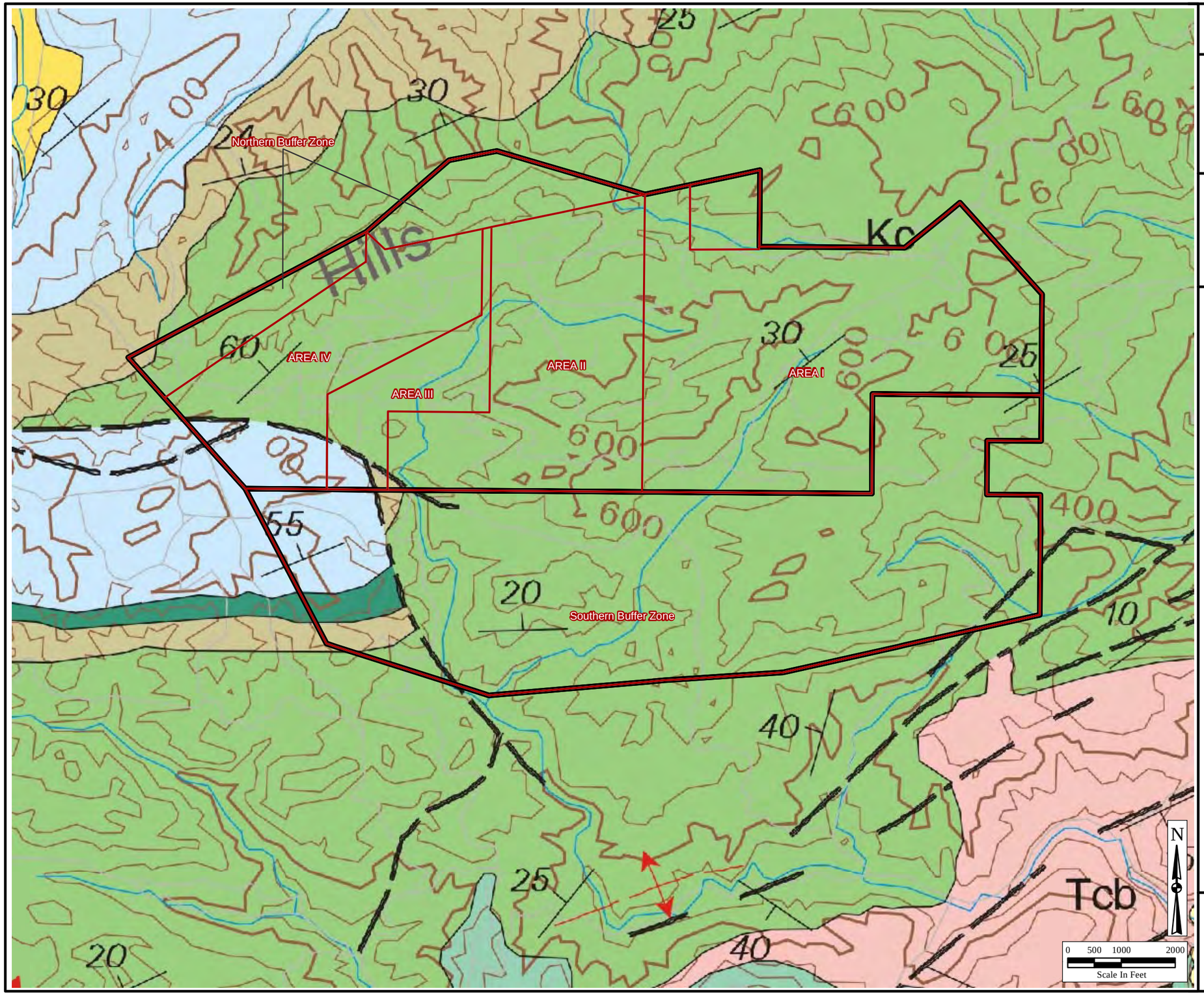
- 100' Division
- 50' Division

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review\
(1c)TopographicMap.mxd
9/15/2011 sdrallos-kopecky
Source: CDM Inc. (2008). Draft Gap Analysis Report, Submitted on June 1, 2008. Prepared for the U.S. Department of Energy

HGL HydroGeoLogic, Inc

Figure 1d
Geologic Map
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Santa Susana Field Laboratory Property Boundary
- Administrative Boundaries at the Santa Susana Field Laboratory

Geologic Formation

- Kc — Chatsworth Formation (late Cretaceous)
- Tss — Santa Susana Formation (early Eocene to late Paleocene)
- Tlv — Las Virgenes Formation (Paleocene)
- Tsi — Simi Conglomerate, Undivided (Paleocene)
- Tcb — Calabasas Formation, Undivided (early late Miocene and late middle Miocene)
- Tm — Modelo Formation Undivided (late Miocene)
- Qof — Old alluvial-fan deposits, Undivided (late to middle Pleistocene)

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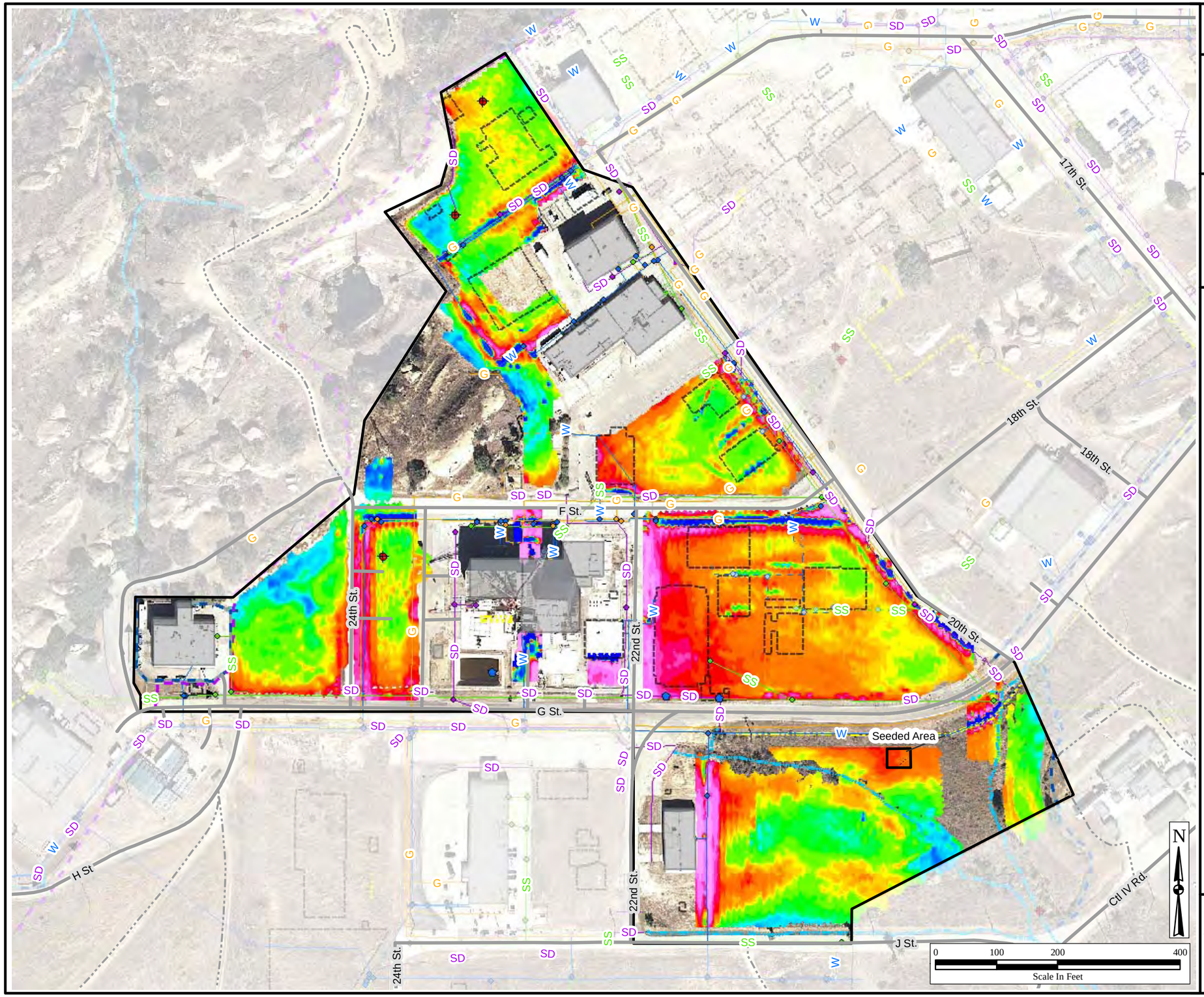
(1d)GeologicMap.mxd
9/15/2011 sdrallos-kopecky
Source: Preliminary Geologic Map of the Los Angeles 30´ x 60´ Quadrangle, Southern California; Yerkes and Campbell; 2005
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 2a
Terrain Conductivity
Subarea 5C
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

-37.0 8.5 10.8 13.5 15.7 18.1 22.3 29.2 41.3 78.1

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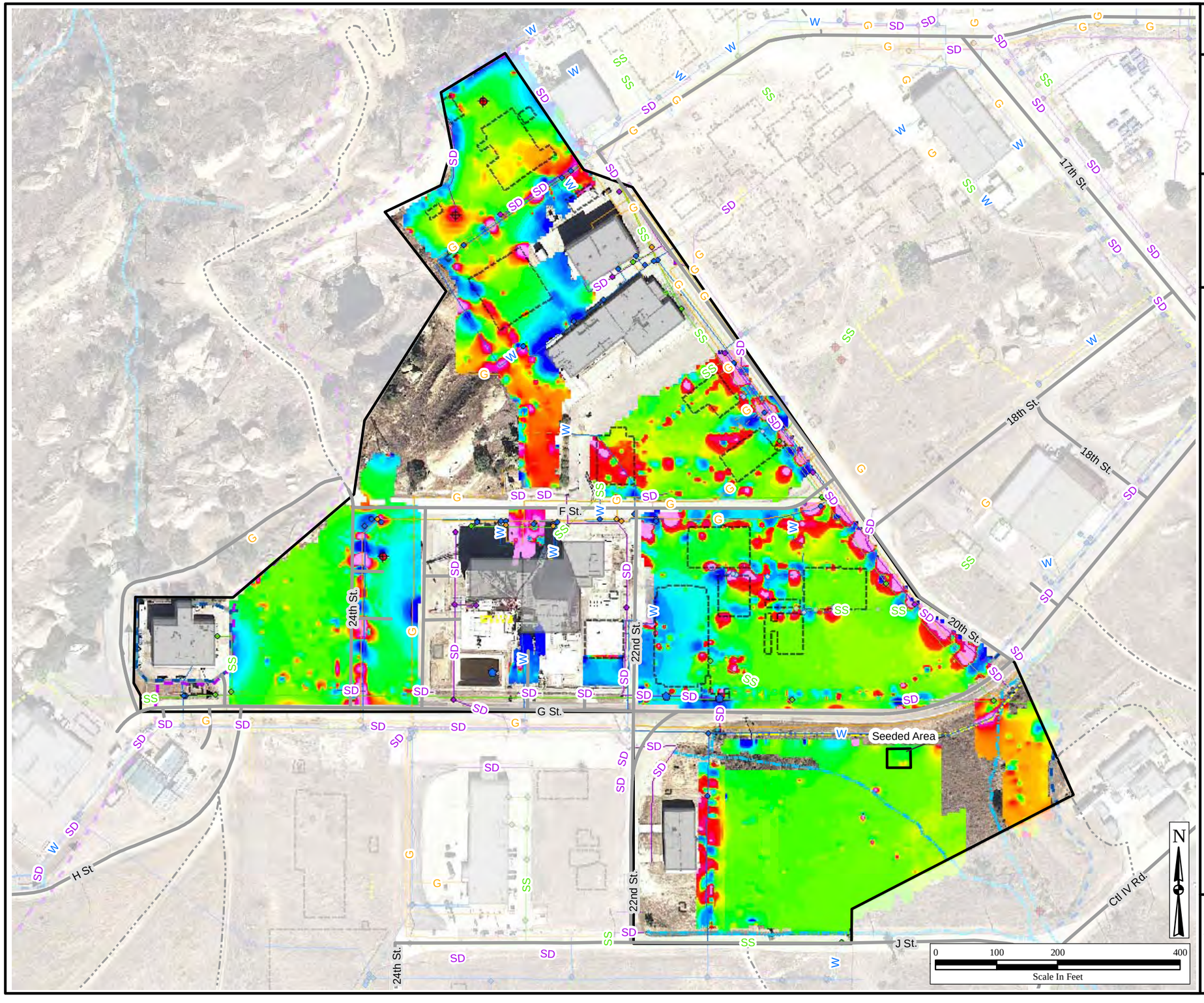
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 2b
Corrected Total Field Data
Subarea 5C
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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- Gutter
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- Tank
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- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 2c
Total Field Analytic Signal
Subarea 5C
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
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- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

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(2c)TotalFieldAnalyticSignal_5C.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

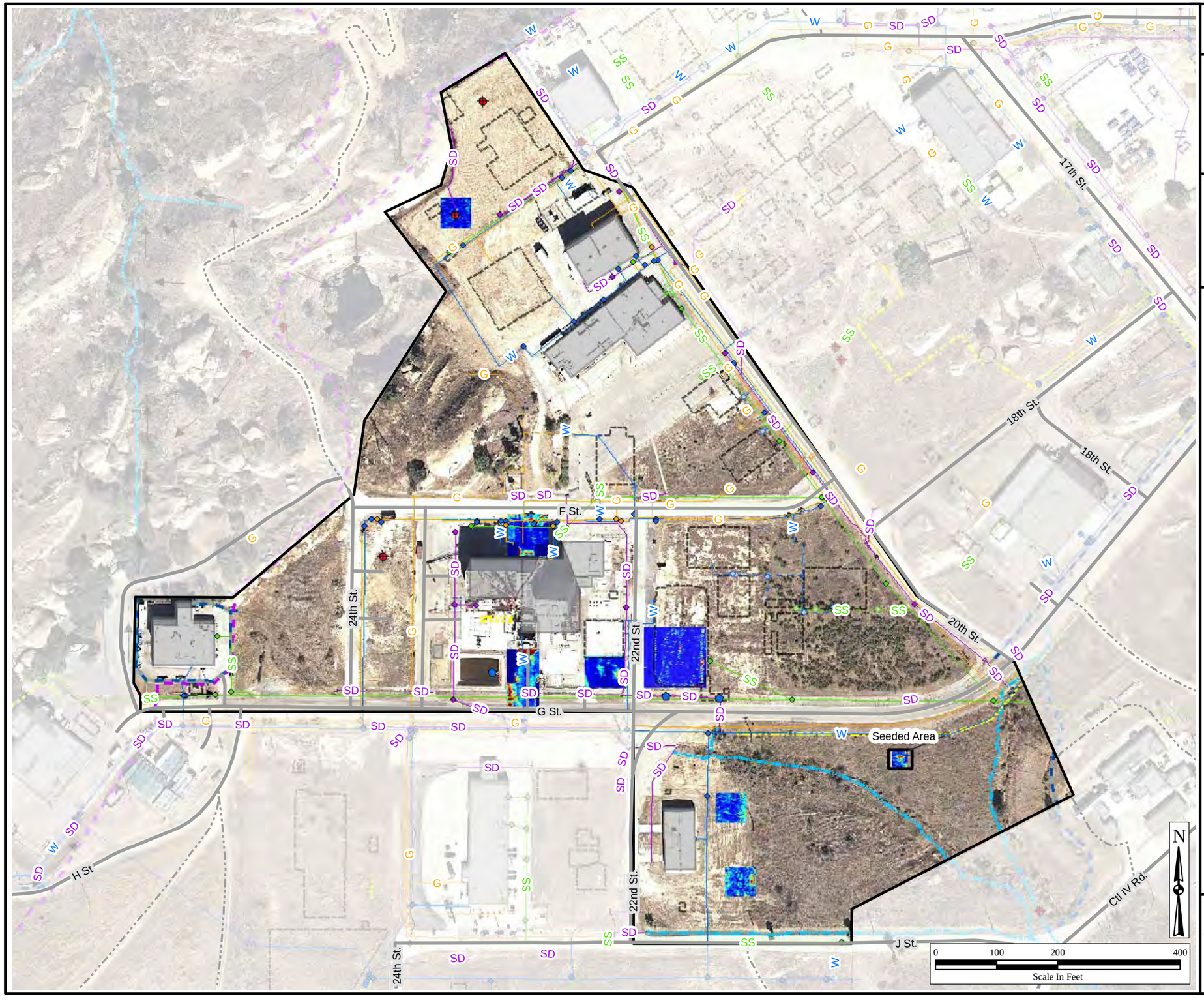
0 100 200 400
Scale In Feet

N

HGL HydroGeoLogic, Inc

Figure 2d
Ground Penetrating Radar
Subarea 5C
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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(2d)GroundPenetratingRadar_5C.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 3a
Terrain Conductivity
Subarea 5B
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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- Water (Removed)
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- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

-176.5 6.1 7.6 8.6 9.9 11.2 13.4 16.3 21.9 38.9

N

0 100 200 400
Scale In Feet

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9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 3b
Corrected Total Field Data
Subarea 5B
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
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- Existing

Surface Water
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- Permanent Stream
- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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Utilities
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- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

0 100 200 400
Scale In Feet

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9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 3c
Total Field Analytic Signal
Subarea 5B
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

0 100 200 400
Scale In Feet

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(3c)TotalFieldAnalyticSignal_5B.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 3d
Ground Penetrating Radar
Subarea 3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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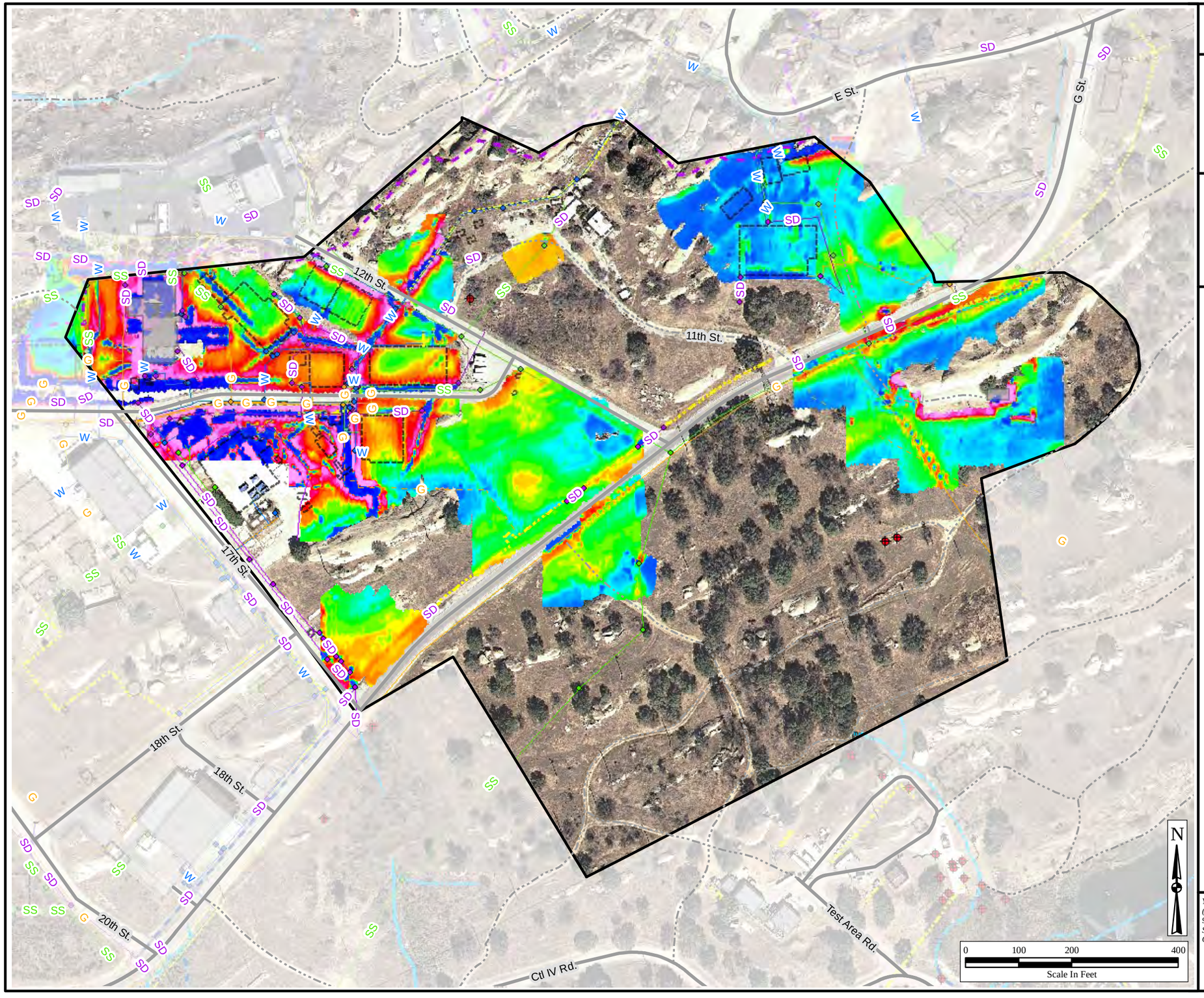
(3d)GroundPenetratingRadar_5B.mxd
10/12/2011 pbillock
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

0 50 100 200
Scale In Feet



HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 4a
Terrain Conductivity
Subarea 5A
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

-176.5 6.1 7.6 8.6 9.9 11.2 13.4 16.3 21.9 38.9

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(4a)TerrainConductivity_5A.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 4b
Corrected Total Field Data
Subarea 5A
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

N

0 100 200 400
Scale In Feet

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(4b)CorrectedTotalFieldData_5A.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 4c
Total Field Analytic Signal
Subarea 5A
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

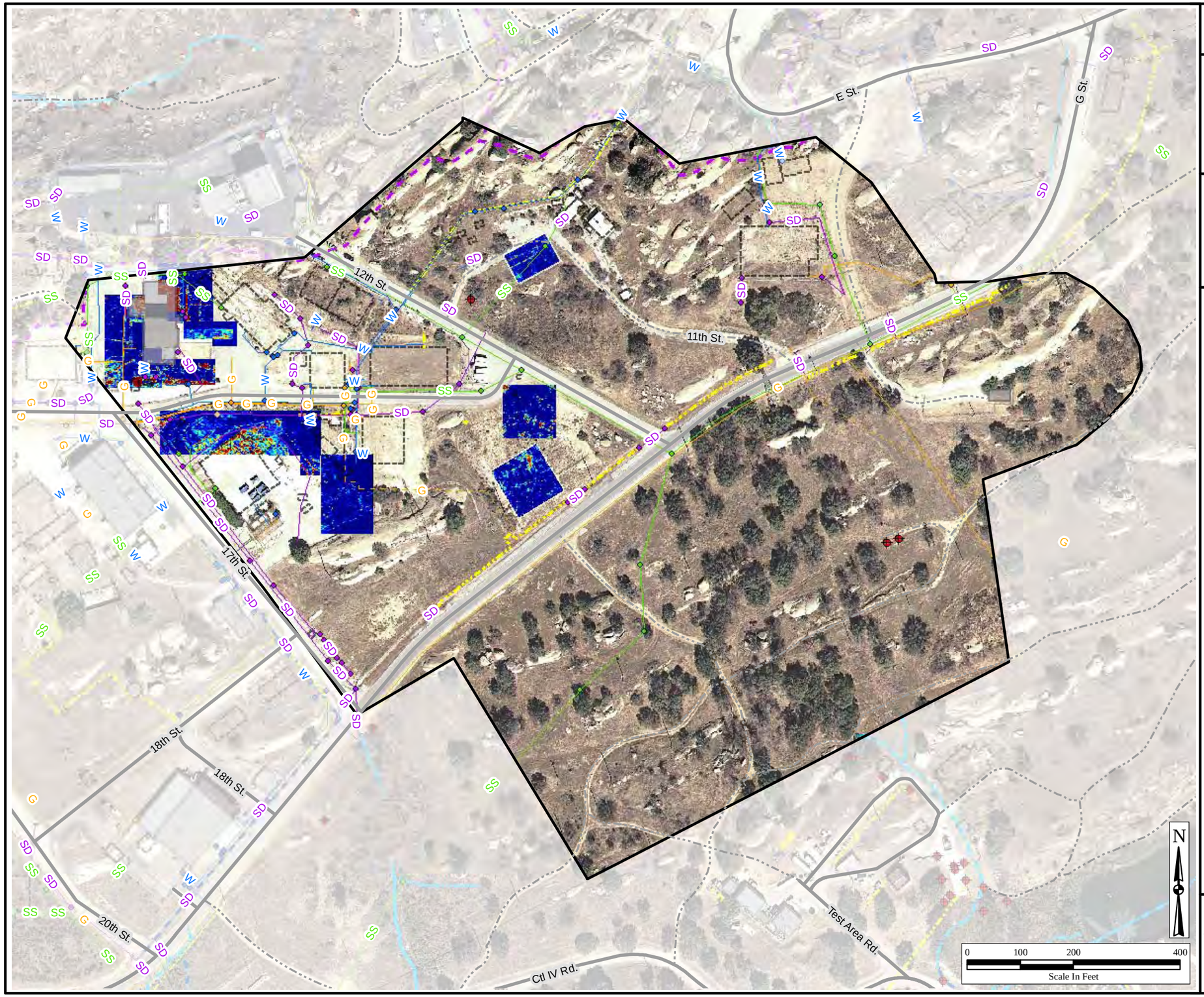
0 100 200 400
Scale In Feet

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(4c)TotalFieldAnalyticSignal_5A.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 4d
Ground Penetrating Radar
Subarea 5A
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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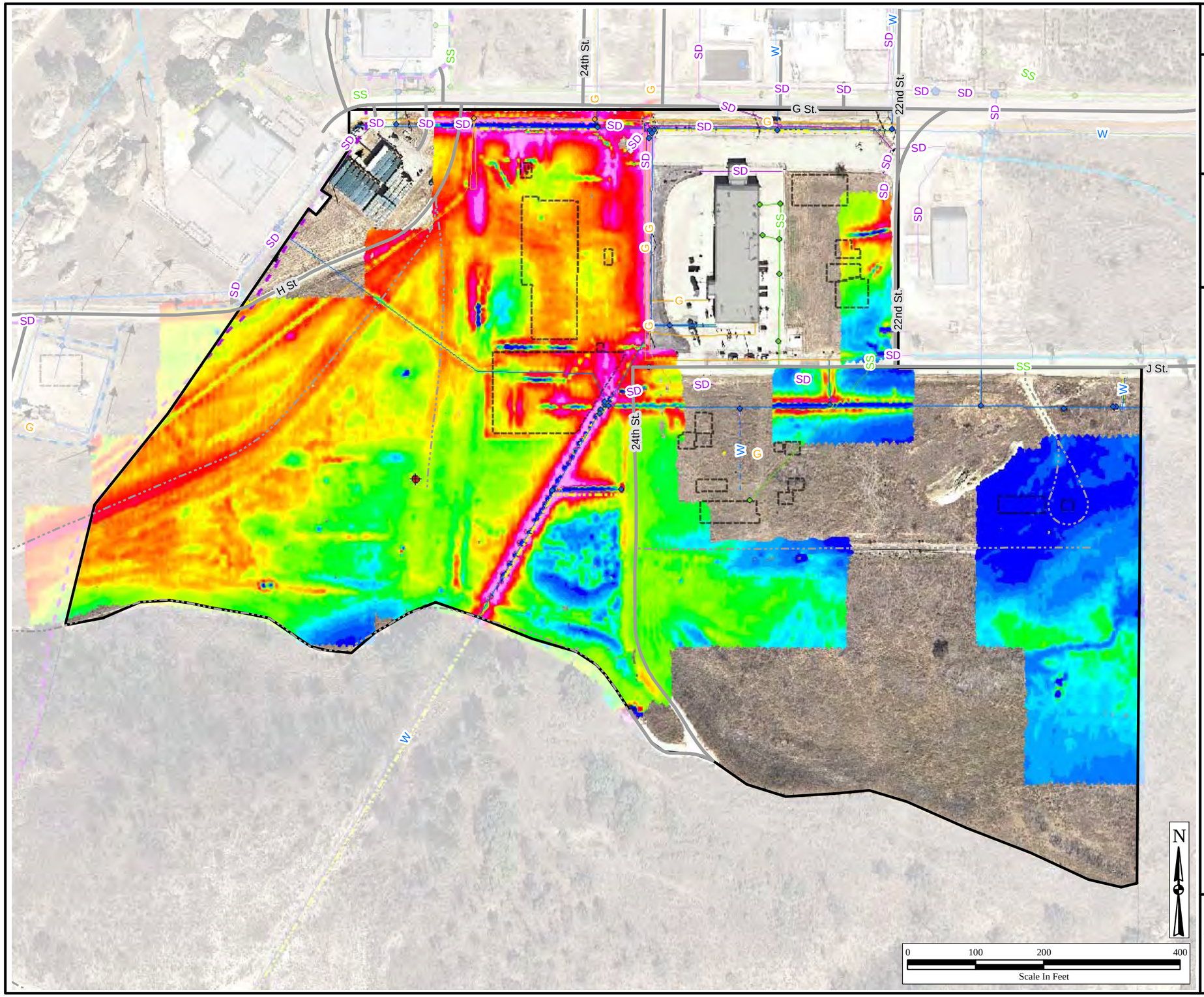
(4d)GroundPenetratingRadar_5A.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

Figure 5a
Terrian Conductivity
Subarea 5D North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

23.7 35.9 39.9 45.4 51.7 59.7 64.7 69.7 85.4 133.2

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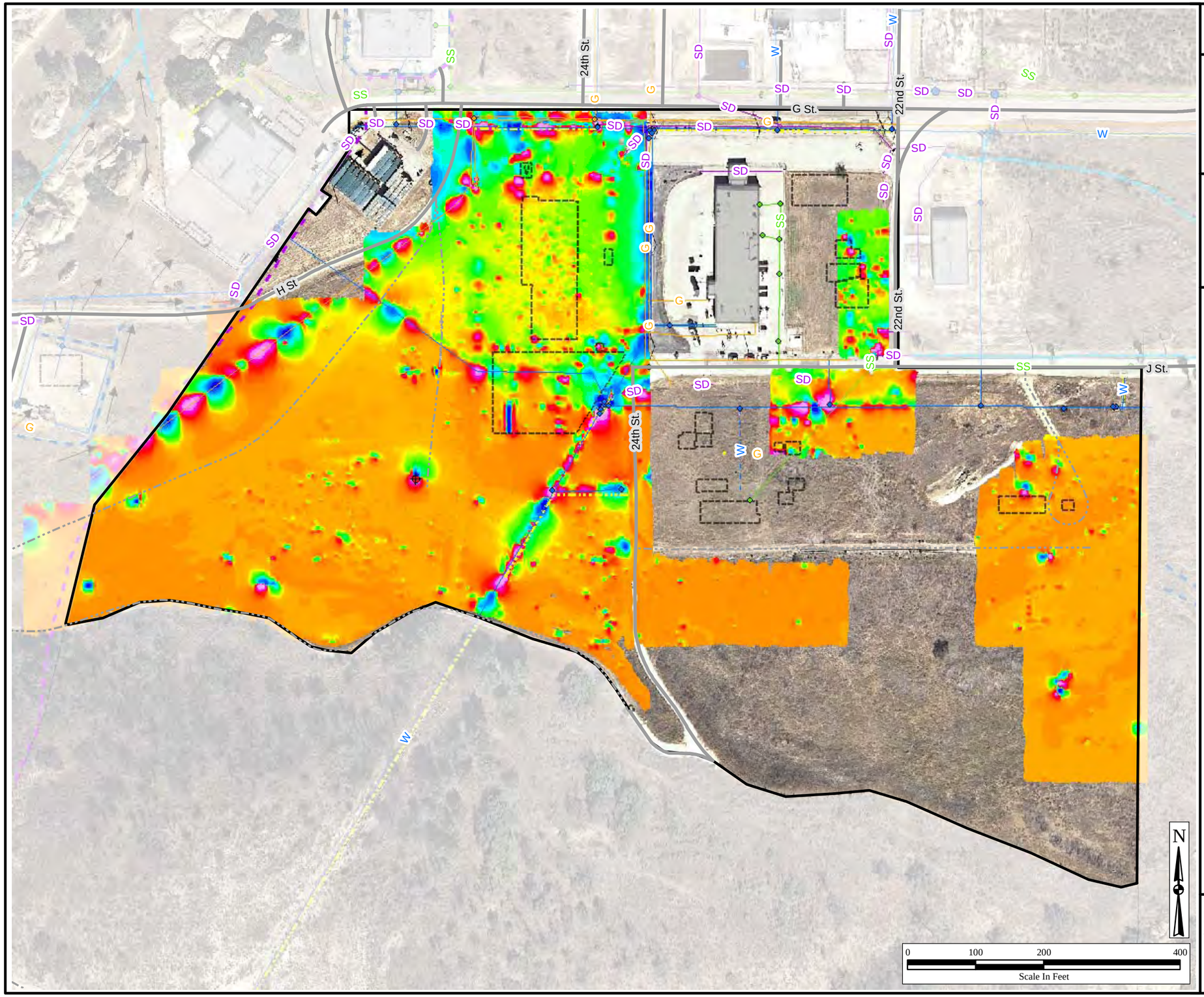
(5a)TerrainConductivity_5DN.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 5b
Corrected Total Field Data
Subarea 5D North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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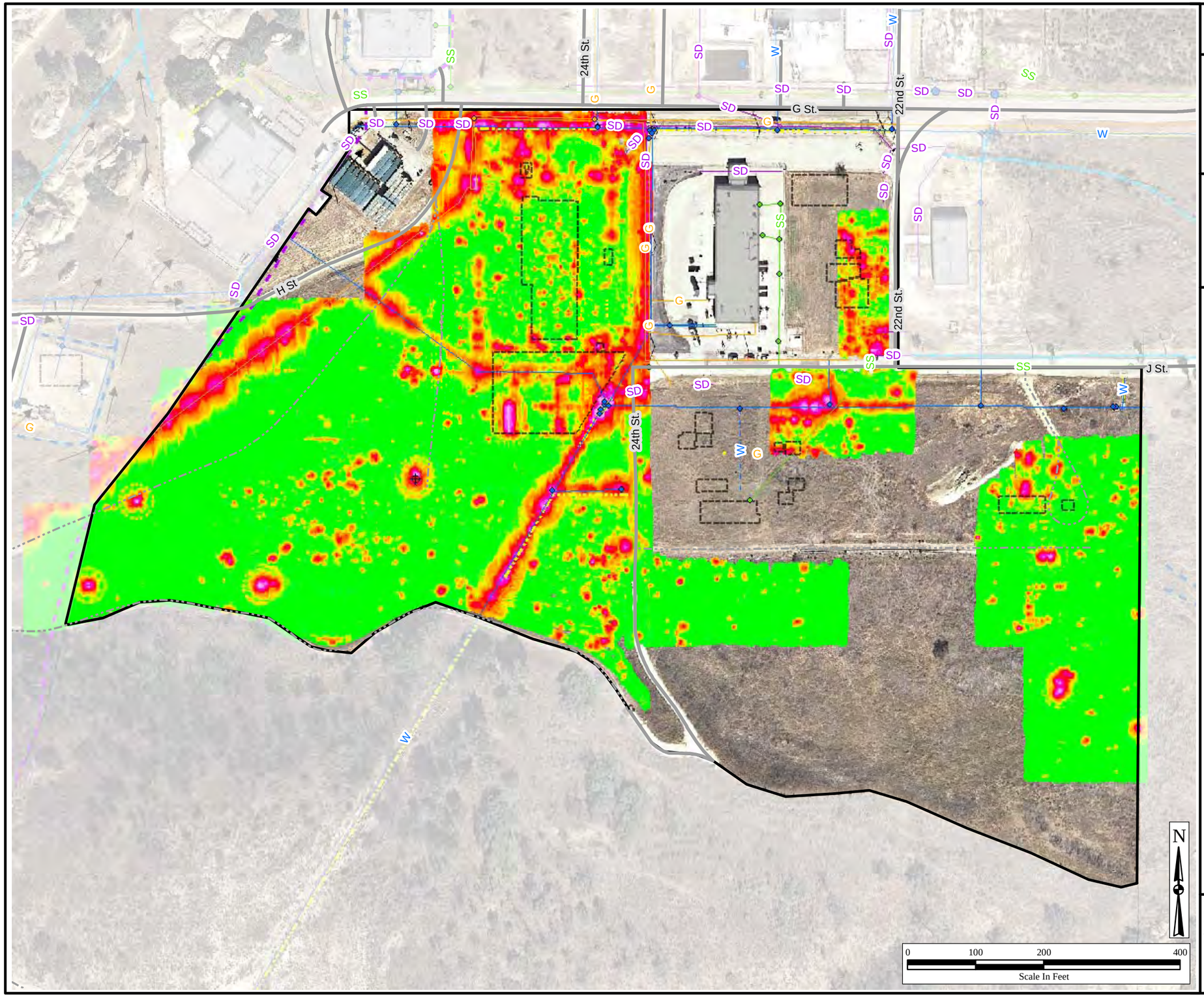
(5b)CorrectedTotalFieldData_5DN.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 5c
Total Field Analytic Signal
Subarea 5D North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

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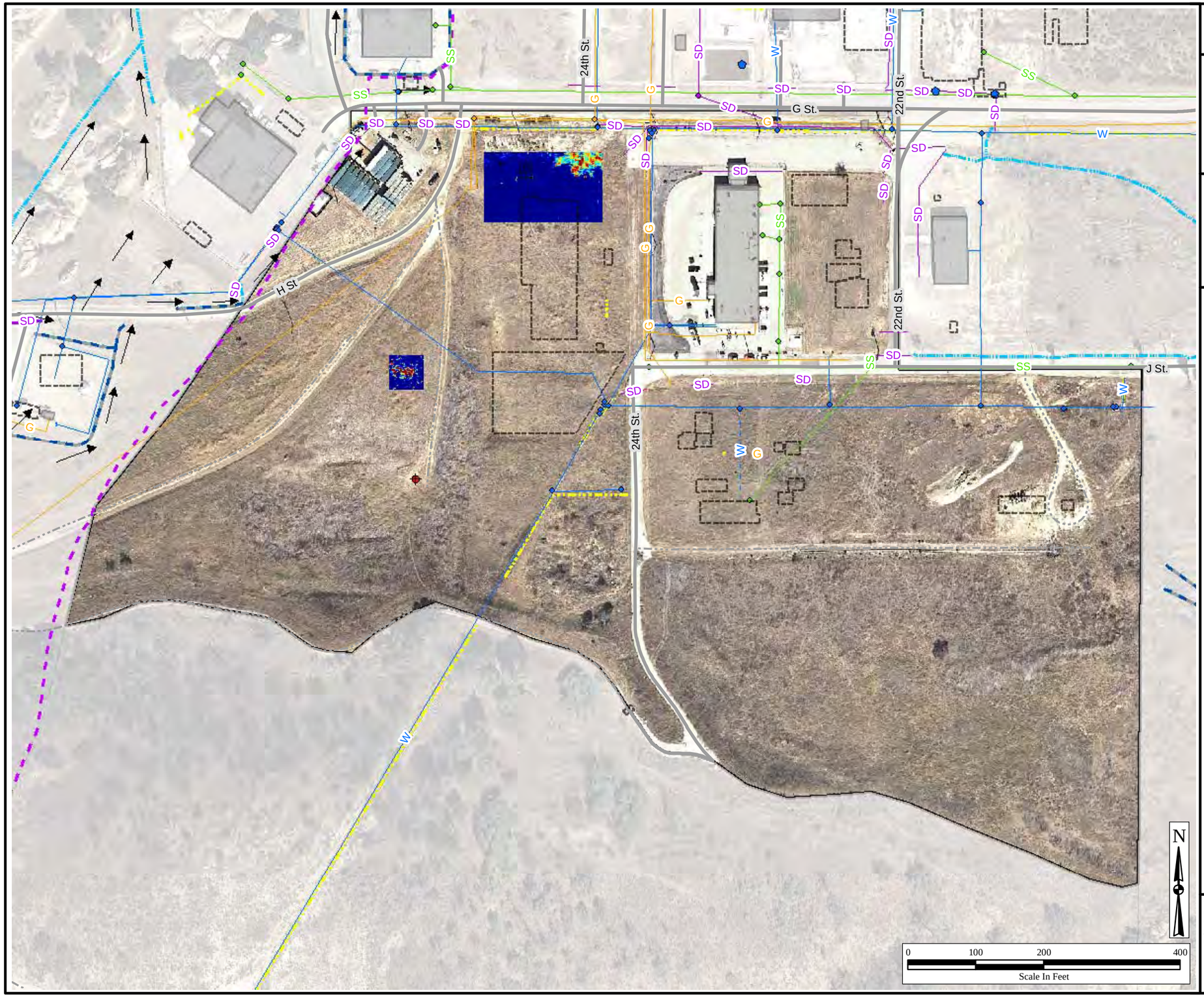
(5c)TotalFieldAnalyticSignal_5DN.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 5d
Ground Penetrating Radar
Subarea 5D North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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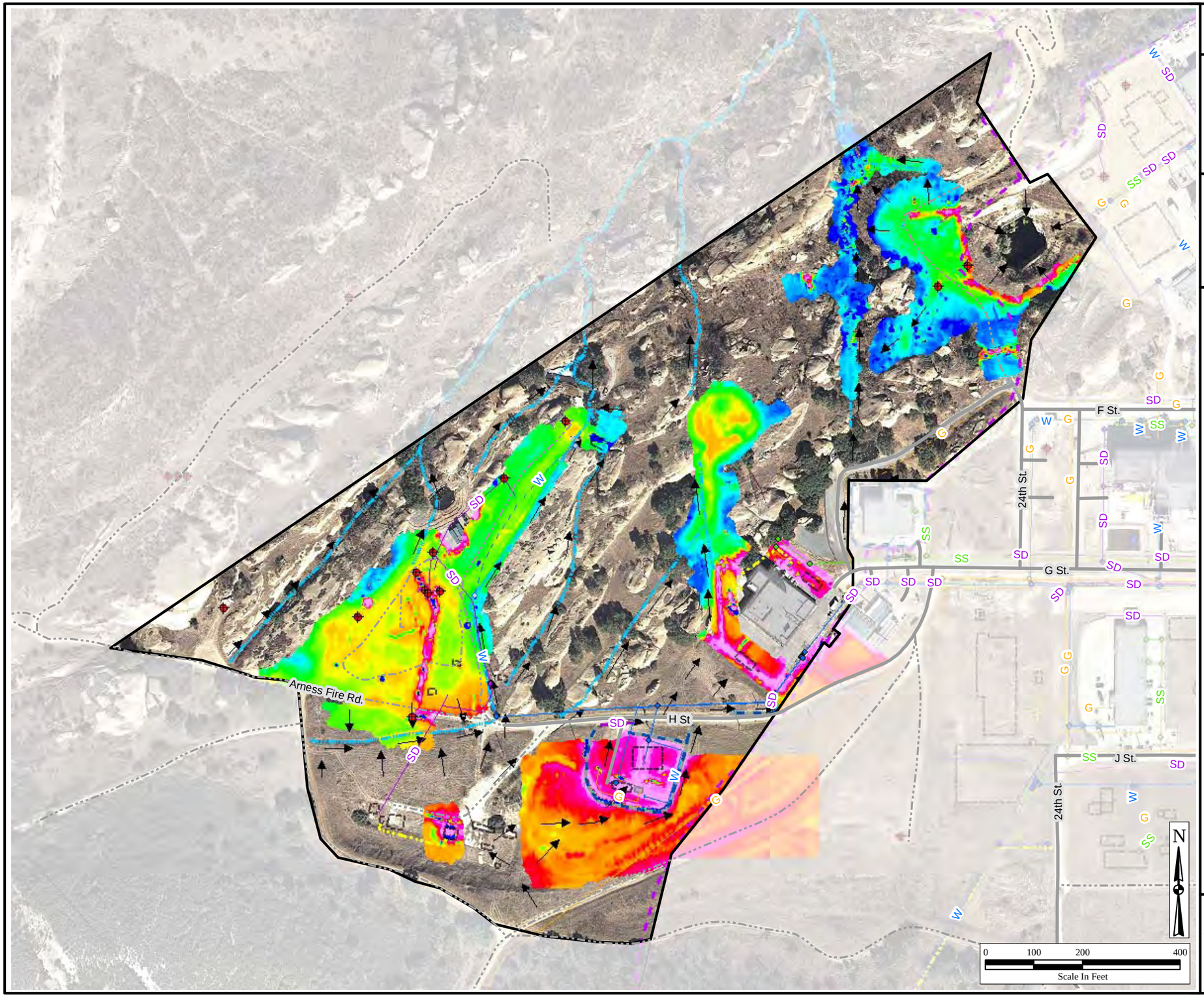
(5d)GroundPenetratingRadar_5DN.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 6a
Terrain Conductivity
Subarea 8-North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

11.9 16.8 21.3 28.1 36.0 41.3 55.1 62.5 70.8 116.0

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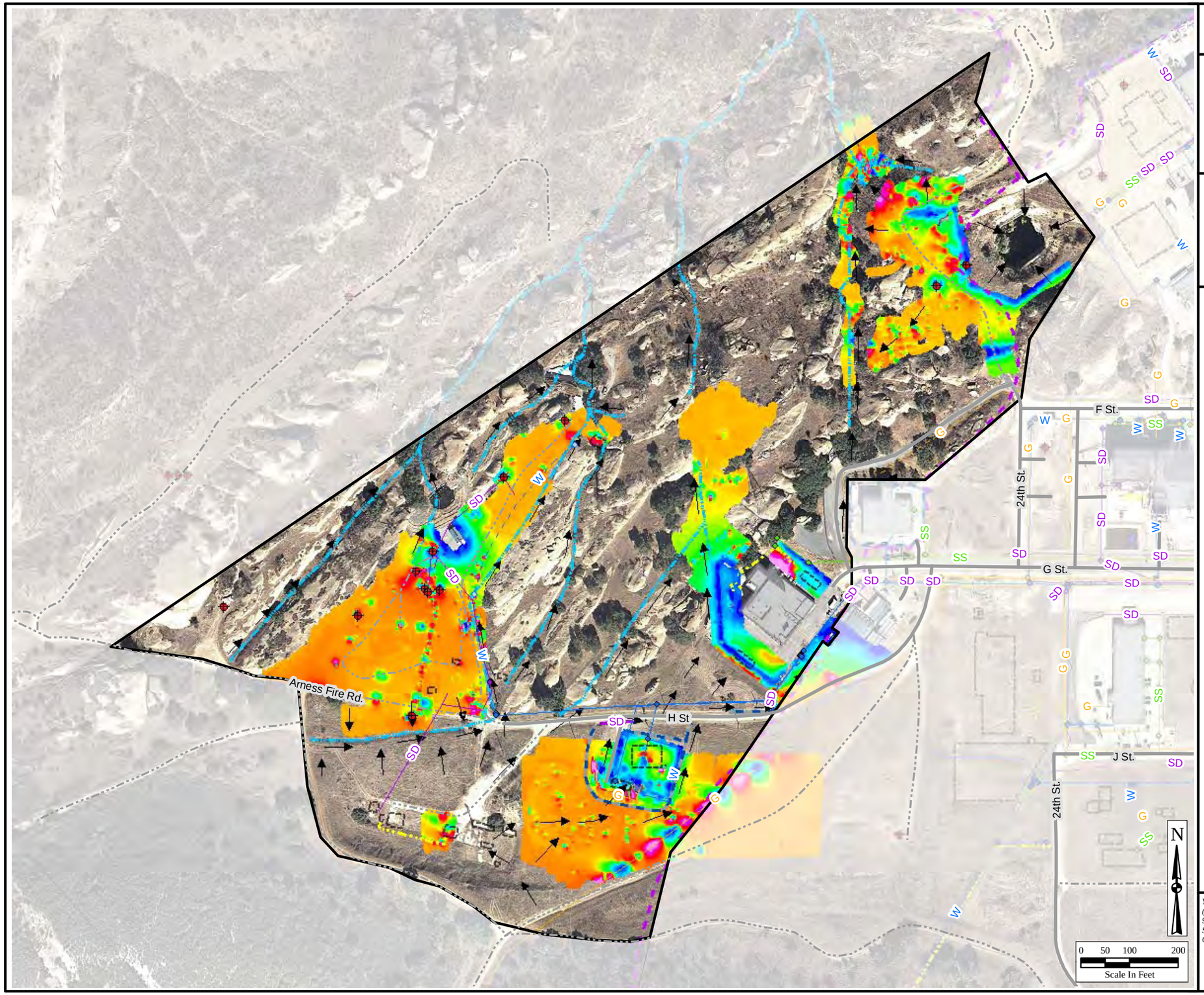
(6a)TerrainConductivity_8.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 6b
Corrected Total Field Data
Subarea 8-North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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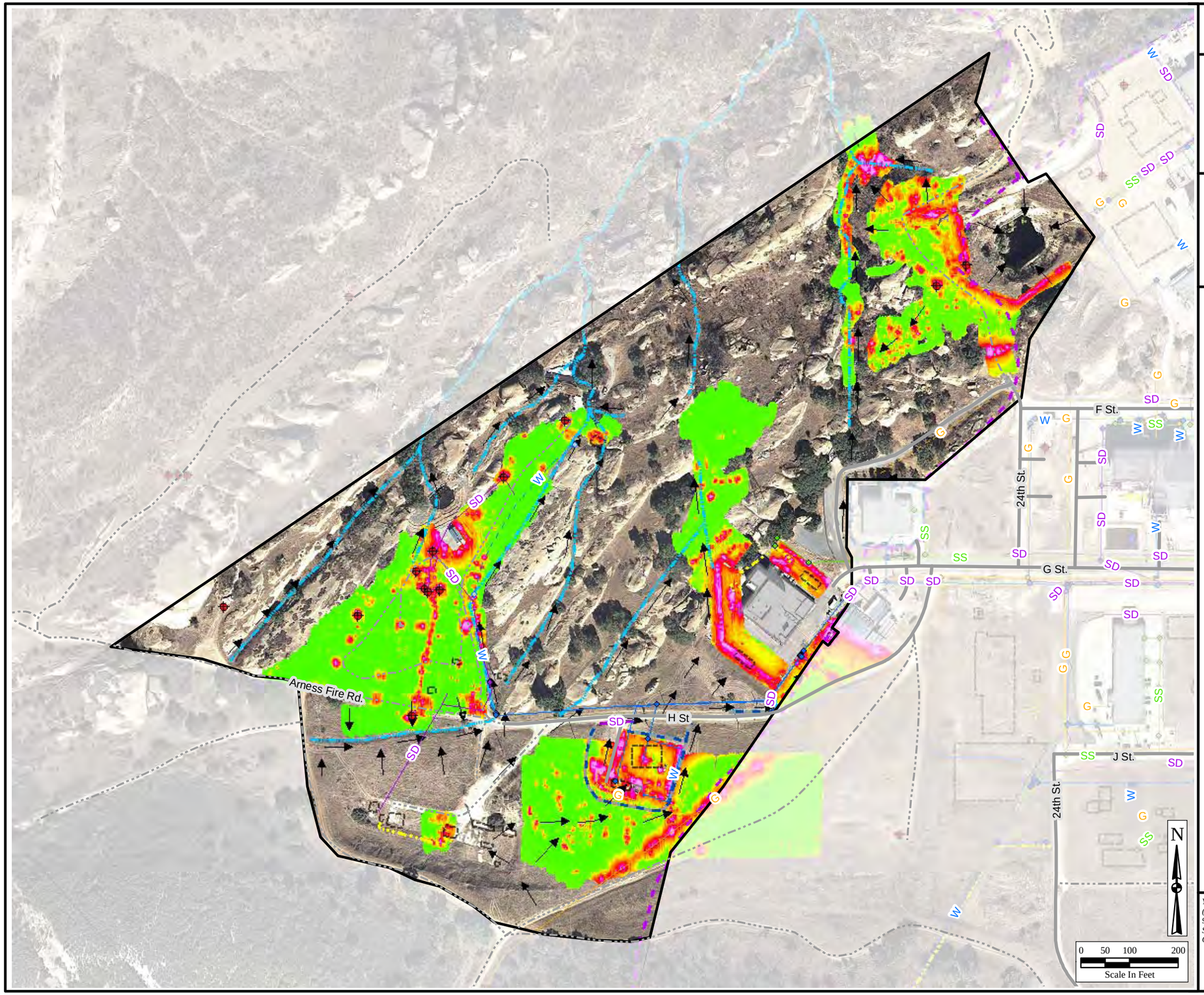
(6b)CorrectedTotalFieldData_8.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 6c
Total Field Analytic Signal
Subarea 8-North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

0 50 100 200
Scale In Feet

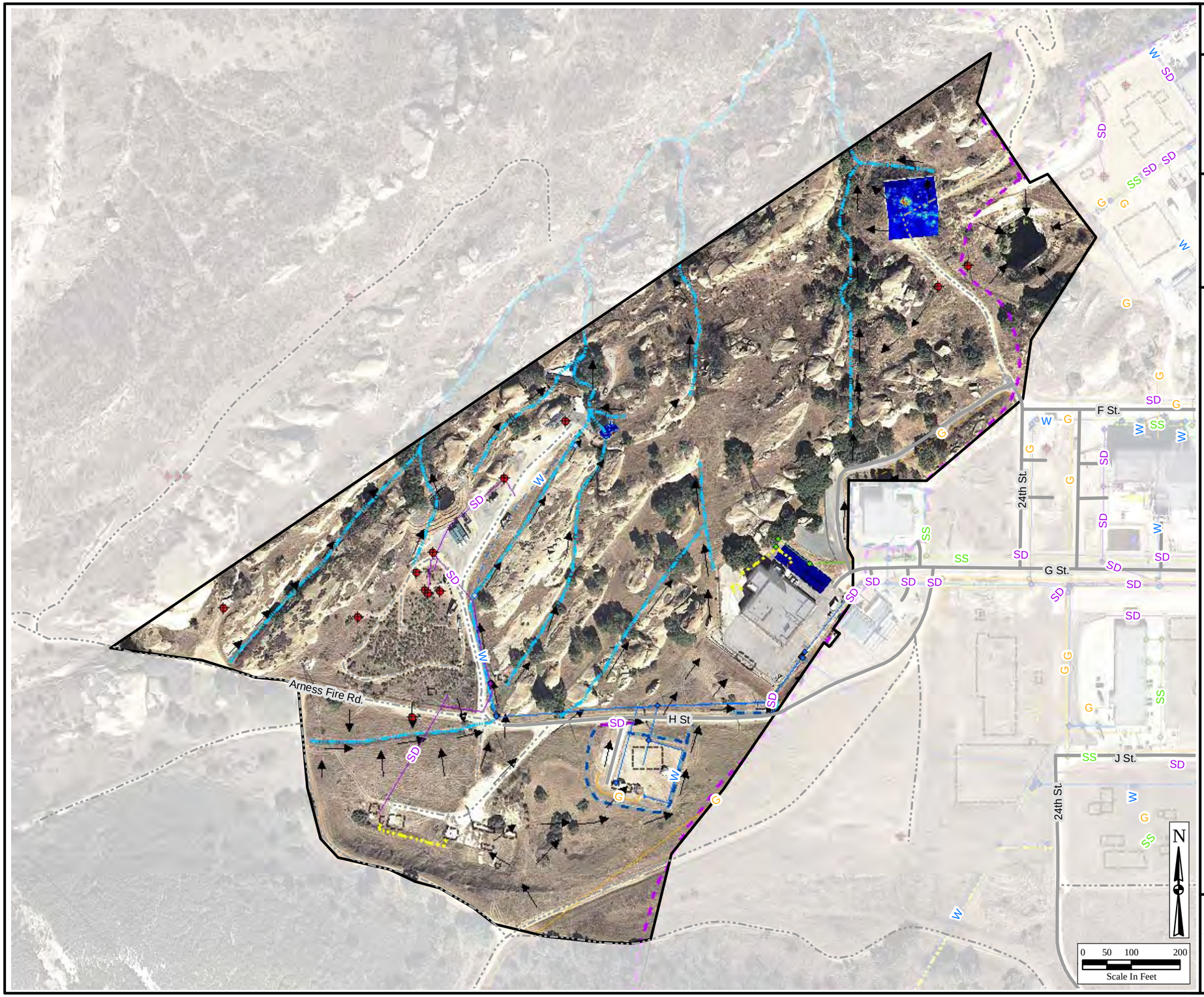
Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(6c)TotalFieldAnalyticSignal_8.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 6d
Ground Penetrating Radar
Subarea 8-North
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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(6d)GroundPenetratingRadar_8.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 7a
Terrian Conductivity
Subarea 6
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

9.5 14.7 18.7 20.9 23.3 25.9 29.7 34.5 40.4 47.7

N

0 50 100 200
Scale In Feet

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(7a)TerrainConductivity_6.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 7b
Corrected Total Field Data
Subarea 6
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

N

0 50 100 200
Scale In Feet

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(7b)CorrectedTotalFieldData_6.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 7c
Total Field Analytic Signal
Subarea 6
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

0 50 100 200
Scale In Feet

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(7c)TotalFieldAnalyticSignal_6.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 7d
Ground Penetrating Radar
Subarea 6
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

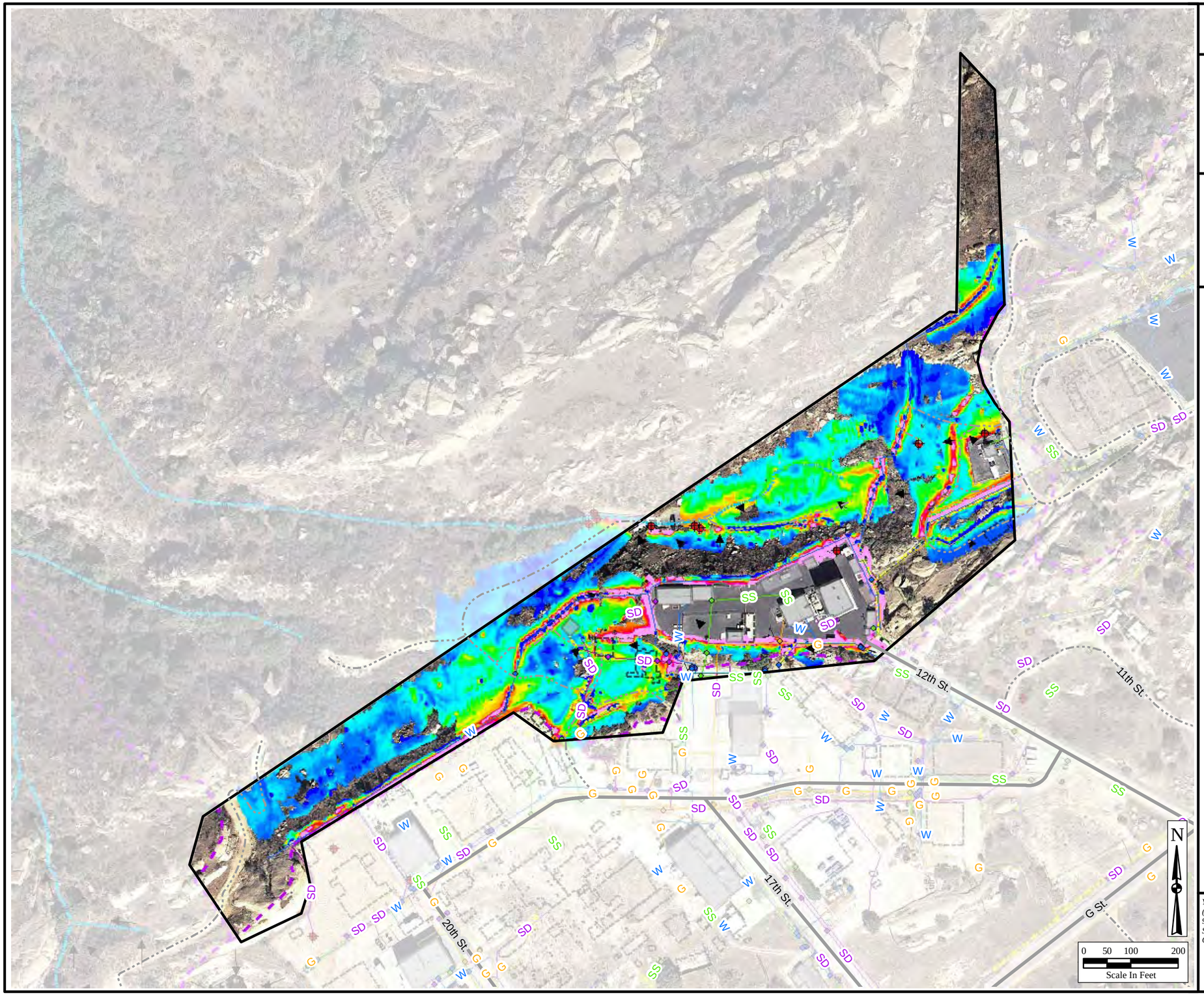
Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(7d)GroundPenetratingRadar_6.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

0 50 100 200
Scale In Feet

N

Figure 8a
Terrain Conductivity
Subarea 7
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

9.5 14.7 18.7 20.9 23.3 25.9 29.7 34.5 40.4 47.7

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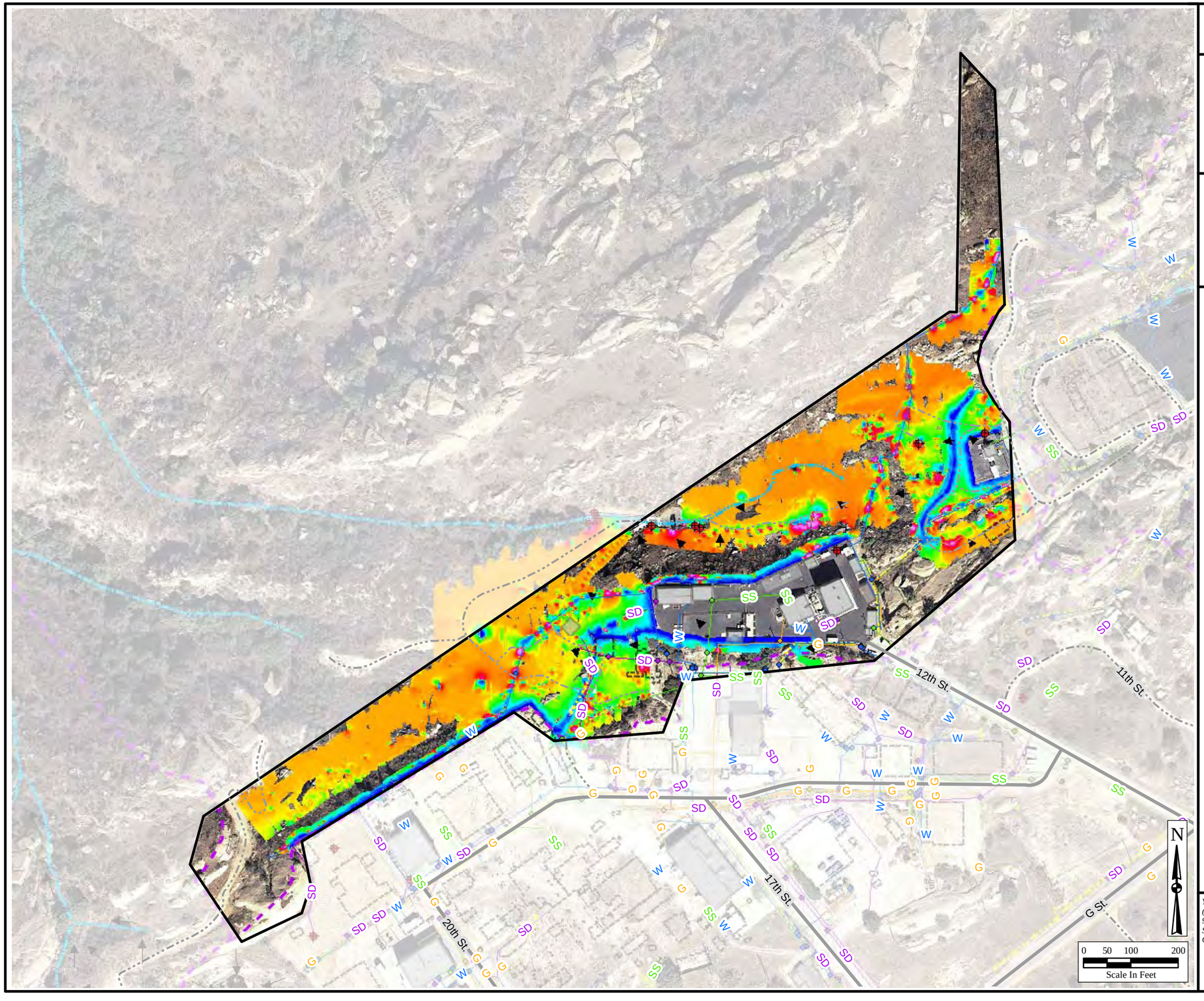
(8a)TerrainConductivity_7.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 8b
Corrected Total Field Data
Subarea 7
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
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Buildings
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Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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Utilities
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- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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(8b)CorrectedTotalFieldData_7.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 8c
Total Field Analytic Signal
Subarea 7
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
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Surface Water
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Utilities
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- Water
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- Water (Removed)
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- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

0 50 100 200
Scale In Feet

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(8c)TotalFieldAnalyticSignal_7.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 8d
Ground Penetrating Radar
Subarea 7
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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Utilities
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- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

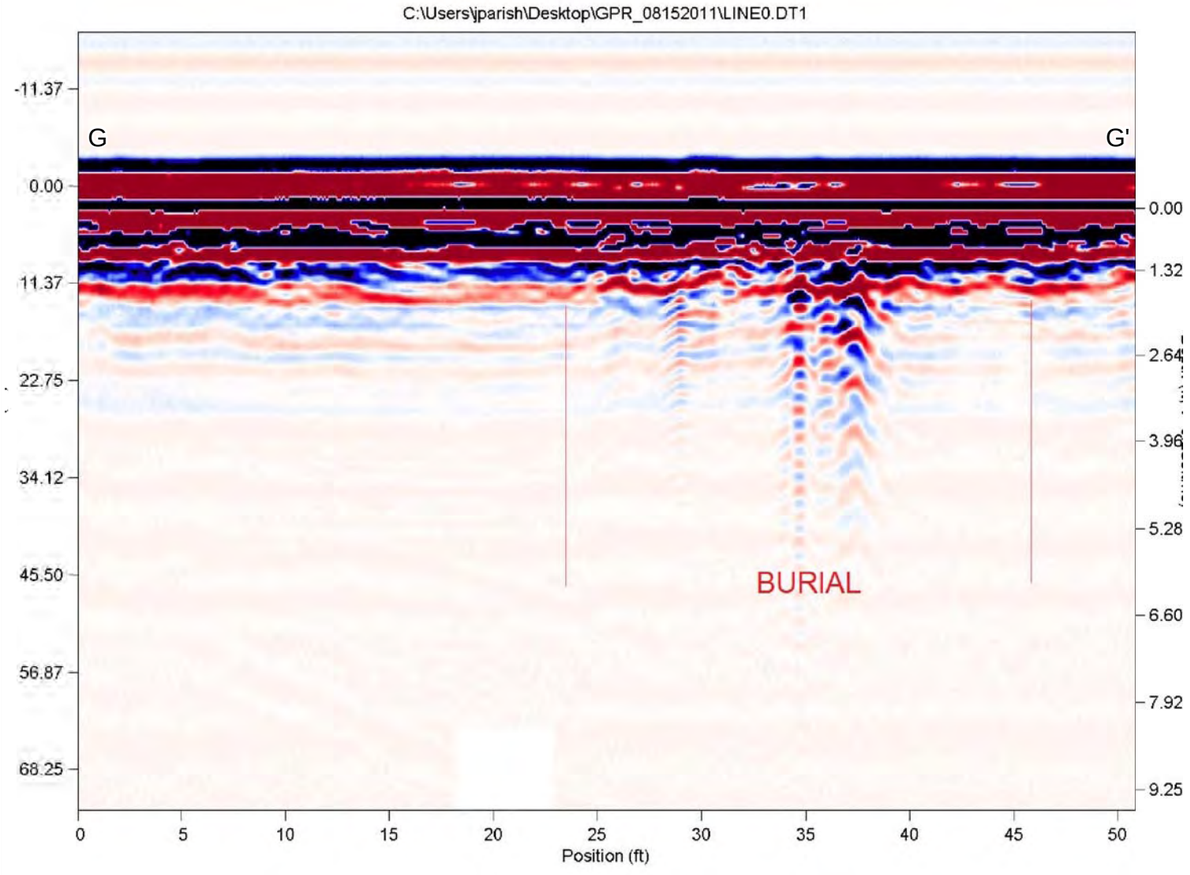
0 100 200 400
Scale In Feet

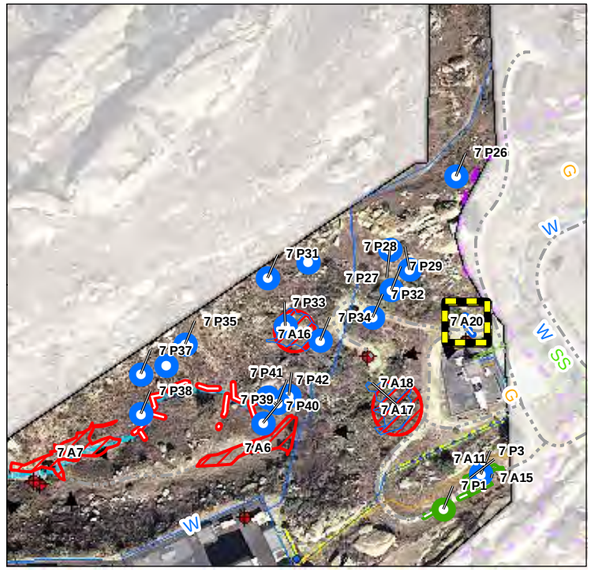
N

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Review
(8d)GroundPenetratingRadar_7.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

Figure 8e
GPR Cross Section over Anomaly 7 A20
Santa Susana Field Laboratory

U.S. EPA Region 9





Legend

Geophysical Anomalies

- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
- Terrian Conductivity Anomaly Linear
- Ground Penetrating Radar
- Interpreted Drain Remnant
- Point Source Magnetometer Anomaly
- Point Source Terrain Conductivity Anomaly

N

0 50 100 200
Scale In Feet

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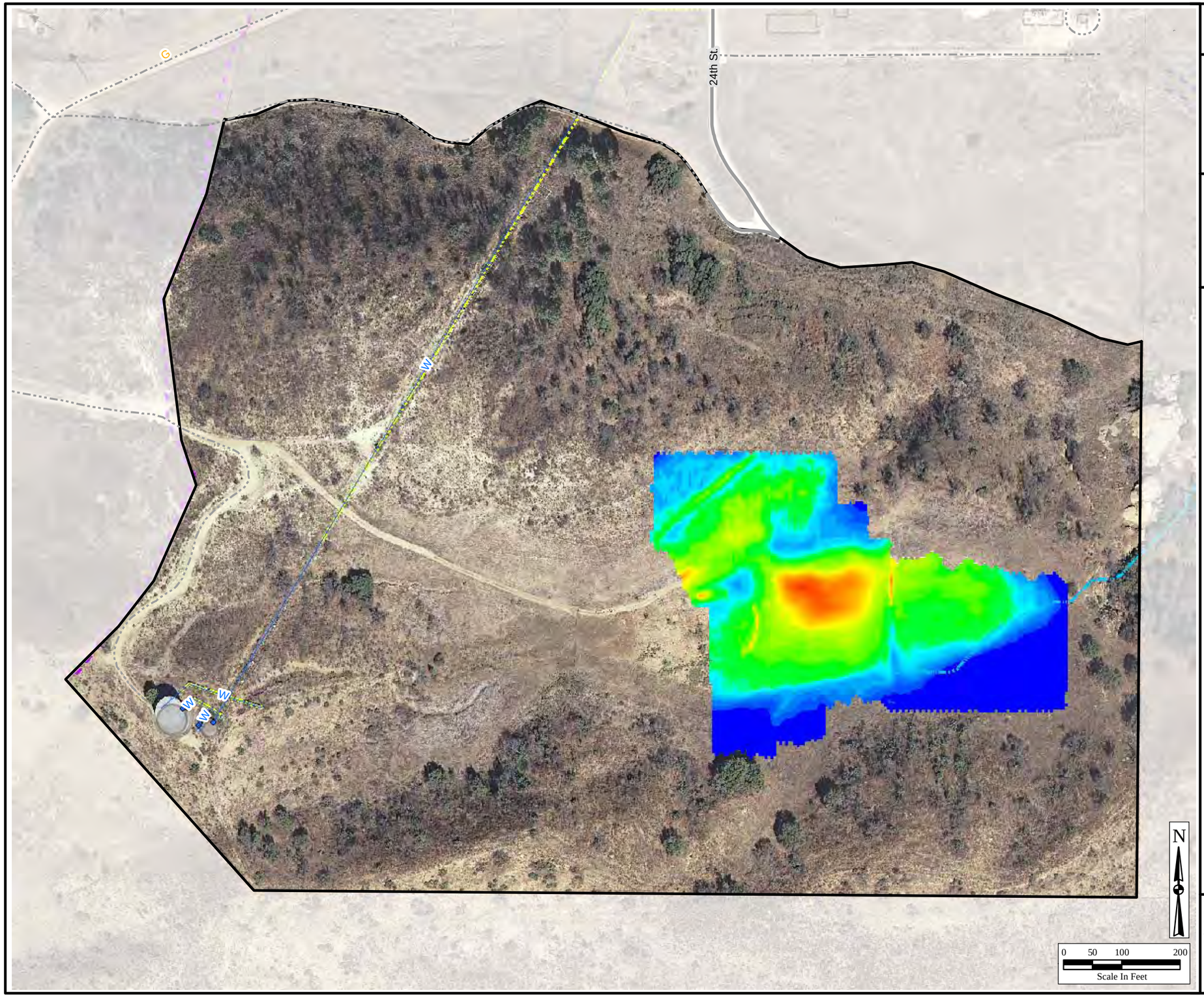
Subarea7_Cross_Section.mxd
9/8/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007

HGL HydroGeoLogic, Inc

Figure 9a
Terrian Conductivity
Subarea 5D South
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
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Buildings
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Surface Water
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- Permanent Stream
- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

23.7 35.9 39.9 45.4 51.7 59.7 64.7 69.7 85.4 133.2

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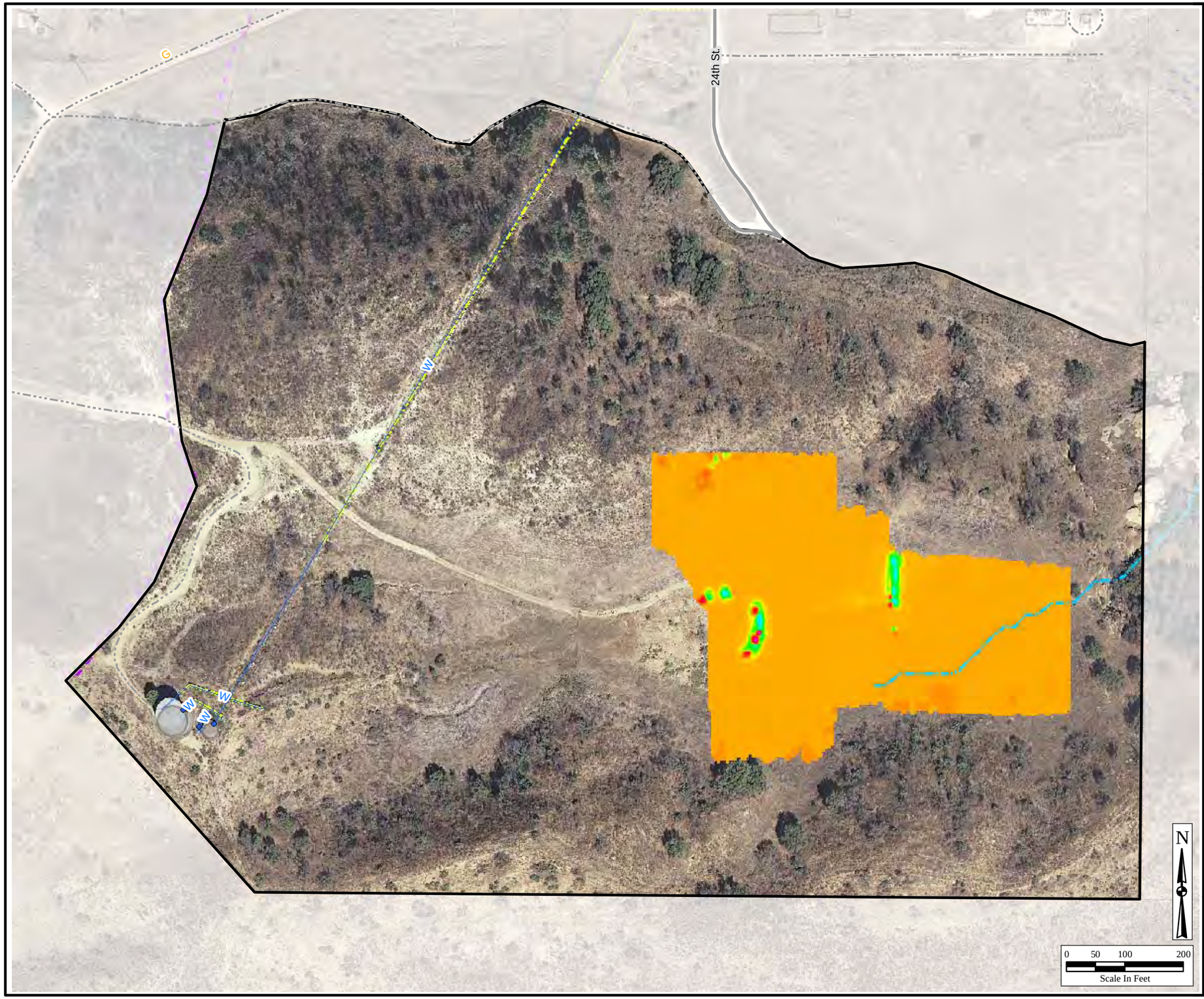
(9a)TerrainConductivity_5DS.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 9b
Corrected Total Field Data
Subarea 5D South
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
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Buildings
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Surface Water
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Utilities
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- Water
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- Water (Removed)
- Pipes (Unknown Type)
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Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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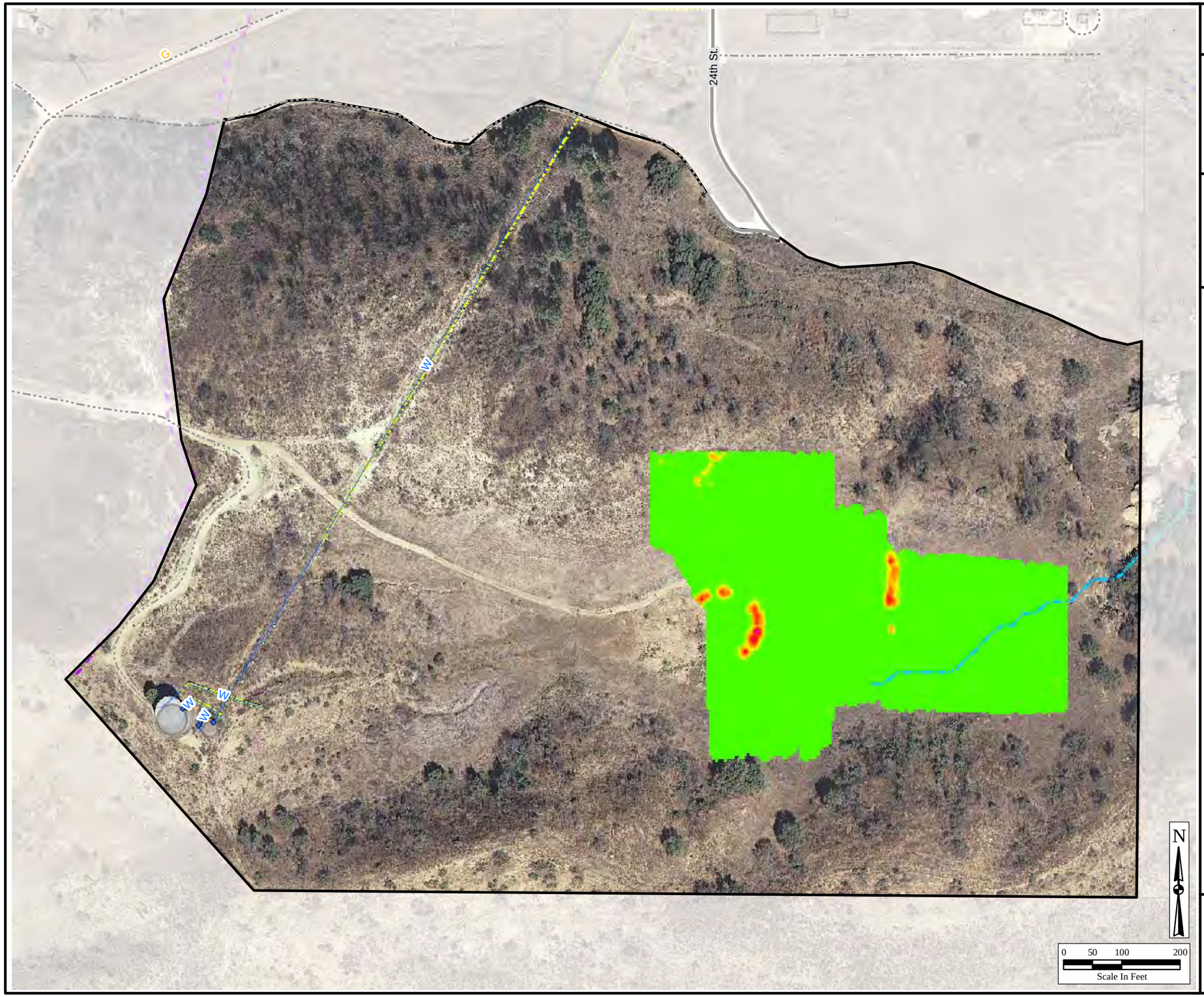
(9b)CorrectedTotalFieldData_5DS.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 9c
Total Field Analytic Signal
Subarea 5D South
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
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- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

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(9c)TotalFieldAnalyticSignal_5DS.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

Figure 10a
Terrain Conductivity
Subarea 3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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Utilities
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- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

9.5 14.7 18.7 20.9 23.3 25.9 29.7 34.5 40.4 47.7

F St.

N

0 50 100 200
Scale In Feet

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(10a)TerrainConductivity_3.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 10b
Corrected Total Field Data
Subarea 3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Utilities
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Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

N

0 50 100 200
Scale In Feet

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(10b)CorrectedTotalFieldData_3.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 10c
Total Field Analytic Signal
Subarea 3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
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Surface Water
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Surface Water Flow
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Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

F St.

N

0 50 100 200
Scale In Feet

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(10c)TotalFieldAnalyticSignal_3.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 10d
Ground Penetrating Radar
Subarea 3
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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(10d)GroundPenetratingRadar_3.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Figure 11a.1
Terrain Conductivity
Northern Buffer Zone- Northwest
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Terrain Conductivity Data
milliSiemens/meter

9.5 14.7 18.7 20.9 23.3 25.9 29.7 34.5 40.4 47.7

N

0 100 200 400
Scale In Feet

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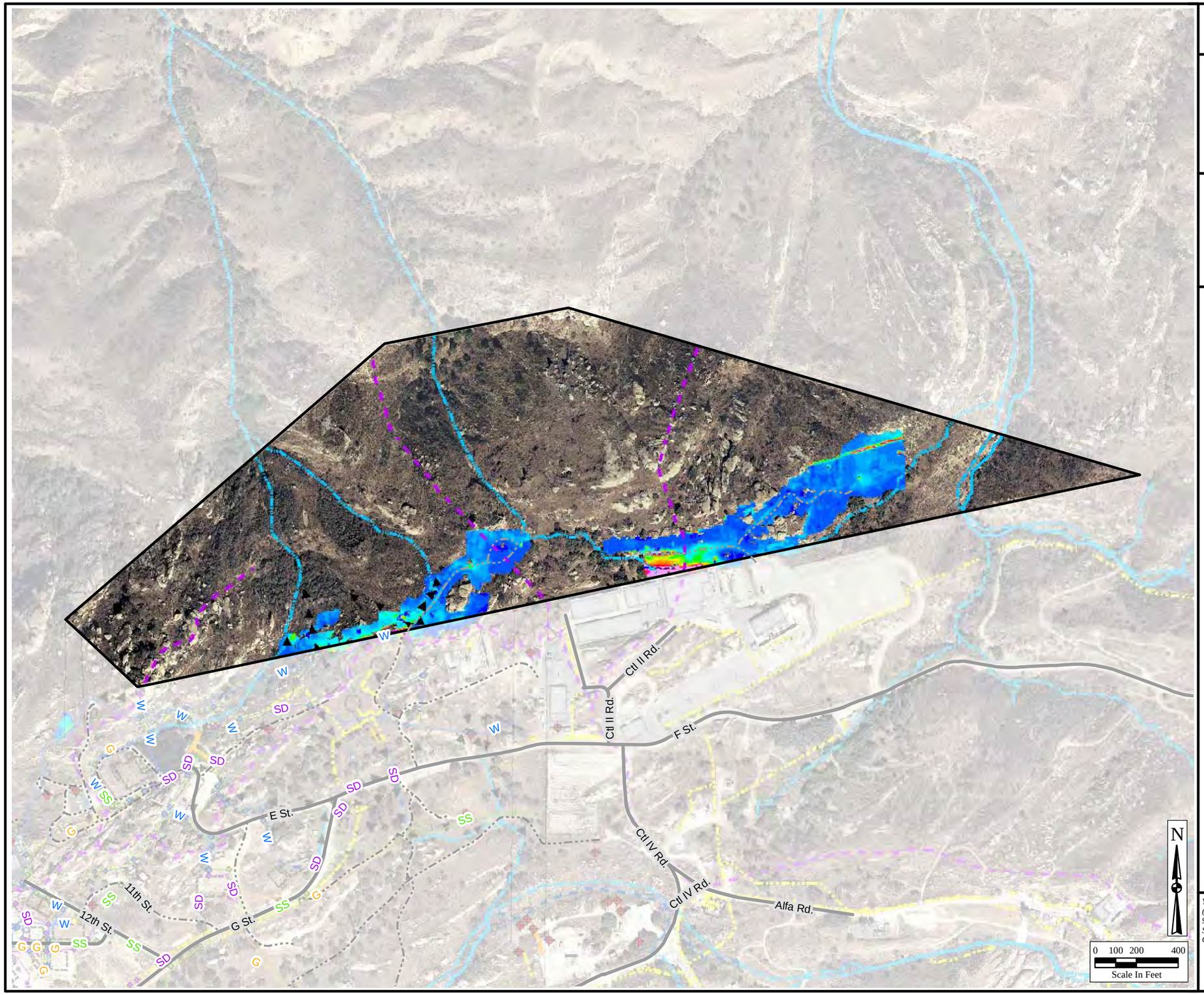
(11a)TerrainConductivity_NBZ_NW.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 11a.2
Terrain Conductivity
Northern Buffer Zone-Northeast
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
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- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Utilities
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Terrain Conductivity Data
milliSiemens/meter

9.5 14.7 18.7 20.9 23.3 25.9 29.7 34.5 40.4 47.7

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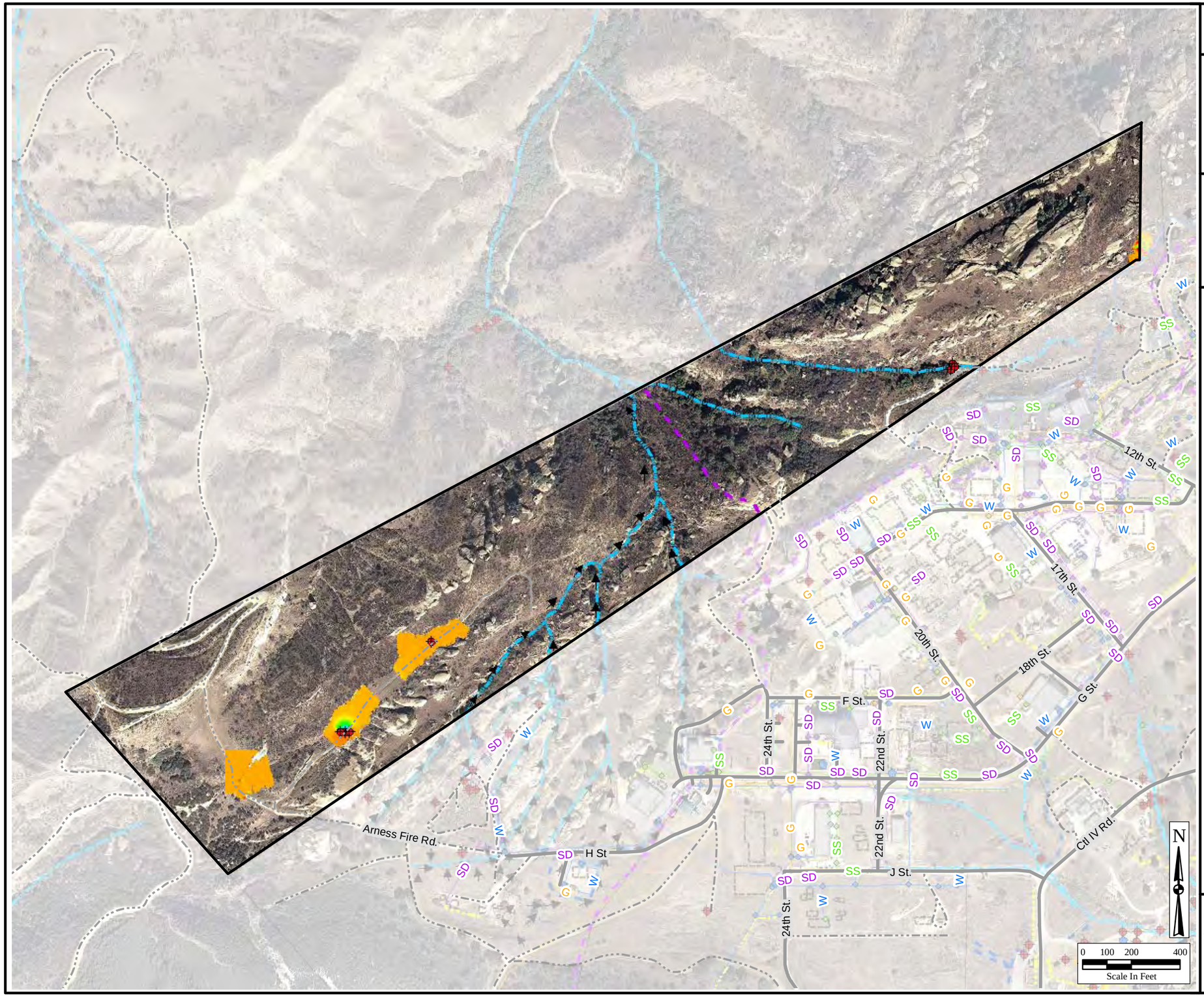
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 11b.1
Corrected Total Field Data
Northern Buffer Zone-Northwest
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
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Surface Water
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Surface Water Flow
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Surface Features
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- Water (Removed)
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Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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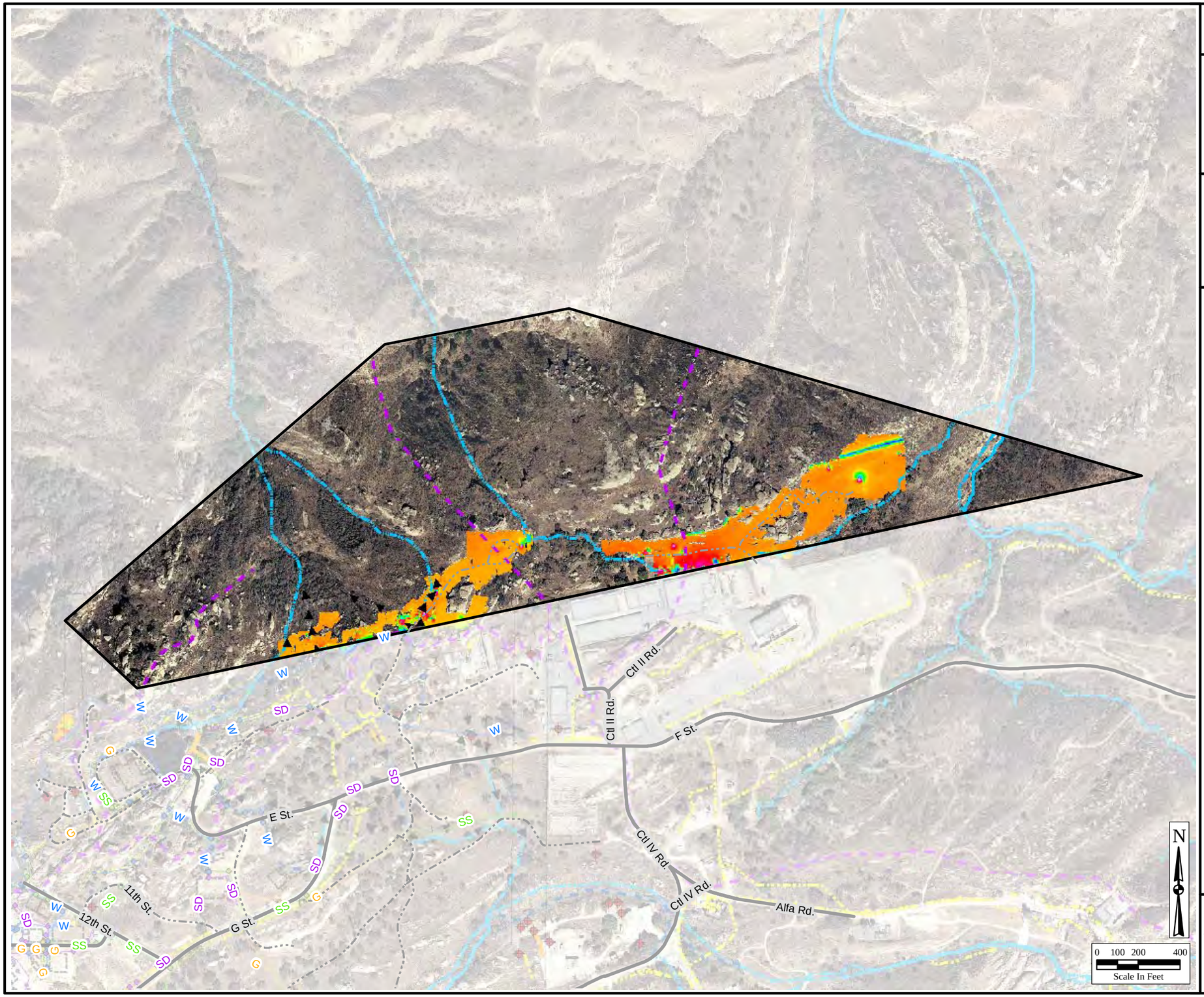
(11b)CorrectedTotalFieldData_NBZ_NW.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

HGL—Geophysical Investigation Report,
SSFL—Ventura County, CA

Figure 11b.2
Corrected Total Field Data
Northern Buffer Zone-Northeast
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
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Buildings
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Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
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Corrected Total Field Magnetometer Data
NanoTesla

-1933.7 -320.2 -163.9 -27.9 -0.7 6.0 12.3 189.3

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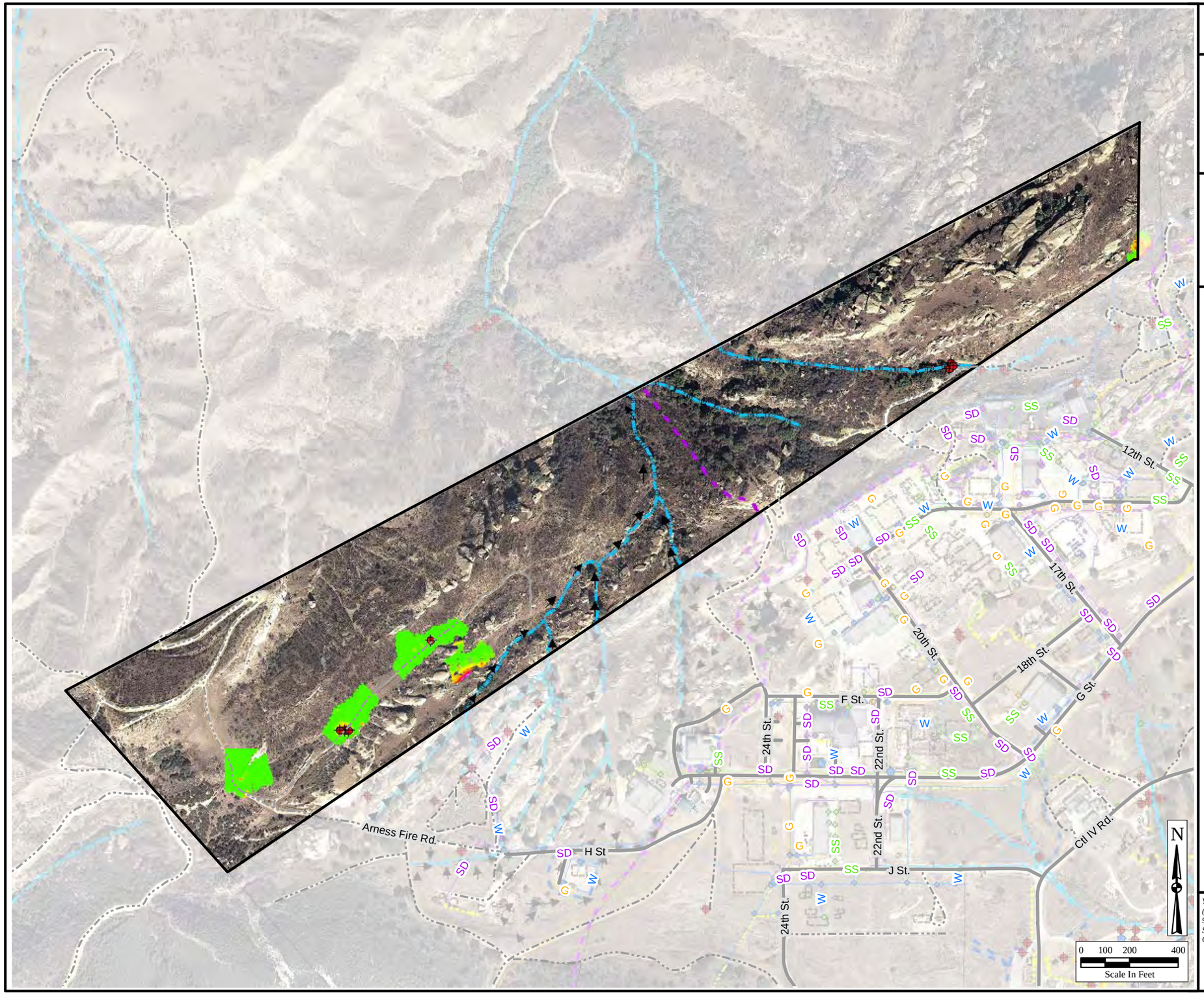
(11b)CorrectedTotalFieldData_NBZ_NE.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 11c.1
Total Field Analytic Signal
Northern Buffer Zone-Northwest
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
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Buildings
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Surface Water
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Surface Water Flow
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Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

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9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 11c.2
Total Field Analytic Signal
Northern Buffer Zone-Northeast
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
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Surface Water Flow
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Surface Features
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Analytic Signal Data
NanoTesla/meter

0.5 1.5 2.8 4.6 6.9 10.2 17.8 32.5 62.1 124.8 417.7

N

0 100 200 400
Scale In Feet

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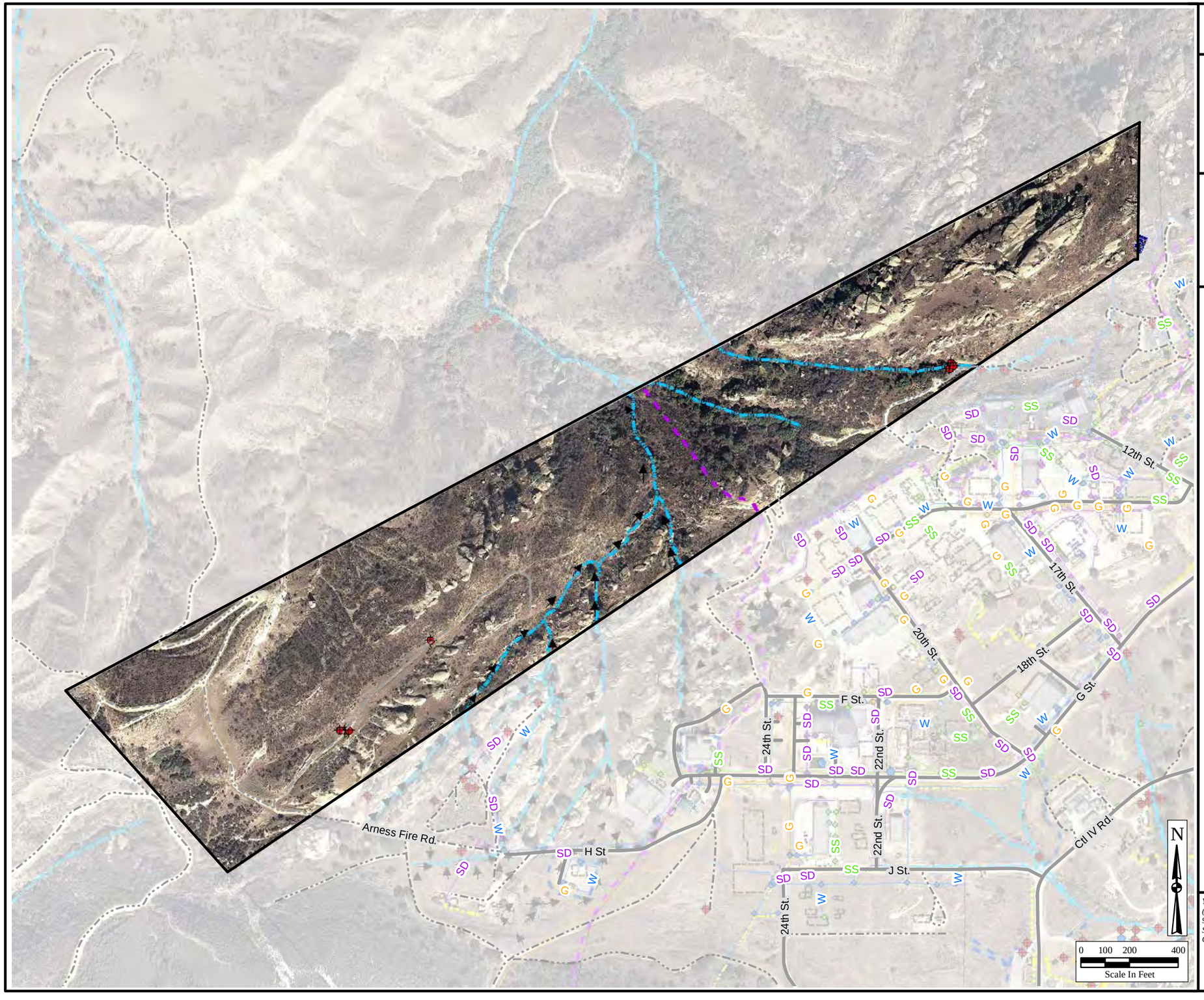
(11c)TotalFieldAnalyticSignal_NBZ_NE.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 11d.1
Ground Penetrating Radar
Northern Buffer Zone-Northwest
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
Antenna – 250 MHz

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(11d)GroundPenetratingRadar_NBZ_NW.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Figure 11d.2
Ground Penetrating Radar
Northern Buffer Zone-Northeast
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
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Surface Water
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- Surface Water
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Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)

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Depth Slice Range 1 to 3 Feet Below Ground Surface
Velocity – 0.260 feet per nanosecond
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(11d)GroundPenetratingRadar_NBZ_NE.mxd
9/15/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Legend

Subarea 5C Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
- Terrian Conductivity Anomaly Linear
- Ground Penetrating Radar
- Interpreted Drain Remnant
- Point Source Magnetometer Anomaly
- Point Source Terrain Conductivity Anomaly

Surface Water
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- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)
- Drains
- Wells

Surface Features
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- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 25 50 100
Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12a
Subarea 5C Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

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9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Legend

- Subarea 5B Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
- Terrian Conductivity Anomaly Linear
- Ground Penetrating Radar
- Interpreted Drain Remnant
- Point Source Magnetometer Anomaly
- Point Source Terrain Conductivity Anomaly

Surface Water
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- Lined Channel

Surface Water Flow
- Surface Water Flow (From Boeing Database, 2008)
- Drains
- Wells

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 50 100 200
Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12b
Subarea 5B Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

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9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

See Inset

A

B

C

D

E

F

G

H

0 50 100 200
Scale In Feet

0 5 10 20
Scale In Feet

Legend

Subarea 5A Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
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Surface Features
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- Drain
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- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12c
Subarea 5A Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

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(12C)Subarea_5A_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Legend

Subarea 5D North Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
- Terrian Conductivity Anomaly Linear
- Ground Penetrating Radar
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Surface Water Flow
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Surface Features
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- Drainage Divide
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- Tank
- Tank
- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

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SSFL—Ventura County, California

Figure 12d
Subarea 5D North Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Anomalies\(12D)Subarea_5DN_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HydroGeoLogic, Inc.

E

D

C

B

A

RD-74

Armess Fire Rd.

F St.

G St.

H St.

J St.

24th St.

Bldg 4459

Bldg 4059

Bldg Concrete Pad

Bldg Concrete pad

Bldg 4626

Bldg concrete pad

Bldg 4100

Bldg 4463

Bldg 4662

Bldg 4009

Bldg ISI Storage

Bldg 4709

Bldg 4155

Bldg 4020

Bldg 4468

Bldg 4055

Bldg 4323

Bldg solar facility

Bldg Astronomical

Bldg weather station

Bldg 4425

Bldg 4874

Bldg 4875

Bldg 4375

Bldg 4873

Bldg 4363

Bldg 4865

Bldg 4885

Bldg 4609

Bldg 4604

Bldg 4886

Bldg 4370

Bldg 4814

Bldg 4514

Bldg Shed

Bldg 4317

Bldg 4314

Bldg 4318

Bldg 4730

Bldg 4820

Legend

Subarea 8 North Groups

Centerline Roads

- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings

- Demolished
- Existing

Geophysical Anomalies

- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
- Terrian Conductivity Anomaly Linear
- Ground Penetrating Radar
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- Point Source Magnetometer Anomaly
- Point Source Terrain Conductivity Anomaly

Surface Water

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- Permanent Stream
- Surface Water
- Lined Channel

Surface Water Flow

- Surface Water Flow (From Boeing Database, 2008)
- Drains
- Wells

Surface Features

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Utilities

- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 35 70 140

Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12e
Subarea 8- North Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Anomalies\(12E)Subarea_8N_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HydroGeoLogic, Inc

Points inside this box are labeled in SRE INSET

Points inside this box are labeled in LAUNDRY FACILITY INSET

SRE INSET

LAUNDRY FACILITY INSET

0 12.5 50
Scale In Feet

0 15 30 60
Scale In Feet

0 35 70 140
Scale In Feet

Legend

Subarea 6 Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
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- Cut and Fill Boundaries
- Magnetometer Anomaly Linear
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- Lined Channel

Surface Water Flow
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Surface Features
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- Gutter
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- Vault
- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12f
Subarea 6 Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

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(12F)Subarea_6_Geophysical_Anomaly_Map.mxd
11/30/2011 pbillock
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc

Legend

Subarea 7 Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
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Surface Features
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- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 25 50 100
Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12g
Subarea 7 Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Anomalies
(12G)Subarea_7_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

Legend

- Subarea 5D South Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
- Cut and Fill Boundaries
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Surface Water
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- Well

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 50 100 200
Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12h
5D South Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Anomalies
(12H)Subarea_5DS_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HydroGeoLogic, Inc

DF-A

DF-B

Bldg Edison Substation

Bldg 4313

Bldg 2233

Bldg 2775

Bldg 2796

Bldg 2205

Bldg 2204

Bldg 4114

Bldg Generator

Bldg 4113

Bldg 4623

F St.

3 P10

3 P15

3 P7

3 P9

3 P8

3 P14

3 P5

3 P6

3 P13

3 P31

3 P16

3 P12

3 A1

3 A3

3 L1

3 L2

3 L3

3 A4

3 A5

3 A6

3 A10

3 A8

3 P29

3 P28

3 P11

3 A9

3 A2

3 A7

3 P26

3 P27

3 P4

3 P2

3 P3

3 P1

3 P18

3 P23

3 P32

3 P17

3 P19

3 A11

3 L4

3 P21

3 P20

3 P22

3 P24

3 P25

Legend

Subarea 3 Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
- Magnetometer
- Ground Penetrating Radar
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Utilities
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- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

0 12.5 25 50

Scale In Feet

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12i
Subarea 3 Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

UNITED STATES • ENVIRONMENTAL PROTECTION AGENCY

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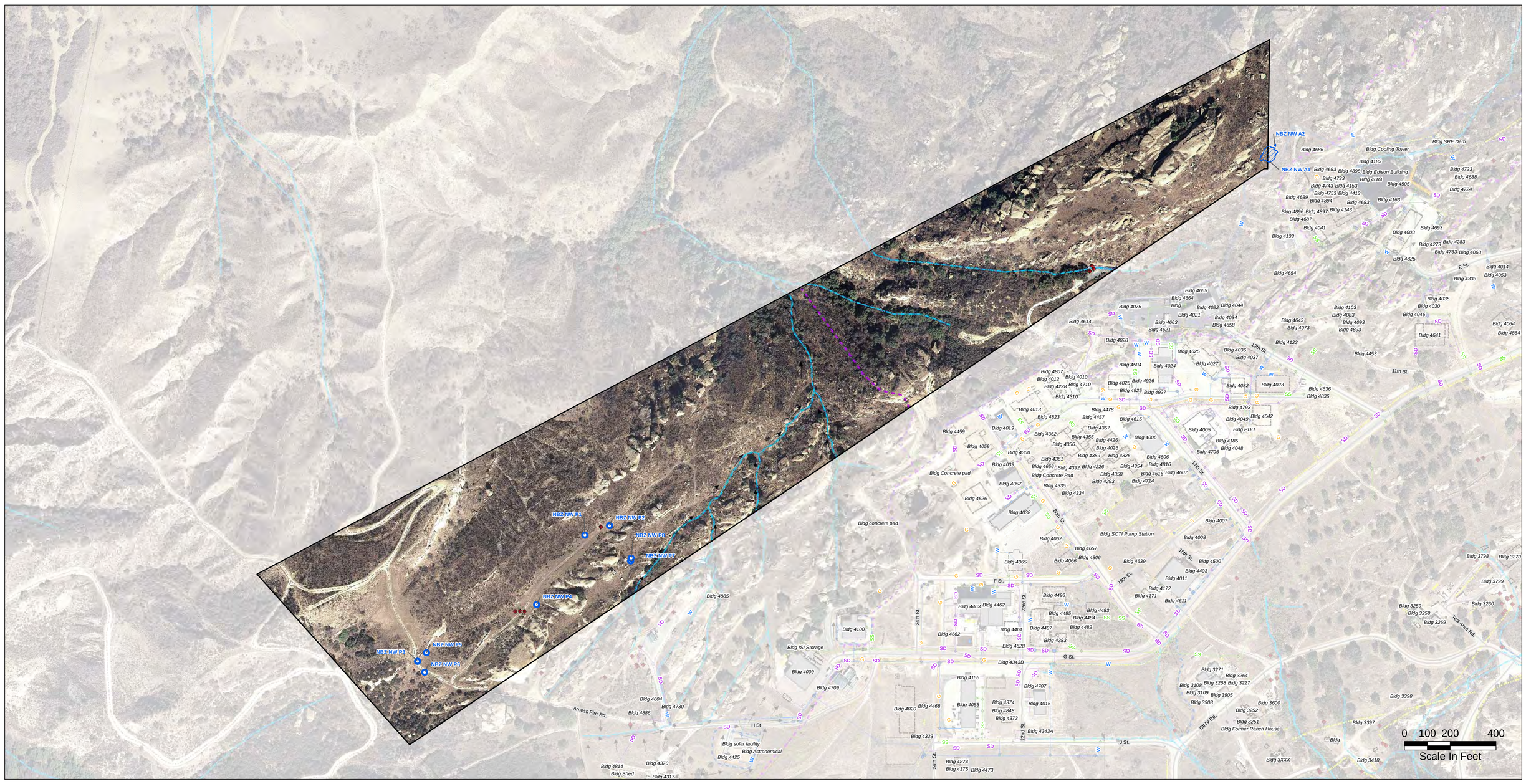
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.



Legend

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing

Geophysical Anomalies
- Terrain Conductivity
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Utilities
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- Storm Drain
- Sanitary Sewer
- Water
- Water (Removed)
- Water (Removed)
- Pipes (Unknown Type)
- Pipes (Unknown Type)

N

HGL—Geophysical Investigation Report,
SSFL—Ventura County, California

Figure 12j
Northern Buffer Zone Anomalies
Santa Susana Field Laboratory

U.S. EPA Region 9

Y:\Santa_Susana\EP9038\Geophysical\ReportMaps_Anomalies\(12J)Northern_Buffer_Zone_Geophysical_Anomaly_Map.mxd
9/14/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007
Coordinate System: NAD83 CA State Plane V

HGL HydroGeoLogic, Inc.

APPENDIX A

ANOMALY TABLES

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LIST OF TABLES

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Appendix A.1
Subarea 5C Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Building 4015 Fill Area		
P0-P24, P49, P50	CVM	Scattered and minor buried metal point source anomalies.
A1	CVM	A rough approximation of the fill area boundary by the scattered subsurface ferrous materials as compared to historical information.
A4, A9	EM, CVM	Small burial area, with some partially buried metal visible at the surface.
A15	EM	Interpreted as a general trend of high terrain conductivity between the fill material to the east and soils to the west.
P25	EM,CVM, GPR	The point source anomaly corresponds to the seeded area created as part of quality assurance and quailiy control anomaly reacquistion.
Area B: Site 4538 Area		
A6, A10	EM	High terrain conductivity at the footprint of former Building 4487 is likely due to moisture retention, possibly caused by seepage from abandoned service lines.
L19	GPR	The linear feature resolved is interpreted to map the footings of Building 4487.
L3-L7, L9, L10	EM, CVM	Linear anomalies map unmarked service lines to former buildings.
Area C: Building 4066 Area		
L1, L2, L11, L12, L16-L18	EM, CVM	Linear anomalies map unmarked service lines to former buildings.
Area D: Building 4059 Area		
A12, P37-P48	CVM	A rough approximation of the fill area boundaries was determined by the distribution of scattered subsurface point source ferrous metals.
A11	EM	The boundaries of former building foot prints and the fill area was approximated by the slightly above background conductivity responses.
Area E: Building 4626 Area		
L13-L15	CVM	Linear anomalies map unmarked service lines to former buildings.
Area F: Building 4100 Open Storage/Fill Area		
A3 P26-P36	CVM	The rough approximation of the fill area boundaries is delineated by the distribution of scattered subsurface ferrous materials that correspond to historical information.

Appendix A.1
Subarea 5C Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
A7, A8	EM	Two circular shaped anomalies east of 24th Street with conductivity values lower than background correlate to a remediation area where the soil was excavated and backfilled.

Appendix A.1
Subarea 5C Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area G: Sodium Pump Test Facility Area		
L20, L21, L23	GPR	Linear anomalies resolved some unmapped service lines and piping structures.
A14	GPR	A larger metallic object along the side of the building was detected.
L24, L25	GPR	Linear anomalies resolved the a footprint of an old road between 22nd and 24th Street, possibly "23rd Street".
A5, A13	CVM, GPR	A near surface ferrous object, that was determined to not be a UST by the GPR profiles.
P51-P53	CVM	Various uninterpreted point source ferrous objects under the surface of the asphalt.
Area H: Northeast of 4015 Fill Area		
A2	CVM	An elongated mounded feature that appears to be underlain by multiple ferrous targets.

Notes:

CVM - cesium vapor magnetometer

EM - electromagnetic method

GPR - ground penetrating radar

UST - underground storage tank

Appendix A.2
Subarea 5B Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Building 4013 (Systems for Nuclear Auxiliary Power) Area		
A2, A6	EM, CVM	Correlated with a materials stockpile area. High terrain conductivity suggests compacted material remnants.
P18	EM, CVM	Buried metal point source anomaly within the possible stockpile area.
L14	EM	Massive linear anomaly that appears to be a large pipe segment or steel structure.
A13 - A15	CVM	CVM anomalies that may correlate to a septic leach field, exact location is unknown.
A1	EM	High terrain conductivity correlated to building demolition.
P4, P10, P11, P13	EM, CVM	Various buried metal point source anomalies.
Area B: Building 4025 Small Component Test Loop Building Area		
L15 - L18, L24	EM, CVM	Linear anomalies that delineated unmapped utilities and piping.
Area C: Building 4356 Processing Area 1		
A7, A9	EM, CVM	Anomalies likely caused by Building 4356 demolition backfill.
L2 - L13, L25 - L28	EM,	Linear anomalies delineated various unmapped utilities and storm drains.
A3, A4	EM, CVM	Anomalies likely located massive demolition debris and buried metals in the area of former Buildings 4334 and 4335.
A19, A20, P3	EM, CVM	Large ferrous metal object near former Building 4226, possibly a small tank.
A17	EM	Likely the remnants of the former leach field.
P12, P14 - P17	EM, CVM	Various buried metal point source anomalies.
Area D: Building 4011 Area		
A11, A12	EM, CVM	Anomalies showed lateral contrasts in soil properties just south of the former spill area.
P6	CVM	Point source anomaly identified in a culturally noisy area northeast of Building 4011, with nothing significant discerned.

Appendix A.2
Subarea 5B Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area E: South Fill Area 11		
A5, A8, A10, A16, A18, A24 P1, P2, P5, P8	EM, CVM	Substantial buried ferrous materials were identified, delineating the remnants of the fill area.
A21 - A23	EM	Anomalies show areas of light toned mounded material from historical information and confirmed small sandy mounds with ground truthing.
L19 - L23	EM, CVM	Linear anomalies delineated unmapped or incorrectly mapped utilities.
P7, P9	EM, CVM	Various buried metal point source anomalies.

Notes:

CVM - cesium vapor magnetometer

EM - electromagnetic method

Appendix A.3
Subarea 5A Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Coal Storage Area		
L1, L2	CVM	Linear anomalies that defined the footings of old coal bin.
L3	CVM	Appeared to be an unmapped utility line.
A32	EM	Anomaly interpreted to indicate excavation and backfilling from the demolition process.
Area B: Debris Field Area		
A19, A21, A24-A28, A39-A44	EM, CVM	Anomalies approximately defined the debris area boundaries, ground truthing suggested that materials were covered with soil rather than buried in a trench.
A20	EM	Anomaly also suggested excavation activities.
Area C: Building 4049 Area		
L7, L8	EM	Linear anomalies delineated the likely location of drain lines that connected two removed radioactive materials storage tanks.
A13	GPR	This anomaly west of the above mentioned "drain lines" might be related to this system.
L9, L10	EM	Delineated the possible location of drain lines from trenches which could not be identified from a historical search.
L4-L6	EM	Linear anomalies that delineated unmapped utility lines, possibly process drain lines.
P10, P11	CVM	Uninterpreted buried metal point source anomalies.
Area D: 4536 Parking Lot Area		
A23, A29, A30	EM	Suggested disturbed areas (possibly backfill) with no direct evidence of buried materials.
A22	EM	Correlated with a light colored feature form historical photos, but was determined to be a natural feature.
A10	GPR	Interpreted as compacted soil due to excavation activities.
P1-P9	CVM	Point source anomalies that identified small amounts of buried ferrous material scattered throughout this area.
A33	CVM	A substantial anomaly with a shape that suggests it may be identifying magnetite concrete debris.
Area E: Building 4029 Area		

Appendix A.3
Subarea 5A Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
A31	EM	High terrain conductivity correlated with a dark spot in historical photos and what appeared to be ponded water.
Area F: Systems for Nuclear Auxiliary Power Environmental Test Facility Area		
L18-L20	EM	Linear anomalies delineated unmapped utility lines.
L21	CVM	Linear anomaly delineated a utility pipe near former Buildings 4027 and 4625, according to historical documents all utilities were removed.
L22	CVM	Linear anomaly possibly delineated the 3 inch cast iron drain line near former Building 4023 that ran through the vault and was part of the liquid waste hold up system.
P12, P13, P16 - P18	CVM	Uninterpreted buried metal point source anomalies.
Area G: Leachfield Area		
A1	EM	Identified targeted leach field.
L28, L29	GPR	Delineated terra cotta pipes associated with the leach field.
L30 - L33	GPR	Broken up terra cotta pipes associated with the leach field.
A5, A8, A9	EM	Likely utility lines in the area of the leach field.
A2 - A4, A6, A7	EM	Changes in soil density due to fill and compaction activities.
Area H: Building 4641 and 4046 Storage Areas		
L16, L17	EM	L-shaped linear anomaly correlated to the west and south side of former Building 4641.
A34 - A38	CVM	Interpreted as buried metal from demolition activities.
L11-L15	CVM	Linear anomalies were interpreted to be remnants of utility lines connecting to former buildings in area.
A45, A48 L27	EM, CVM, GPR	Anomalies were interpreted to delineate a massive ferrous material burials area.
A14 - A18	CVM	Anomalies identified as areas of buried metal.
A46, A47	EM	Areas of high terrain conductivity were interpreted as drainage pathways.
P14, P15, P19 - P21	CVM	Uninterpreted buried metal point source anomalies.

Notes:

Appendix A.3
Subarea 5A Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description

CVM - cesium vapor magnetometer

EM - electromagnetic method

GPR - ground penetrating radar

Table A.4
Subarea 5D-North Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Pond Dredge Area		
A14, A15	EM, CVM	Anomalies A14 and A15 are a rough approximation of the boundaries of Fill Area 14, based on the distribution of instrument responses.
A2-A5, A22-A29	EM, CVM	Various anomalies located in the middle of the approximated Fill Area 14.
P1-P13, P35-P38, P40	EM, CVM	Scattered buried metal point source responses found within the approximate boundaries of Fill Area 14.
A1, A7, A8	EM, CVM	Small anomalies that identified mounded and buried and materials of concentrated ferrous metal, possibly containers.
A18	EM	Interpreted as a "Disturbed Area" within Fill Area 14.
L8, L9, L12	EM	Linear anomalies interpreted to be important drainage pathways.
L17	EM	Linear anomaly that was interpreted to be the linear ground scar identified by historical aerial photography.
L15, L23, L24	EM	Uninterpreted linear anomalies, likely unmapped utility lines.
A9-A10 A12, A16 P14-P34, P53	EM, CVM	A16 is an approximation of a circular debris field and fill area to the east of Fill Area 14, defined by the numerous point source anomalies and smaller area anomalies of ferrous and non-ferrous materials.
Area B: Rockwell International Hot Laboratory (Hot Lab) Area		
A17	EM	Identified as a low saturated area that correlated with the area of Open Storage 16.
A30	CVM	Indentified scattered ferrous materials at the location of Building 4020 demolition excavation. The points were interpreted as magnetite/concrete debris used for radiation shielding in the walls of the buildings.
P39, P50, P56	CVM	Point source ferrous anomalies which are possibly the same magnetite/concrete material found near former Building 4020.
A19-A21	EM	Low areas of sediment accumulation and drainage.
L2-L7, L13, L18	EM, CVM	Linear anomalies that delineated unmapped utility lines.
Area C: Systems for Nuclear Auxiliary Power Critical Facility		
L19-L22 P51	EM, CVM	The point source anomaly and the linear anomalies delineated unmapped utilities.
P54, P55, P57	CVM	Point source ferrous materials.

Table A.4
Subarea 5D-North Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area D: Building 4353 Area		
A31	CVM	Identified mounded materials of buried ferrous metals.
P41-P49, P52	CVM	Point source anomalies identified scattered buried ferrous material. These may be magnetite/concrete debris or metal scrap.
L14	CVM	Linear U-shaped anomaly was interpreted to indicate a structure remnant which corresponded to outside storage area identified from a 1959 aerial photograph.
A13	EM	L-shaped anomaly corresponded to a berm area that was used for surface water erosion control. This area also correlates with an identified potential gamma radiation anomaly (PGRAY).

Notes:

CVM - cesium vapor magnetometer

EM - electromagnetic method

Appendix A.5
HSA Subarea 8 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Borrow Pit Area		
A29, A37, A38, A110, A119, A120	EM, CVM	Anomalies indicate disturbed areas where excavation and fill activities occurred.
A39, A41, A42, A111	EM	Anomalies interpreted to be remnants of truck load sized mounds of non-native soils.
A30-A40, A112-A114 P65-P74	EM, CVM	Indicated that ferrous materials were also disposed of in the borrow pit.
A112, A113	CVM	Identified along the west side of a cut and fill area (A110), near a two sigma radiation response location.
L7	EM	Narrow linear anomaly of high terrain conductivity along sloped area, likely a drainage pathway.
L6	CVM	Linear anomaly identified as a section of pipe.
Area B: Empire State Atomic Development Association Area		
A50	EM	Anomalies corresponded to mounded materials that were visually identified.
A51	EM	Located on the edge of a concrete pad and identified as a vent pipe for a UST, interpretation was not verified.
L8-L10	EM, CVM	Linear anomalies indentified unmapped utility lines.
Area C: Former Sodium Disposal Facility Area		
A114, A115, A123	EM	Interpreted to identify footprints of impoundments 77, 3, and 2 that were inside the Former Sodium Disposal Facility Area.
A116	EM	Indentified foot print of a former Waste Disposal Area 1.
L2, L3	EM	Uninterpreted linear anomalies.
A122	EM	Corresponded to light toned mounded material identified in historical aerial photography.
A2	CVM	Interpreted to be the likely location of a former burn area identified in historical aerial photography.
A124	CVM	Suggested an area of dark toned material identified in historical aerial photography.
A129	EM	Anomaly interpreted as fill material associated with Fill Area 1.
A127, A128, A130	CVM, GPR	GPR and CVM data suggest possible buried metal within an area of subsidence located in Fill Area 11. Data is inconclusive due to interference from structures associated with Outfall 6.

Appendix A.5
HSA Subarea 8 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
A126	EM	Identified the location of the former pistol range.

Appendix A.5
HSA Subarea 8 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area C: Former Sodium Disposal Facility Area (Continued)		
L4, L15-L18	EM, CVM	Interpreted as remnants of the former concrete ditch drainage.
L5, L19	EM, CVM	Linear anomalies located mapped and unmapped utility lines.
Area D: Building 4009 Area		
A52, A53	EM	A UST was identified at the north end of the Building 4009 by all three technologies, in the location of the contaminated waste holdup tank. Note that only EM data was indicated on map.
A54	EM	Uninterpreted area of high terrain conductivity on the northeast end of Building 4009.
A117	EM	Responses corresponded with a known leach field north of Building 4009.
A55	EM	Uninterpreted, but may be associated with the leach field identified in A117.
L11, L12	EM	Linear anomalies were interpreted as effluent drainage from the leach field to the north towards Fill Area 2.
L1	EM	Linear anomaly indentified unmapped utility line across the parking lot.
A121	EM	Interpreted to delineate the boundaries of Fill Area 2.
A17, A18	CVM	Anomalies identified locations of buried metal associated with Fill Area 2 and a possibly section of pipe.
A56	EM	Uninterpreted area of high terrain conductivity south of Building 4009.
Area E: Building 56 Landfill Area		
A3-A16, A19, A22-A27, A44-A49, A84	EM, CVM	Indicated areas of massive surface and subsurface ferrous metal and likely demolition debris in the landfill area and ravine.
A1	GPR	Small anomaly located west of well RD-74, at about 1.5 feet below ground surface suggested multiple sources of non-metallic debris.
A20, A21	EM	Interpreted as "disturbed areas" with buried ferrous material.

Notes:

CVM - cesium vapor magnetometer

EM - electromagnetic method

GPR - ground penetrating radar

Appendix A.6
HSA Subarea 6 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: North of the Sodium Reactor Experiment		
A31, A32, A34	EM, CVM, GPR	Indentified as former radioactive waste storage facility Building 4686 pad.
A30, A33 L28 P124-P126	EM, CVM	Identified areas of buried metal south of former Building 4653 in the liquid waste tank area.
P122, P123, P163-P166	CVM	Various point source buried metal anomalies.
A35	CVM	Anomaly east of Tower 4703 indentified as a potential gamma radiation anomaly location, that was later determined to be geologic in nature.
Area B: Sodium Reactor Experiment		
A22, A26-A29, A51, A64, P85-P120, P192-P206, P208-P221, P223-P235	EM, CVM, GPR	Numerous point source anomalies and larger area anomalies identified massive buried ferrous metal, presumed to be demolition debris, located southwest of the tarp area and beneath the tarp area.
L13, L20, L21, L27, L30, L31, L39-L41	EM, CVM	Several linear anomalies beneath the tarp suggested supply lines and possibly building girders from demolition based on historical photographs.
A15	EM	A large area of high terrain conductivity in the of location of former Building 4143 likely identifying an area of moisture retention where excavation could have occurred.
A16, A17, A37-A39	GPR	Indentified as likely changes in soil density or compaction at shallow depths due to excavation activities.
A55	EM	Identified as a septic tank excavation area.
A56-A58, A63	EM	Elongated anomaly and several smaller anomalies of high terrain conductivity indentifying a former leach field from septic tank. Peaks in terrain conductivity may represent residual leachate contamination.
A36 P127, P128	CVM	Marks the location of demolition debris and in-situ footing remnants of the cooling tower.
Area C: Building 4003 and Laundry Buildings Area		
A59	EM	Area of high terrain conductivity identified in the former Building 4003 area, a low lying area where moisture ponds during rains, this likely marks the area of demolition excavation with contrasting fill material.
L2-L7, L14	EM, GPR	Several linear anomalies locating abandoned service lines to former building 4003.

Appendix A.6
HSA Subarea 6 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
L8, L17	EM, GPR	Linear V-shaped anomaly between the cluster of former buildings in the laundry area where identified.

Appendix A.6
HSA Subarea 6 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area C: Building 4003 and Laundry Buildings Area (Continued)		
P1-P35, P52-P84, 133-142, P243-P253, P268-277	EM, CVM	Many scattered point source ferrous and non-ferrous anomalies were identified throughout area likely demolition debris concrete, magnetite nodules and scrap metal. A magnetite nodule was uncovered in the location of P6.
A65	EM	Elongated anomaly of high terrain conductivity marked a drainage pathway and what appears to be old asphalt pavement. Possibly a septic leach field from the former laundry buildings.
A66-A69	EM, GPR	Area of mounded soils, responses from instruments indicated areas of non-metallic materials of coarser material than the surrounding soil matrix.
A14, A25	EM, CVM	Mounded material area identified as an area of demolition debris and partially in-situ structures remaining from former Building 4783.
Area D: Sodium Reactor Experiment Fuel Storage and Support		
A40, A44-A47, A50 P255-P257	CVM, GPR	Various anomalies clustered at the northwest end of former Building 4064, likely indentifying demolition debris. GPR data indicated 1-2 feet of soil overburden.
A18,	EM	Elongated anomaly extending to the southwest of former Building 4064, interpreted as a drainage pathway.
A41, A42 P130, P132, P258	CVM, GPR	Indentified in a former open storage area that overlaps an excavation area that may indicate a former leach field.
L33-L35	EM	Linear anomalies interpreted as unmapped utility lines.
P145-P149, P173-P180, P182-P185, P254	CVM	Various point source anomalies near former Building 4014 footprint and near F Street, likely demolition debris. A magnetite nodule was uncovered in the location of P175.
L15, L16	EM	Linear anomalies interpreted as remnants of the footings for former Building 4014.
L36-L38	EM, CVM	Uninterpreted linear anomalies, possibly unmapped utility lines to former buildings.
Area E: Central Subarea 6		
L42, L43	EM	Located in areas of mounded material made up of asphalt and concrete debris, the nature of the response resembled pipe signatures.
P50, P51, P168, P169, P172, P265	CVM	Point source anomalies of subsurface metal and some surface scrap metal was observed.

Appendix A.6
HSA Subarea 6 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area F: Old Conservation Yard		
A60, A61	EM	Area of high terrain conductivity corresponding to a paved area of the same shape in historical aerial photography, responses are probably from compacted soil and paving material used for construction.
P242, P266, P278-P290	CVM	Various point source anomalies in and around the above mentioned paved area.
A52	EM	Corresponds to an identified chemical contamination area known as "Central Transformer".
A53	EM	Uninterpreted anomaly near the "Central Transformer" chemical contamination area.
L45-L47	EM	Linear anomalies that divide the above mentioned, formerly paved area. These anomalies were identified as abandoned steel pipeline that was exposed at the surface in a few locations.
A1-A7	GPR	Small scattered anomalies, most likely biologically disturbed zones and not buried materials.
A19 P259, P267	EM, CVM	Area of high terrain conductivity that corresponds to the footprint of AST 4732, and likely fill material from the tanks demolition
A20	EM	Remnants of the berm surrounding AST 4732 was evident in the U-shaped area of high terrain conductivity.
A23, A24	EM	Two elongated anomalies that suggest excavation and stockpiling of materials, which corresponded to ground truthing observations.
A8, A9	GPR	Anomalies were interpreted as changes in soil density likely due to excavation and backfilling activities.
P143, P159, P260-P263, P186-P189	CVM	Point source anomalies surrounding the area of former AST 4731.
P144, P156-P162	CVM	A cluster of point source anomalies suggesting a burial area that corresponds to an identified chemical contamination area known as the "Northern Bench Area".
P154, P236-P241	CVM	Scattered point source anomalies of buried ferrous materials which corresponds to former area of Open Storage 4.
A10-A13, A62 L1	EM, GPR	Uninterpreted small anomalies and linear anomalies in the area of Open Storage 4.
L32	EM	Interpreted as a culvert or section of pipe.

Appendix A.6
HSA Subarea 6 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area G: New Conservation Yard		
6 A71	EM	Anomaly corresponded to identified chemical contamination area known as "New Conservation Yard South", This anomaly was difficult to define due to interference from existing fence and surface metal.
6 A70	EM	Strong anomaly in center of surveyed area suggested a reinforced concrete structure, such as a footing for a small building, partially in the "New Conservation Yard South".
L48-L51	EM, CVM	Linear anomalies interpreted as unmapped utility or service lines.
L18, L19	GPR	Uninterpreted linear anomalies, possibly unmapped utility or service lines.
P41-P49, P291-P295	CVM	Scattered point source anomalies identifying isolated buried ferrous materials.

Notes:

AST - aboveground storage tank

CVM - cesium vapor magnetometer

EM - electromagnetic method

GPR - ground penetrating radar

Appendix A.7
HSA Subarea 7 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
Area A: Building 4028 Area		
P4-P25	CVM	Various point source anomalies representing isolated buried ferrous materials.
A4	EM	Corresponded to a disturbed area in historical aerial photos and was identified as piles of blasted out bedrock boulders.
A3	EM	Corresponded to a disturbed area in historical aerial photos and was identified as mounded material and a disturbed area near a well.
A1, A2, A8	EM	Corresponded to a disturbed area in historical aerial photos and was identified as an a cut and fill area.
A9	EM	Elongated anomaly corresponding to a grading slope north of former Building 4012, that appeared to be a scattered debris field of general trash.
A5	EM	Indentified northeast of the retention pond and corresponded to blasted rock material and fill.
L2, L9	EM	Uninterpreted linear anomalies probably unmapped utilities.
Area B: Radioactive Material Handling Facility and Leach field Area		
A7	EM	Elongated anomaly defined a wide drainage path towards Outfall 3.
L3-L8	EM	Linear anomalies that identified significant drainage pathways.
A6	EM	Elongated anomaly that delineates the former Radioactive Materials Handling Facility leach field that served the septic system in former Building 21.
P35-P42	CVM	Various point source anomalies representing isolated buried ferrous materials. Some may be caused by ferrous minerals in neighboring rock formations.
Area C: Building 4133 Area		
A16-A19 P33, P34	EM, CVM	Anomalies identified two debris fields, various surface metal, concrete debris, partially buried and buried ferrous materials were observed.
P26-P32	CVM	Various point source anomalies representing isolated buried ferrous materials.
A10-A15 P3	CVM, GPR	Corresponded with the location of the Interim Storage Facility and interpreted to show remnants and debris from the interim waste storage facility and the storage pad excavation.
L1, L11 P1	GPR	Linear anomalies and point source anomaly identified unmapped utility/pipe lines in the Interim Storage Facility area.
A20	CVM, GPR	Identified as a burial area measuring 5 feet by 10 feet of concentrated ferrous material. Some magnetite/concrete debris observed at the surface, but does not rule out buried containers.

Appendix A.7
HSA Subarea 7 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description

Notes:

CVM - cesium vapor magnetometer EM - electromagnetic method GPR - ground penetrating radar

Appendix A.8
Subarea 5D-South Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
A3, A4	EM	High terrain conductivity interpreted to be an area of subsidence due to borrow activities causing water ponding and sediment accumulation.
A1	EM	Anomaly on the slope was identified as a "disturbed area" where soil had been moved and backfilled.
A2	EM	Oblong anomaly on west side of drainage basin, corresponds to the remains of an open trench.
L1	EM	Linear anomaly interpreted to represent a drainage pathway.

Notes:

EM - electromagnetic method

Appendix A.9
HSA Subarea 3 Anomaly Summary Table

Anomaly Identification	Instrument	Anomaly Description
A1-A3, A7	EM, CVM, GPR	All three technologies identified large areas of subsurface and surface ferrous and non-ferrous materials, indentified as debris fields DF-A* and DF-B.
P1-P33	CVM	Point source anomalies of buried ferrous material were scattered around the area.
A4-A6, A8-A10	CVM, GPR	Smaller areas of ferrous materials east of DF-B.
A5	GPR	Likely identified an area of compacted fill and soil from excavation activities.
L1, L3	CVM, GPR	Linear anomalies identified buried sections of pipe or demolition debris.
A7	EM	Responses suggested excavation activities beyond the boundaries of the surface metal.
L4	EM	Linear anomaly identified a segment of an unmapped utility line or culvert.
P24, P25	EM	Point source anomalies corresponded to mounded material.
A11	EM	Identified in the vicinity of identified chemical contamination area designated "Southeast Transformer".
A1, A2	CVM, GPR	Defined an identified chemical contamination area designated "Eastern Debris Area".

Notes:

*DF-A is located in Subarea 6, but was surveyed during the Subarea 3 survey. Thus it was included in the Subarea 3 discussion.

CVM - cesium vapor magnetometer

EM - electromagnetic method

GPR - ground penetrating radar

Appendix A.10
Northern Buffer Zone Anomaly Summary Table

Area	Anomaly Identification	Instrument	Anomaly Description
NBZ Northwest	**Area A: Wells Area**		
	P1-P8	CVM	Scattered point source anomalies were identified indicating small ferrous materials.
	Area B: AD HOC Area		
	A1, A2	CVM	Interpreted to be disposal grounds for magnetite/concrete debris as evident by several magnetite/concrete nodules found on the surface. There may be buried metal associated with this disposal area as well*.
NBZ Northeast	**Area C: Northern Storage PCB Areas 1 and 2**		
	A1, A2, A6	EM, CVM	Indentified substantial buried ferrous materials and debris fields.
	P1-P10	CVM	Scattered point source anomalies indentified various buried ferrous materials.
	A7-A11 P12, P13	EM, CVM	Anomalies near the debris fields indicated surface and buried material, empty 55-gallon drums were observed.
	A12	EM	Area of high terrain conductivity was interpreted to be a drainage pathway to the debris field.
	Area D: North of Building 203 Complex		
	A5 P11	CVM	Small anomalies and point source anomalies were observed in portions of the area.
	A3, A4	CVM	Anomalies identified light debris fields with small amounts of buried metal.

Notes:

*A2 and part of A1 are located in Subarea 7, but was identified and surveyed during the NB survey. Thus it was included in the NBZ discussion.

CVM - cesium vapor magnetometer
EM - electromagnetic method
GPR - ground penetrating radar