MCCORMICK AND BAXTER SUPERFUND SITE CASE STUDY: STOCKTON, CALIFORNIA

U.S. Environmental Protection Agency
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Notice

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FOREWORD

Cost-effective cleanup (remediation) of hazardous waste sites cannot occur unless the type, quantities, and locations of chemical contaminants present at the site are adequately determined by a process called characterization. Sampling and chemical analysis of environmental media (water, soil, sediment, etc.) is vital to designing a remediation regimen that will accomplish the desired goal of reducing risk to human health and the environment. Unfortunately, site characterization has historically been very costly and time consuming because the technological options have been few and sometimes inefficient.

Recent technological advances promise better site characterization at less cost and in a shorter time frame, yet adoption of new technologies into mainstream engineering practice is very slow. Three widely acknowledged barriers to the adoption and use of innovative site characterization technologies at hazardous waste sites are:

- Potential users lack personal awareness and/or experience with the technology.
- Potential users lack the established performance criteria needed to assess the applicability of the technology for a prospective project, and
- Potential users lack the cost and performance information needed to efficiently plan the project and allocate resources.

The collection and dissemination of cost and performance information is essential to overcoming these barriers. While technology developers and vendors can be valuable sources of this information, their claims often carry less weight than evaluations from colleagues who have used the technology themselves. Case studies are a means by which technology users and impartial observers may disseminate information about successful applications of innovative technologies and add to the pool of knowledge that helps move a technology past the “innovative” stage, thus significantly shortening the time required for widespread benefits to be realized. Case studies can also be a rich source of feedback to researchers and developers seeking to improve or refine technology performance under various site conditions.

Individual case studies may focus on a particular technology or on a characterization approach or process. Case studies focused on process can provide education about how efficient characterization strategies can be implemented on a site-specific basis, and thus can be valuable adjuncts in training courses, For many reasons, case studies are valuable tools for the environmental remediation community.

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CASE STUDY ABSTRACT

McCormick and Baxter Creosoting Company
Stockton, San Joaquin County, California

<table>
<tr><td>Site Name and Location:
McCormick and Baxter Creosoting Company, California</td><td colspan="2">Sampling & Analytical Technologies:

Sampling Technologies
1. Site characterization and penetrometer system (SCAPS)
2. Rotosonic Drilling
3. Low-flow groundwater sampling
4. Conventional “3 volume purge” groundwater sampling
Field Based Analytical Technologies
5. Laser induced fluorescence (LIF) sensor
6. Cone penetrometer tip (CPT)
7. Total recoverable petroleum hydrocarbons (TRPH). SCAPS SOP.
8. TPH analysis with diesel range extended (TPH-Dx). EPA Region 9 SOP modified.
Fixed Laboratory
11. TPH-Dx. EPA Region 9 SOP.
12. PAHs and PCP. EPA Region 9 SOP modified.
13. Dioxin and Furans. SW-846 method 1613B.
14. Polychlorinated Biphenyls (PCBs). CLP-SOW modified.
15. Metals (As, Cu, Cr, Zn). CLP SOW.
16. Total Organic Carbon (TOC). Walkley-Black method.
17. Grain size. ASTM method D422.
18. Density. ASTM method D2937.
19. Porosity. API method RP40.
20. Permeability. Kerr laboratory SOP.
21. NAPL Saturation (Oil and Grease). PTS SOP.
22. Cation Exchange Capacity. SW-846 method 9081.</td></tr>
<tr><td>Period of Operation:
1942 to 1991. Creosoting facility.</td><td></td><td>Current Site Activities:
Site is currently closed.</td></tr>
<tr><td>Point of Contact:
Kira Lynch, US Army Core of Engineers, Seattle District
4735 East Marginal Way South
EC-TB-ET
Seattle WA 98134
Phone: 206-764-6918
Fax: 206-764-3706</td><td>Media and Contaminants:
Groundwater, soils, and sediments at the McCormick and Baxter facility in Stockton, California are contaminated with chlorinated and aromatic solvents, metals, and petroleum compounds.</td><td>Technology Demonstrator:
None</td></tr>
<tr><td colspan="3">Number of Samples Analyzed during the 1999 and 2000 NAPL Investigations:
• 181 SCAPS LIF/CPT pushes
• 161 TPH Confirmation Samples</td></tr>
<tr><td colspan="3">Cost Savings:
The cost savings using this approach are estimated at 40-50% of traditional methods</td></tr>
<tr><td colspan="3">Lessons Learned:
• It is often technically impossible to characterize complex NAPL sites using traditional sampling and analytical technologies because of the density of data points required to characterize the source material distribution, the time associated with collecting samples by conventional drilling techniques and analyzing at an analytical laboratory, the enormous costs associated with a traditional investigation, and the inherent difficulties in locating NAPL in complex matrices.
• Data from field-based and fixed laboratory methods must be used collaboratively to characterize the NAPL and evaluate the feasibility of proposed treatment options in a time and cost efficient manner.
• The use of performance based measurement standards (PBMS) is crucial in order to determine the applicability of methods for the site-specific matrices, modify field and laboratory analytical methods to provide the data necessary for making project decisions, and ultimately save the project time and money.</td></tr>
<tr><td colspan="3">Results:
• Finished sampling 30 days ahead of schedule.
• Field crew and project manager were able to review data as it was produced at the site and then use that knowledge to determine appropriate future sampling locations
• 31 Borings and a number of SCAPS sampling locations eliminated once it was determined that NAPL was not migrating north of the Old Mormon Slough or found closer to the site.
• 19 Borings were added to increase data points in areas where the extent of contamination exceeded original estimates.
• 9 SCAPS LIF/CPT pushes were added to determine the source of TPH in a previously overlooked area.
• Although 11 microwells were planned, 16 were installed due to rapid installation times.</td></tr>
</table>

WHO SHOULD READ THIS CASE STUDY

- √ **Remedial Project Managers (RPMs) and technical teams developing conceptual site models at large complex sites.**
- √ **RPMs and technical teams using dynamic field activities during the RI/FS and RD/RA stages of the Superfund process.**
- √ **Technical personnel using site characterization and penetrometer systems (SCAPS) to obtain site specific data.**
- √ **Technical personnel using laser induced fluorescence (LIF) sensors to obtain site-specific petroleum hydrocarbon data.**
- √ **Technical personnel using cone penetrometer (CPT) sensors to obtain site-specific stratiographic and subsurface geological information.**

WHAT YOU WILL LEARN FROM THIS CASE STUDY

- √ **Why conventional sampling and analytical technologies may be inadequate or cost prohibitive for use at large complex NAPL sites.**
- √ **Information necessary to compile a comprehensive conceptual site model for subsurface soil and groundwater contamination at a NAPL site.**
- √ **Example data quality objectives (DQOs) for field based measurement technologies, modified mobile laboratory methods, and commercial analytical laboratories.**
- √ **How field based measurement results for SCAPS LIF and CPT data are used collaboratively with mobile and fixed lab methods to meet project objectives.**
- √ **DQOs for development of field investigation programs to provide the necessary information to make site decisions in the Superfund process.**
- √ **How performance based measurement systems (PBMS) are used to determine method applicability for the site matrices, make method modifications as necessary, and ultimately save the project time and money.**

EXECUTIVE SUMMARY

A case study of the McCormick and Baxter Superfund site located in Stockton, California is provided in this attachment to highlight the processes involved in characterizing a Superfund site and developing a conceptual site model (CSM) for remedial investigations and feasibility studies (RI/FS) as well as remedial design and remedial action (RD/RA) activities. The McCormick and Baxter site is relatively large, and given the various types, location, and volume of contamination, it presents the project manager and other decision makers with a series of complex challenges that must be met in order to characterize the site and ultimately determine a clean-up strategy.

For the purpose of this case study, we will focus on the non-aqueous phase liquids (NAPL) contamination found in the subsurface soils and groundwater at the site and the dynamic field activities used to characterize the contamination and develop a detailed CSM. Although this case study provides some testimonial as to the effectiveness of the innovative site characterization sampling and analytical techniques used, the main focus of the study is to provide insight into how a dynamic approach to planning and field activities can provide large quantities of appropriate quality data while saving the project time and money.

Due to the application of systematic planning and dynamic field activities used during the 1999 and 2000 NAPL field investigations, the volume of data points was significantly increased while the number of mobilizations and the time needed to complete field activities decreased when compared to the expectations of the original management plan. A conventional “static” workplan that dictates the location and number of samples collected often does not allow for the real-time data review and field decision-making utilized at the McCormick and Baxter site during these investigations. When compared to the techniques used during the 1999 and 2000 NAPL investigations it is clear that use of a conventional workplan would have resulted in an increased number of field mobilizations leading to increased costs and a decreased number of usable data points.

The most obvious advantage of using the dynamic work plan was the ability of the field crew and project manager to review data as it was produced at the site and then use that knowledge to determine appropriate future sampling locations. Analytical methods used at the on-site mobile laboratory and the off-site fixed analytical laboratory were modified to increase turn around time on the data and still provide the information necessary to make project decisions. Additionally, the flexibility offered from this approach allowed for the completion of approximately 5 additional microwells and 60 more soil borings than expected, and field activities were completed

30 days prior to the scheduled completion dates. The field crew also had the ability to sample previously unidentified surface contamination found during the investigations and gather an abundance of geotechnical and subsurface geologic data.

The large quantity of data collected was ultimately used to develop and refine a detailed CSM, a necessary component used to aid in making informed project decisions. Crucial information gathered included: determining the vertical and horizontal distribution of NAPL, physical and chemical characteristics of the NAPL; type, thickness, and heterogeneity of the subsurface geologic material and the presence of any manmade subsurface physical barriers. This information was ultimately used to evaluate the fate and transport characteristics of the various types of contamination found at the site and determine the technical and economic feasibility of in-situ remedial options such as steam injection/stripping and electrical heating.

1.0 SITE BACKGROUND AND HISTORY

The McCormick and Baxter Company located in Stockton, California operated as a wood treatment facility from 1942 to 1991. The site address is 1214 Washington Street in Stockton, California 95203, and the EPA identification number is CAD009106527. The site occupies approximately 32 acres in an industrial area near the Port of Stockton at the junction of Interstate 5 and State Highway 4 (**Figure 1-1**). The site is bound by the Old Mormon Slough to the north, which connects the facility to the Stockton Deepwater Channel on the San Joaquin River, Washington Street to the south, Interstate 5 to the east, and an industrial facility located at the Port of Stockton Turning Basin to the west (**Figure 1-1**). In addition, an 8 acre parcel located in the southeast portion of the McCormick and Baxter site is owned by the Union Pacific Railroad. Entry to the site is controlled by a perimeter fence and 24-hour security.

A variety of wood preservation processes were conducted during the operational history of the facility to provide treated wood products to the power and utility industry, railroads, and construction companies. Preservatives used included: creosote, pentachlorophenol (PCP), arsenic, chromium, copper, and zinc. In addition to the chemicals used to preserve wood products, a number of other chemicals were used as carriers or solvents to aid in the preservation process. These chemicals were mainly petroleum-based fuels and included kerosene, diesel, butane, and ether. For most of the processes used at the site, wood products were impregnated with the resulting solutions using a pressurized retort. The wood was then removed from the pressurized retorts and allowed to dry at various storage locations throughout the site.

Waste oils generated from the wood treatment processes were disposed of in unlined ponds and concrete tanks on-site. In 1977, the California Department of Fish and Game investigated a fish kill in the Old Mormon Slough and the Port of Stockton and concluded that the fish kill resulted from PCB-contaminated water runoff from the McCormick and Baxter site. A cleanup abatement order was issued to McCormick and Baxter by the California Regional Water Quality Control Board (RWQCB) in January 1978 and water runoff from the site, which was previously discharged into the Old Mormon Slough, began to be collected it in two storm water collection ponds on site.

In 1981, McCormick and Baxter filed for bankruptcy protection under Chapter 11 of the bankruptcy code. Then in early November 1990, the United States Bankruptcy court for the District of Oregon entered a first amendment plan of reorganization, which included an agreement for environmental remediation at the Stockton facility. The plan required McCormick and Baxter to undertake environmental response actions at the site, however in October 1991 due to actions taken by the lender for McCormick and Baxter the state was advised that they would cease operating and discontinue environmental response actions. EPA added the site to the national priorities list (NPL) in October 1992 and later conducted a number of investigations at the site.

Early investigations at the site focused on upland soils and groundwater as well as surface water and sediment contamination at the site. Preliminary site investigations included soil, groundwater, and sediment sampling; well installation; aquifer testing; a NAPL study; tidal influence study; vadose zone modeling; and performance of a human health and ecological risk assessment.

The primary past sources of contamination in the upland area of the site were found to include:

- Old oily waste pond area
- Concrete oily waste tank
- Paved pole washing area
- Track pit
- Underground and aboveground storage tanks (USTs and ASTs)
- Oil/water separators
- Condensate storage tanks

- Stormwater collection sumps

(Several of these source areas are identified in **Figure 1-2**)

Primary sources of contamination to the Old Mormon Slough were process spills, direct discharges of industrial waste and storm water to the slough, and subsurface migration of contaminants from the upland area.

Field activities conducted during the site characterization phase at McCormick and Baxter revealed that soil and groundwater at the site were contaminated primarily with creosote, PCP, dioxin/furans, and metals that were used as wood preservatives. Free phase product, found as NAPL was determined to exist in the subsurface and additional contamination was found dissolved in groundwater and adsorbed to subsurface geologic materials.

A record of decision (ROD) was signed on March 31, 1999 to address basic, neutral, and acid-extractable semivolatile organic compounds (SVOCs), dioxins and dibenzofurans, metals, and polycyclic aromatic hydrocarbons (PAHs) in contaminated groundwater, sediments and soils. The ROD presents final remedies for vadose zone soils and sediments, and an interim remedy for groundwater. The selected remedies include excavation of some soils, consolidation and capping of some soils, in-situ capping for some sediments and groundwater extraction and treatment with systematic removal of dense non-aqeous phase liquids (DNAPL). The groundwater treatment interim remedy was selected in order to contain the groundwater contamination, prevent migration of contaminants in the downgradient direction, and prevent further degradation of the aquifer beneath the site. Additional feasibility studies were conducted in 2000 and 2001 at the McCormick and Baxter site to evaluate potential NAPL source material remedial actions and to develop a final remedial strategy for contaminated groundwater.

1.1 PRELIMINARY CONCEPTUAL SITE MODEL

This section provides a conceptual model of the fate and transport of contaminants based on sources of contamination, type and extent of contamination, and mechanisms impacting contaminant migration. The preliminary conceptual site model (CSM) was developed from information collected during the early site characterization activities at the McCormick and Baxter site.

1.1.1 Sources of Contamination

Areas identified as the probable sources of contamination found at the site include the main (central) processing area (operational from 1942 through 1990), the oily waste pond area (operational from 1942 through 1980), and the treated wood storage areas (operational from 1942 through 1990). In the main processing area, the primary sources of contamination were the retorts and associated sumps and piping, track pit, pole washing area, USTs and ASTs, oil/water separator (O/WS) systems, and condensate storage tanks.

All wood treatment process units and storage tanks at the site have been emptied of the chemicals they contained, cleaned, and removed from the site. The remaining contaminant source areas at the site developed from the past release of wood-treating chemicals to surface soils, deeper soils and groundwater through past processing operations, spills, chemical handling practices, and drippage from treated wood. The sediments of Old Mormon Slough were also found to be contaminated as a result of chemical process spills, surface runoff, direct discharge of stormwater through outfalls, and/or subsurface migration from other operable units (i.e., seepages from the former oily waste pond area).

A removal action to control seeps in 1996 resulted in the development of a repository unit adjacent to the main processing area and the filling of cement-lined basements in the main processing area. The repository was used for 15,000 cubic yards of contaminated soil from the oily waste pond area, and the basements were filled with tank bottom sludge, investigation-derived waste, and other debris. The main processing area, which is the most heavily contaminated area of the site, has been covered with an asphalt cap, but remains as a potential contaminant source to the subsurface.

1.1.2 Description of the Contaminated Physical System

The wood-preserving process at this site used the preservatives creosote, PCP, copper, chromium, and arsenic. Creosote is a blend of various coal tar distillates that may contain up to 90 percent PAHs mixed with other hydrocarbons. Technical-grade PCP contains 85 to 95 percent PCP; the remainder is a mix of other polychlorinated phenols and about 0.1 percent dioxins and furans. Both creosote and PCP were mixed with an aromatic carrier oil such as No. 2 fuel oil prior to use for wood preservation. In addition, creosote was also mixed with butane and ether as carrier fluids to create Cellon. Metals were typically mixed with ammonium.

Chemicals detected in LNAPL and DNAPL are consistent with the products historically used on site (i.e., creosote, PCP, and aromatic carrier oils). These two liquid phases generally contain varying concentrations of PAHs, polychlorinated phenols, and various other semivolatile and volatile organic compounds (SVOCs and VOCs). Detected chemical concentrations in LNAPL and DNAPL are similar, except that PCP is more prevalent in LNAPL because LNAPL has a lot of di-isopropyl ether which was used with PCP in the cellon process. The process and contaminant source areas are shown on **Figure 1-2**.

The primary chemicals of concern (COC) for the site are creosote and PAH components of creosote mixtures (including carcinogenic PAHs, non-carcinogenic PAHs (acenaphthene, anthracene, fluorene, naphthalene, and pyrene), PCP, arsenic, and dioxins/furans. Dioxins/furans are believed to have originated as manufacturing impurities contained in the PCP solutions. Although relatively nontoxic, naphthalene is included as a COC because it is widely distributed throughout soil and groundwater at the site in relatively high concentrations and it serves as an indicator for the presence of noncarcinogenic PAHs.

1.1.3 Description of Soil Contamination

In general, elevated chemical concentrations in site soils appear to be present primarily in the western portion of the site, mainly the former main process area, the Cellon process area, the oily waste pond area, and the track pit. Only shallow soils are contaminated in the eastern portion of the site, with the exception of a few isolated hot spots. Areas containing lower levels of contaminants in the western portion of the facility are the former pole wash, tank farm, and butt tank areas. Concentrations of COCs in soils generally decrease with increasing depth.

Two sources of NAPL have been identified at the site, creosote and non-creosote NAPL. Creosote NAPL was identified using multiple lines of evidence, including:

- Visual observation of NAPL in soil cores
- Presence of Sheens in soil cores
- SCAPS LIF Data

NAPL saturation observed in soil cores ranged from oozing or dripping product to brown stains or a sheen.

Geologic cross-sections depicting the distribution of NAPL contamination were prepared by reviewing soil logs for visible evidence of NAPL. It was determined from a review of available data and logs the chemical compositions of the LNAPL and DNAPL were similar. The DNAPL contains relatively more PAHs and less PCP than the LNAPL. The greater percentage of PAHs in the DNAPLs (20 to 24 percent) relative to LNAPL (6 percent) may be an indication that the mass of PAHs in the oil affects the products' density and may be a controlling factor in determining whether the product sinks or floats. All NAPL samples contained a substantial portion of miscellaneous hydrocarbons that were not identified. These likely derive from the various fuel oils and petroleum products used as carriers in the original PCP and creosote solutions.

Field observations, soil data, and SCAPS LIF data suggest that there are four primary NAPL source areas at the McCormick and Baxter site: the oily waste pond area, the central processing area, the main processing area, and the south main processing area known as the PCP mixing shed. The data also suggests that NAPL has migrated and continues to migrate away from these areas extending vertically downward as well as outward to the north south, east, and west. DNAPL has migrated from the water table to a maximum observed depth of 212 feet below ground surface (bgs) and existing DNAPL data has been interpreted as having migrated in the saturated zone by moving vertically through permeable sand units, spreading laterally in sands and above sloping low-permeability silts, pooling above low-permeability silts, and migrating vertically through silts.

NAPL data compiled from previous investigations including the 1999 and 2000 events were used to map the product distribution and estimate NAPL volumes sitewide. Although some NAPL has migrated off-site, the amount of NAPL offsite is presumed to be small and plume volume estimates have been truncated by the property boundaries. The minimum volume of subsurface NAPL contamination is estimated at the site is 975,000 gallons, while the maximum estimates put the volume of NAPL in the subsurface at 1.9 million gallons.

1.1.4 Description of Groundwater Contamination

Groundwater contamination at the site was found to be limited to SVOCs and, to a lesser degree, dioxins. The SVOCs naphthalene, benzo (a) pyrene, and PCP serve as indicators of site-related contamination because they are compounds known to have been used in former processes and they occur at greater concentrations than other SVOCs. Groundwater contamination above the maximum contaminant level (MCL) was found not to extend beyond the site fenceline. However, naphthalene, for which there is no MCL, was detected beyond the fenceline at levels exceeding the Region 9 preliminary remediation goal (PRG) of 6.2 µg/L. This indicates that the leading edge of the plume may be moving off site because naphthalene is the most mobile PAH compound. The extent of PCP and dioxin and furan contamination at levels above their respective MCLs was found to be limited to the central portion of the site.

As in the soil contamination, two sources of NAPL have been identified at the site, creosote and non-creosote NAPL. Creosote NAPL was identified using multiple lines of evidence, including:

- Visual observation of NAPL in soil cores
- Presence of Sheens in water
- SCAPS LIF Data

The extent of the dissolved phase plume from the McCormick and Baxter Site has been evaluated by observing detections of naphthalene and PCP in down-gradient wells. Naphthalene and PCP are two of the more soluble COCs at the site. In general, naphthalene and PCP contamination outside of the NAPL source areas is limited. Dissolved PCP and some dioxin and furan contamination was identified, mainly in the upper portions of the aquifer and are less of a concern for deeper zones. Arsenic sampling was discontinued after the completion of the RI in 1998. It was concluded that arsenic concentrations, which typically ranged up to 50 µg/L, were representative of background.

1.1.5 Description of Sediment Contamination

Sediment contamination at the site appears to be limited to Old Mormon Slough, which is directly north of the facility. The sediments are variably contaminated with NAPL and the primary COCs identified in the sediments were PAHs and dioxin. PCP contamination is limited to the eastern half of the slough sediments. The following contamination patterns were also identified:

PAHs

- Concentrations are generally greater at depth in Old Mormon Slough except at the oily waste ponds. At the pond, contamination is worse near top due to run-out.
- Concentrations are highest in sediments 2 to 8 feet below the mud line in the main processing area, exceeding 1,500 mg/kg.
- The highest concentration is 1,811 mg/kg at 6 to 8 feet below the mud line in a composite sample collected at the main processing area.
- Sediments deeper than 8 feet below the mud line at the oily waste ponds, main processing area, and the eastern end are visibly contaminated with petroleum hydrocarbons.
- The maximum depths sampled at two stations at the main processing area (29.2 feet below the mud line and 18 feet below the mud line) had PAH concentrations of 87.1 and 1,573 mg/kg, respectively, so contamination may extend beneath those depths.

PCDD/PCDF

- The dioxin toxicity equivalent concentration (TEQ) is often above 1 ppb.
- TEQs exceeded the Stockton Channel reference concentration (87.7 parts per trillion) at the following locations and depths:

  0 to 4 feet below the mud line at the east end
  0 to 6 feet below the mud line at the main processing area
  0 to 2 feet below the mud line at the oily waste ponds

PCP

- PCP is not widely distributed in Old Mormon Slough; it degrades over time.
- Concentrations are restricted to upper 4 feet bml in the END and upper 8 feet below the mud line at the main processing area.
- The main processing area was most contaminated, up to 5.6 mg/kg in a 6- to 8-foot below the mud line composite sample.
- Shallow sediment concentrations correlated with concentrations of PCDD/PCDF.

A soil cap remedy has been selected to limit interaction between contaminated sediments and the slough. This remedy is expected prevent further communications between the sediments and groundwater north of site, limiting source material for groundwater contamination.

1.1.6 Contaminant Fate and Transport

Based on the data obtained, some general conclusions concerning the fate and transport of COCs have been made. Transport of contaminants is largely due to the movement of NAPL in the subsurface. PAHs as a component of pure creosote NAPL are DNAPLs, however they can also be found as LNAPLs if the creosote was mixed with as petroleum. PCP solutions are mainly LNAPLs and PCP does not generally penetrate below the upper zone of the aquifer.

LNAPL and DNAPL were considered to be the principal sources of groundwater contamination at the site. Both were present at the site in unsaturated soil and below the water table. Wood-preserving chemicals that are only slightly soluble in water may travel greater distances when dissolved in a carrier solvent such as LNAPL or DNAPL. Contaminants in the vadose zone move as a mobile NAPL phase, adsorb onto soil, volatilize into soil gas, and dissolve into pore water. Except for the volatilization pathway, similar partitioning occurs below the water table. Compared with many other contaminants, the PAHs exhibit very low aqueous solubilities and are strongly adsorbed to particulate surfaces. Volatilization is a dominant release mechanism for the lower-molecular-weight PAHs with higher vapor pressure. Site conditions are not ideal and the compounds are present in mixtures. These conditions must be considered in using the data to evaluate contaminant movement.

Mobile NAPL migrates downward through the vadose zone until it reaches the water table. NAPL phase separation occurs when the NAPL encounters the water table; LNAPL accumulates at the water-table surface and continues to migrate laterally. DNAPL continues migrating downward until it encounters an underlying less permeable stratum. The DNAPL then builds up above this layer until it stabilizes, migrates laterally, or continues further downward migration through pore spaces and fractures in the low-permeability layer.

The NAPL also undergoes dissolution as it encounters water in the pore spaces and in the aquifers, resulting in dissolved contaminants in the groundwater. The contaminants are then transported with the groundwater laterally and vertically downward, when gradients allow, into underlying groundwater through pore spaces and fractures in the low-permeability layer. The mobility of contaminants in groundwater is affected by adsorption/desorption processes.

The movement of NAPL through the subsurface is complex highly non-uniform. NAPL released to the subsurface migrates downward through the vadose zone under gravitation force and may continue to move into the saturated zone. Once in the saturated zone, the NAPL begins dissolving components into the flowing groundwater, creating a dissolved contaminant plume. The NAPL continues to migrate through preferential pathways leaving a trail of residual liquid trapped in pore spaces. At the McCormick and Baxter site the NAPL appears to migrate regardless of soil type, such that aquitards in a hydrogeologic sense, do not prevent further migration. Due to the complex migration of NAPL at the site it becomes very difficult to characterize and limits the remediation options available to the project.

2.0 APPROACH TO CHARACTERIZING SITE CONDITIONS AND DEVELOPING THE REFINED CONCEPTUAL SITE MODEL

Much of the information gathered in early investigations was used to begin developing a CSM in order to understand the types and extent of contamination at the site. As the McCormick and Baxter site progressed through the RI/FS stage and leads into RD/RA, increasingly specific information concerning the location of contaminants and a thorough understanding of the subsurface geology is required to develop and design remedial alternatives.

Two field efforts, one in 1999 and another in 2000 were conducted to sufficiently characterize the NAPL contamination at the McCormick and Baxter site and help refine the CSM and begin to develop remedial strategies for the NAPL source areas. A brief description of the field investigations, how the Triad Approach was used, and how the resulting data were interpreted can be found in Sections 3,4, and 5 of this case study. The following Sections provide information on the types of equipment and analytical techniques used to conduct the 1999 and 2000 NAPL field investigations.

The Triad Approach focuses on limiting the number of mobilizations necessary to conduct a site investigation, however in the case of the NAPL investigations at the McCormick and Baxter site it was necessary to conduct the field activities in two phases. The investigation was conducted in two phases over the summers of 1999 and 2000 for several reasons. First, the costs associated with the investigation could be split over two fiscal years. Second, the legal requirements necessary to gain offsite access for the 2000 investigation took 6 months to finalize. Finally, the drilling under the Old Mormon Slough was expensive because the drill rig had to be deployed from a floating barge and project planners did not want to sample the slough unless data collected in 1999 indicated potential contamination issues. The extra time gained by conducting the NAPL investigation over 2 years allowed project planners to refine the approach for sampling in the Old Mormon Slough and minimize the time and costs associated with this sampling.

2.1 FIELD BASED ANALYTICAL METHODS

The “Triad Approach” incorporates real-time data, often supplied by field based analytical methods (FAMs), in the context of thorough systematic planning and dynamic workplans to achieve project objectives faster, cheaper and with less uncertainty. Several FAMS were used during the field activities conducted during the 1999 and 2000 NAPL field investigations including: a site characterization and penetrometer system (SCAPS), mounted with laser induced fluorescence (LIF) and cone penetrometer (CPT) sensors.

Methods and equipment for the 1999 and 2000 NAPL field investigations were selected to give rapid assessments of site conditions and therefore have a higher degree of uncertainty when compared to more rigorous methods conducted in an analytical laboratory. The uncertainty associated with these methods is acceptable because the greater number of measurements collected allow for more representative sampling throughout the site despite the inherent variability in the measurement methods and contaminant distribution heterogeneity.

2.1.1 Site Characterization and Penetrometer System (SCAPS)

The SCAPS uses direct push technology to hydraulically advance samplers and analytical instrumentation such as the LIF and CPT sensors into the subsurface using a string of drill rods. The very nature of the rig allows it to be used in hard to reach areas such as outside locations with little overhead clearance. In addition, the direct push technology generates little waste because drill cuttings are not produced from the hydraulic advancement of the drill rods but they are limited to use in unconsolidated soils and generally cannot advance much more that 150 feet below ground surface (bgs) even in ideal conditions. A more complete discussion of the capabilities of direct push technologies can be found in Section 4.6.1 of the handbook.

The SCAPS is well suited for applications in the “Triad Approach” because the on-site analytical tools and mounted sensors can be used to streamline sampling, analysis and data management necessary to meet project objectives. The direct push technology incorporated by the SCAPS is ideal for large complex sites where accelerated sampling is needed to collect high volumes of sample points and obtain access in difficult areas.

2.1.2 Cone Penetrometer (CPT) Sensors

The SCAPS CPT consists of a steel cone at the end of the hydraulic push rods that is advanced into the subsurface. CPT sensors located on the end of the cone provide continuous measurements of cone tip pressure and friction in accordance with ASTM standard D3441. Software is then used to translate the electromechanical responses of the strain gauges into a soil classification number. The cone tip pressure and friction sleeve respond independently to soil stresses, however the combined ratio, which leads to the soil classification number and is given by the software is actually determined using a ratio of cone pressure to sleeve friction. The soil classification numbers and associated material descriptions produced by the SCAPS CPT are as follows:

0	Peats
0-1	Clays
1-2	Silt mixtures
2-3	Sand mixtures
3-4	Sands
4-5	Sands and gravel

2.1.3 Laser Induced Fluorescence (LIF) Sensors

The SCAPS LIF sensor uses a nitrogen laser as the ultraviolet (UV) light source to bombard the subsurface sample with UV causing petroleum hydrocarbons in the sample to fluoresce. The fluorescence is actually the result of polycyclic aromatic hydrocarbons (PAH) components of the petroleum products that become excited after receiving energy from the UV light and then give off that energy in the form of fluorescence in order to return to their “natural” or ground state. The resulting fluorescence is measured using an electronic detector and the reading is then converted into a contaminant concentration.

A fiber optic umbilical cord attached to the LIF sensor can actually provide “real time” in-situ detection of subsurface petroleum hydrocarbons containing PAHs. This in-situ detection provides a continuous reading of petroleum hydrocarbons in subsurface as the SCAPS advances the LIF sensor. The result is a significant decrease in the time required to delineate the vertical and lateral extent of a petroleum hydrocarbon plume. Multiple profiles across a site can also be used to generate a 3 dimensional view of the plume for site characterization.

It is important to note that fuels with lower proportions of PAH compounds can have significantly higher detection limits for the LIF and that a number of man-made and naturally occurring compounds can produce fluorescence in the presence of UV light. Naturally occurring minerals such as calcite or naturally occurring organic matter containing PAHs and other man-made non-hydrocarbon materials such as deicers, antifreeze, and many detergents can also fluoresce. Experienced operators may be able to determine the differences between petroleum products and other interfering compounds, however confirmation samples are recommended. The 1999 and 2000 NAPL investigations included confirmation samples analyzed by LIF ex-situ and total recoverable petroleum hydrocarbons (TRPH) in the SCAPS laboratory as well as total petroleum hydrocarbons diesel extended (TPH-Dx) analyses conducted by the EPA Region IX laboratory.

2.2 MOBILE LABORATORY METHODS

In addition to the FAMs used to collect data during the 1999 and 2000 NAPL field investigations a number of analyses were conducted on soil and groundwater samples in the SCAPS mobile laboratory and the EPA Region 9 Field Analytical Support Program (FASP) mobile laboratory. Soil samples were analyzed for TRPH by the SCAPS laboratory to provide estimated concentrations of petroleum hydrocarbons and results were also used to correlate SCAPS LIF responses. Results were generally available within an hour of sampling and were used to better interpret SCAPS LIF responses.

Although the TRPH results do not identify specific fuel types or composition and can be subject to interferences from natural organic materials, they provided valuable confirmation results and assisted in interpreting LIF signatures.

The mobile laboratory conducted more comprehensive analyses of soil and groundwater samples using a modified version of the Region 9 TPH-Dx method. The method was modified to allow for a quicker less vigorous extraction and expanded recovery windows for QC parameters. This allowed for quick data generation assisting in on-site decision making. In addition to providing estimated concentrations of TPH, the method provided gas chromatograph/mass spectroscopy (GC/MS) analysis. The chromatograms provided by the TPH-Dx analysis were evaluated qualitatively by an experienced analyst, and fuel types present (TPH fingerprinting) was compared to a spectral library or other laboratory analyzed fuel standards to profile different fuel types.

The TPH fingerprinting data was used as collaborative information to provide a chemical signature for NAPL products found within various locations of the McCormick and Baxter site. Known fuel patterns and other chemical data could then be reviewed against LIF signatures from corresponding samples to link chemical data with specific LIF signatures. As LIF sampling locations were extended out from source areas, changes in LIF signatures indicated the need to collect additional soil samples for chemical analysis and TPH fingerprinting. This resulted in better LIF interpretation and limited the need to collect costly analytical samples, by requiring chemical analysis only in areas where the LIF signature changed from adjacent push locations.

Uncertainties in concentration and compound identification associated with the TPH-Dx analysis are considered acceptable for the NAPL investigations because it still allows for the identification of the presence or absence of TPH at the site. The on-site rapid analysis of samples allows for a greater number of measurements resulting in a more representative sampling approach site-wide. Additionally, results were immediately available to assist the sampling team in making informed decisions as to subsequent sampling locations, and assure that the extent of different fuel types present were identified. Tables 1-1 and 1-2 provide summaries of the methods used by the SCAPS and FASP laboratories.

2.3 EPA REGION IV AND COMMERCIAL LABORATORIES

Off-site fixed analytical laboratories were also sent samples from the 1999 and 2000 NAPL field investigations to analyze for a number of parameters. The TPH-Dx analysis was used for confirmation of on-site laboratory TPH-Dx results and to assist with the interpretation of SCAPS LIF data.

Additional analyses were also performed for target analytes that could not be analyzed in the field or for analytes that provide secondary information crucial to the design of remedial alternatives.

SVOC analyses for PAHs and PCP were based on SW-846 methods, although as in the case of the TPH data the extraction was modified to include a quicker less vigorous procedure using sonication and expanded recovery windows. The data was used to provide qualitative information on the types of PAHs present in a sample and evaluating the exact concentration was not as important. In general high concentrations of PAHs were found where the NAPL was believed to be present and were not found in other areas.

A number of geotechical analyses and a NAPL saturation analysis were also performed to aid in the interpretation of CPT results and design the remediation systems. The samples were collected to provide information for different stratographic areas identified by CPT logs and provide valuable information for the placement of extraction and injection wells for the remedial design. Table 2-1 lists the analyses performed at all laboratories for the 1999 and 2000 NAPL field investigations.

Analytical methods for the off-site laboratories were selected to provide additional data and support project objectives. In some cases these methods were modified to allow rapid data generation so that data would be available for on-site decision making. The modifications generally included a shorter less vigorous extraction procedure and expanded recovery windows for surrogate compounds. The shorter extraction time and expanded recovery windows allowed for quick generation of data, generally within 48 hours of sampling.

The analytical methods, calibration procedures, and QC measurements and criteria were based on analytical protocols from the following:

- EPA Contract Laboratory Program (CLP) scope of work
- EPA SW-846 *Test Methods for Evaluation of Solid Waste* (U.S. EPA 1994)
- American Society for Testing and Materials (ASTM annual updates)
- *Methods for the Chemical Analysis of Water and Wastes* (U.S. EPA 1979)
- Laboratory-specific SOPs

Laboratory method summaries, including reference and preservation, extraction, cleanup and instrumentation, are included in Tables 1-1 through 1-4. Laboratory-specific SOPs and project-specific modifications to documented methods are not included with this case study.

3.0 1999 NAPL FIELD INVESTIGATION

During the period of July through September 1999, an investigation of the nature and extent of the subsurface non-aqueous phase liquid (NAPL) contamination at the site was conducted to better define the type and extent of NAPL contamination and further refine the conceptual site model (CSM).

A number of activities were conducted during the 1999 NAPL field investigation including; a site survey, geophysical investigation, groundwater sampling, NAPL sampling, site characterization and penetrometer system (SCAPS) investigation using a laser induced fluorescence (LIF) sensor and cone penetrometer (CPT) measurements, and rotosonic drilling with associated soil sampling and monitoring well installations. A brief description of the tools and methods used for these activities and the information provided is given below.

Site Survey - Conventional surveying equipment was used to establish horizontal and vertical controls using state plane coordinates. Monuments were placed and surveyed at the site and all pertinent site features were surveyed. Features surveyed included: existing aboveground structure, the lined repository pit, the sheetpile wall, perimeter fences, two stormwater holding ponds, corners of the asphalt cap, buildings, paved areas, and the well pumphouse.

Geophysical Investigation - Electromagnetic line locating was used to locate near surface metal objects such as: utilities, railroad spurs, and buried metallic debris. Electromagnetic devices with terrain conductivity and in-phase component sensors was used to determine shallow (10-15 feet below ground surface) conductivity. Variations in conductivity are indicative of buried debris or changes in subsurface materials. Additionally, total field magnetrometry was used to locate buried ferrous objects.

Groundwater and NAPL Sampling - Groundwater samples were collected from 15 existing wells using low-flow and conventional sampling techniques. Additionally samples were collected at 18 wells where either dense NAPL (DNAPL) or light NAPL (LNAPL) had been detected during earlier sampling events or previous data indicated that dissolved phase contaminants were near their respective solubility limits.

SCAPS LIF and CPT - SCAPS sampling was conducted using LIF sensors to evaluate the presence or absence of TPH and estimate petroleum hydrocarbon concentrations (specifically those containing polycyclic aromatic hydrocarbons (PAH)). CPT data was used to provide continuous geotechnical and stratigraphic information. The initial 10 SCAPS sampling locations were pre-selected based on known or suspected areas of high contamination or where previous data gaps were identified. A total of 106 SCAPS penetrations were made and they ranged from 11.5 feet to 155.8 feet below ground surface (bgs).

SCAPS Soil Sampling - SCAPS LIF data was used to determine where additional SCAPS soil samples should be collected. Soil samples were collected at a variety of depths at new borings within 1 to 2 feet of 20 existing SCAPS LIF/CPT push locations. Soil samples were collected and analyzed for TPH to obtain SCAPS LIF calibration and verification samples representative of different soil type, emission spectra, and emission intensities. SCAPS soil sampling was used in areas where high concentrations or multiple types of petroleum products were found, areas where petroleum concentrations exceeded the LIF sensor threshold, areas where free product and dissolved concentrations were found, to fill in previously determined data gaps, and aid in the refinement of the CSM. Analytical results from samples collected from the SCAPS platform also helped to verify anomalous LIF sensor responses and assist in LIF data interpretation.

Physical analysis samples were also collected for permeability, density, porosity, grain size, cation exchange capacity (CEC), and total organic carbon (TOC) to provide crucial information used in the design of thermal treatment systems for remediation. The CPT data was further evaluated by comparing the results with visual core logging conducted by on-site geologists.

Locations for SCAPS soil sampling was chosen in the field based on: push locations where contamination was suspected but not found in order to confirm low LIF responses, in areas where different LIF wavelength signatures were found in order to determine the type of contamination, areas where NAPL may be present above LIF response threshold values, and to verify the presence or absence of contamination at locations where non-target fluorescence was suspected.

Rotosonic Drilling, Soil Sampling, and Monitoring Well Installation - A total of 18 borings were completed using rotosonic drilling techniques to evaluate the extent and type of contamination as well as the geology at depths beyond maximum SCAPS penetrations and determine the potential for downward migration of groundwater and NAPL. The borings were located adjacent to SCAPS borings where the maximum depth of NAPL contamination had not been reached and the SCAPS platform was unable to achieve deeper penetrations. Samples collected were analyzed for TPH, PAH, PCP, heavy metals, and physical parameters. All but two of the rotosonic borings were collocated with SCAPS penetration borings and the analytical data was used to confirm LIF signature data and collect soil samples and provide stratographic information at intervals deeper than the SCAPS was able to penetrate. Finally, two additional groundwater monitoring wells were installed at the site as part of the rotosonic drilling program.

Due to the application of dynamic field activities during the 1999 NAPL field investigation, a number of changes to the original management plan were completed in order to obtain more accurate and useful data and limit the number of field mobilizations necessary to achieve the investigation objectives. The most obvious application of the dynamic work plan was the ability of the field crew and project manager to review data as it was produced at the site and then use that knowledge to determine appropriate future sampling locations. Additionally, the flexibility offered from this approach allowed:

- The use of conventional groundwater sampling techniques at wells where the presence of free product did not allow for low flow sampling.
- The completion of 104 SCAPS borings instead of 40. 40 SCAPS pushes were used as the base estimate of the original management plan.

- Surface sampling of crystals (later determined to be PCP) discovered during the field investigation.
- Rotosonic drilling was used to provide additional samples and stratigraphic data at depths greater than SCAPS penetration. Although the objective was to push to a depth of 200 feet bgs with the SCAPS, the maximum depth achieved was 155.8 feet bgs. The definition of the bottom of the NAPL contamination was seen as a critical data need and the rotosonic drilling was used to obtain this information.

4.0 2000 NAPL FIELD INVESTIGATION

The 2000 NAPL investigation was conducted as a second mobilization for the NAPL characterization effort to spread the costs of the project over 2 fiscal years, allow time to gain access agreements from off-site property owners and allow time for the refined of the costly sampling approach for the Old Mormon Slough. The investigation was conducted from June to August 2000 where the primary objectives were to determine the lateral and vertical extent of the NAPL contamination, determine whether NAPL had migrated off-site, and aid in the selection of a final groundwater remedy including an evaluation of the in situ thermal treatment technologies being considered for remediation. Secondary objectives included further refinement of the CSM, determining if natural attenuation was limiting the mobility of the NAPL contaminants in the subsurface, determining the extent of surface and subsurface PCP contamination found during the 1999 investigation, determining if a light NAPL (LNAPL) is responsible for transporting PCP into shallow groundwater, and determining the nature and extent of the subsurface anomaly which prevented penetration of the SCAPS beyond 16 feet bgs in one area.

The Triad Approach was implemented to use systematic planning, dynamic field activities, and field based measurement technologies to take into account the evolution of the CSM as data was collected at the site. Several sampling locations were identified prior to the field activities, however the majority of locations were determined based on “real time” results of chemical and physical analysis performed on the site materials.

Data collected during this and the 1999 NAPL investigation were collected to aid in the feasibility study (FS) portion of the Superfund process by providing information on the vertical and horizontal distribution of NAPL; the physical and chemical characteristics of the NAPL; the type, thickness, and heterogeneity of the subsurface geologic material; and the presence of any manmade subsurface physical barriers. Information gathered during this investigation was used to determine the technical and economic feasibility of in-situ remedial options such as steam injection/stripping and electrical heating.

The field activities conducted during the 2000 NAPL investigation were implemented in 4 stages. The first phase was conducted to evaluate NAPL migration north of or in the Old Mormon Slough, while the second phase was conducted to definitively determine the Eastern and Southeastern limits of NAPL contamination. The third phase was conducted to evaluate the PCP contamination in the Cellon process area and A-zone groundwater, while the fourth and last phase was conducted to characterize the subsurface anomaly identified during the 1999 NAPL field investigation, which resulted in refusal of the SCAPS penetration at 16 feet bgs.

Consistent with the tools and techniques used during the 1999 NAPL field investigation, the 2000 investigation involved surveying of new sampling locations and new well locations, collecting groundwater samples for PCP and VOCs, SCAPS LIF and CPT measurements, SCAPS soil sampling, rotosonic drilling with associated soil sampling and monitoring well installations, and SCAPS microwell installations. A brief description of the tools and methods used for these activities and the information provided is given below.

Surveying New Sampling and Monitoring Well Locations- SCAPS exploration locations were surveyed during field activities using a hand-held global positioning system (GPS). Elevation levels were also surveyed using a hand level relative to existing site control monuments. Prior to exploration work in the Old Mormon Slough, a survey team surveyed the elevation on a point on the east end of the sheetpile wall. The surveyed locations was subsequently used by the SCAPS team to survey elevations of sampling locations in the Old Mormon Slough. Finally, after completion of all the field activities, the survey team returned to survey the horizontal and vertical positions of the SCAPS exploration locations, rotosonic soil borings, monitoring wells, and microwells.

PCP and VOC Groundwater Sampling- Preliminary groundwater samples were collected at four existing wells screened in the A-zone (ft—ft) and analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). The objective of the groundwater sampling was to determine if isopropyl ether was present and migrating in the A-zone groundwater where PCP was detected and evaluate groundwater quality in wells where PCP had been detected previously. The sampling was also used to focus phase III of the field investigation, which was to evaluate PCP contamination in the A-zone groundwater. All groundwater samples except one were collected using low-flow sampling techniques.

SCAPS LIF and CPT- A total of 75 SCAPS pushes were completed at the site during the 2000 NAPL field investigation. A part of the phase I objectives a number of SCAPS locations were advanced around the Old Mormon Slough to determine the extent of NAPL contamination beneath the slough and determine if the NAPL contamination had migrated north of the slough. As part of the phase II objectives of evaluating the extent of the NAPL contamination in the southern and eastern portions, a number of SCAPS pushes were advanced in soils outside the southeast corner of the McCormick and Baxter property in the Union Pacific Railroad property. Finally, in accordance with phase III objectives, SCAPS pushes were advanced around the PCP mixing shed to evaluate the extent of TPH contamination in the area. Continuous measurements from the LIF and CPT sensors were recorded for all the SCAPS push locations to provide stratiographic information and an indication of the relative concentrations of TPH contamination. Maximum depth of the 75 SCAPS pushes ranged from 13.6 to 144.2 feet bgs with an average push depth of 65.9 feet bgs. Initial SCAPS push locations were determined based on data gaps identified from the 1999 NAPL field investigation while the remaining locations were determined in the field based on the following:

- SCAPS LIF borings were spaced to provide area-wide information on NAPL occurrence and stratigraphy and further define the area of interest for potential in-situ thermal treatment technologies.
- Areas of the highest TPH contamination and multiple fuel types were further defined to evaluate if more than one type of contaminant might require treatment.
- The depth of TPH contamination above the LIF sensor threshold was defined.
- Data was also collected to fill in data gaps identified after the 1999 NAPL field investigation to further refine the CSM.

- SCAPS pushes were also used to optimize the rotosonic soil boring locations and the installation locations of monitoring wells and microwells.

SCAPS Soil Sampling - Similar to the 1999 SCAPS soil sampling, SCAPS soil samples were collected to provide LIF sensor calibration and verification for different soil types, emission spectra, and emission intensities within the SCAPS depth limitations. These soil samples were also collected to verify anomalous LIF responses and confirm the true depth of TPH, PAHs, and PCP, as well as to determine SVOC and trace metal contamination in dredge spoils located on the Dutra Group property north of the facility. Other objectives of the SCAPS soil sampling included: determining the LNAPL and PCP contamination in the A-zone areas not contaminated with creosote NAPL, identifying PCP and LNAPL contamination in subsurface soils around the PCP mixing shed, determining if a subsurface confining structure is present, and finding the extent of PCP contamination in the vadose zone around the Cellon Process area (**Figure 1-2**). Again, consistent with the 1999 investigation, SCAPS soil sampling pushes were offset from the original SCAPS LIF/CPT push locations by 1 to 2 feet to obtain representative samples. The SCAPS 1.5 inch diameter sampling rods with a hollow core were advanced to the desired sampling depth where a 2-foot core of sample was collected. The core was then placed on a table in the field where a visual soil classification was conducted and samples were collected for PCP/PAH and VOC analyses.

Rotosonic Drilling, Soil Sampling, and Monitoring Well Installation- A total of 6 borings were logged and sampled using the rotosonic drilling rig and an additional two groundwater monitoring wells were constructed during these field activities. The two objectives of the rotosonic drilling program were to determine the nature and extent of the contamination and evaluate geology in the E-zone north of the Old Mormon Slough at depths beyond the SCAPS capabilities, as well as in the E-zone southeast of the property on the Union Pacific Railroad property at depths beyond the SCAPS capabilities. Four of the six rotosonic drilling locations were adjacent to SCAPS sampling locations and the information provided was used to confirm the SCAPS LIF data and provide data for depths deeper than the SCAPS could penetrate. The other two locations were used for monitoring well installations where the screen depths were located in the E-zone groundwater.

SCAPS Microwell installations- A total of 15 microwells were installed as part of the 2000 NAPL field investigations. The microwells were 1-inch diameter wells with hydrophobic screens and were screened in the water table (approximately 16 feet bgs). The wells were collocated with a SCAPS LIF/CPT push locations and were installed on the Union Pacific Railroad property east and southeast of suspected source areas, near the PCP mixing shed, south of the main processing area, and south of the oily waste ponds to provide additional groundwater monitoring in the A-zone.

Due to the application of dynamic field activities during the 2000 NAPL field investigation, a number of changes to the original management plan were completed in order to obtain more accurate and useful data and limit the number of field mobilizations necessary to achieve the investigation objectives. The most obvious application of the dynamic work plan was the ability of the field crew and project manager to review data as it was produced at the site and then use that knowledge to determine appropriate future sampling locations. Additionally, the flexibility offered from this approach allowed the following to be accomplished:

- The field activities were completed 30 days prior to the scheduled completion date.
- A maximum of 45 SCAPS LIF/CPT and 18 SCAPS soil sampling locations were planned on the Dutra Group and Stockton Cold Storage properties in the event that NAPL was detected in the initial SCAPS or rotosonic boring locations. Since it was determined that NAPL was not migrating north of the Old Mormon Slough only 14 SCAPS LIF/CPT pushes were conducted and 13 SCAPS samples were collected.
- A total of 18 SCAPS locations were planned in the Old Mormon Slough and a total of 24 were investigated.
- A total of 20 SCAPS locations were planned on the Union Pacific Railroad property and a total of 24 were completed.
- No SCAPS pushes were originally planned in the vicinity of the PCP mixing shed, however discussion with former McCormick and Baxter personnel revealed the use of medium weight petroleum hydrocarbons in this area. Based on this information, 9 SCAPS LIF pushes were completed in the area to focus the SCAPS soil sampling locations and determine if the PCP mixing shed was the source of nearby TPH.
- A number of other SCAPS soil sampling locations originally planned were not necessary because NAPL contamination was not found closer to the site.
- Although 11 microwells were planned, 16 were actually installed due to decreased installation times.

5.0 INTERPRETATION OF DATA AND DEVELOPMENT OF THE FINAL CONCEPTUAL SITE MODEL

Based on the information collected during the 1999 and 2000 NAPL field investigations a number of changes were made to the geologic and hydrogeologic CSM as well as to the NAPL distribution CSM. Interpretation of data from these investigations is provided in the following sections

5.1 EVALUATION OF SCAPS SOIL SAMPLING AND LIF RESULTS

The determination of the presence or absence of NAPL at the McCormick and Baxter site was evaluated using the following criteria:

- LIF counts greater than 500 were considered indicative of the presence of NAPL
- LIF counts less than 300 were considered indicative of the absence of NAPL
- LIF counts between 300 and 500 were considered questionable but were evaluated and may have been considered an indication of the presence of NAPL when used in conjunction with other lines of evidence (i.e. mobile product or a visable sheen found during the core inspection, or significant positive results from the TPH-Dx analysis)

Spectral profiles associated with creosote NAPL, the most abundant NAPL present and the main risk driver at the McCormick and Baxter site due to the presence of PAH and pentachlorophenol (PCP) components, were evaluated to define areas where NAPL was believed to be present. The profiles generally showed the following:

- Site-wide, soil samples where confirmed visual observation of creosote NAPL was found had corresponding LIF results associated with peak wavelengths of between 467 and 476 nanometers
- In the main processing area, soil samples where confirmed visual observation of creosote NAPL was found had corresponding LIF results associated with peak wavelengths of between 480 and 499 nanometers

Soil samples collected using the SCAPS were used to visually inspect cores and the presence of creosote and other NAPLs at the McCormick and Baxter site were evaluated using the following criteria:

- NAPL presence was reported as odor (sample had a strong creosote or diesel smell)
- NAPL presence was reported as visible (sample had a visible NAPL sheen)

- NAPL presence was reported as mobile (mobile NAPL could be poured off of the sample)

Finally, soil sample visual inspections, LIF data, and CPT results from nearby SCAPS pushes were used in conjunction to evaluate down gradient locations where creosote NAPL may have been present due to up gradient sources and preferential pathways for mobile NAPL.

5.2 SITE GEOLOGY

Given the density of CPT data collected during the 1999 and 2000 investigations, the relative horizontal and vertical continuity of sand units beneath the site to approximately 110 feet bgs were evaluated. For intervals deeper than 110 feet bgs the lithologic data available are relatively sparse. The distribution of sand and silt within 5 foot thick slices are available in **Figures 5-1** through **5-40**, where **Figures 5-1** through **5-20** represent the compilation of CPT data from SCAPS push locations and **Figures 5-21** through **5-40** were prepared the same however data from rotosonic borings and monitoring well installations were used to supplement data below 110 feet bgs.

A detailed geologic CSM has been developed by evaluating subsurface geology data collected at depths ranging from the ground surface to approximately 200 feet bgs. The refinement of the geologic CSM has been achieved through the compilation of data from numerous SCAPS CPT pushes and rotosonic borings. The data have been compiled and visual representations of the subsurface geology at the McCormick and Baxter site are available through numerous cross sectional maps. Plate 1 provides a representation of the locations and orientation of 10 cross sections spanning the site. Six of the cross sections (Plates 3 through 8) are orientated as east/west cross sections extending from the north site boundary to the south site boundary. Four additional cross sections (Plates 9 through 12) are orientated as north/south cross sections extending from eastern to western portions of the McCormick and Baxter site. Each plate represents a slice through the property either in the north to south or the east to west direction and provides information on soil types, fill materials, areas where NAPL is believed to be present, monitoring wells screen locations, soil cores exhibiting a sheen or the presence of NAPL, and areas where the detailed lithology is somewhat uncertain. The cross sections also provide approximate depths to water from previous water monitoring events. This information can be used to further refine the hydrogeologic CSM discussed in Section 5.2.

5.3 SITE HYDROGEOLOGY

The upper 200 feet of sediments beneath the site are now collectively referred to as the shallow aquifer with groundwater occurring primarily in laterally continuous layers of fine to course grained sand. Sediments from 200 feet bgs to at least 1,000 feet bgs have been termed the deep aquifer. Previous investigations at the McCormick and Baxter site had divided the subsurface into 5 hydrogeological sand zones designated A, B, C, D, and E with thick clay sequences separating the zones. The problem with this strategy was that the well screens within a particular zone were not always consistent across the site resulting in different A, B, C, D and E zones in various locations at the site. Further refinement of the hydrogeologic CSM determined that aquifer zone designations applied only to local areas where the silts are laterally continuous and not intersected by vertical sand channels. As a result of these findings the A through E flow zones are now believed to behave as a single contiguous aquifer system with substantial communication between adjacent zones.

The groundwater flow at the site is southeastward in the A-zone and turns east/northeast in the successfully deeper zones (B-E). The east/northeast E-zone flow is consistent with historical regional groundwater flow data that show a large cone of depression from groundwater pumping centered beneath the town of Stockton located north east of the site. Calculated vertical groundwater velocities are 3 to 4 orders of magnitude less than the calculated horizontal groundwater velocities, resulting in the majority of groundwater flow and contaminant transport taking place horizontally within sand zones.

The Old Mormon Slough appears to have very poor communication with the upper aquifer due to four lines of evidence. First, groundwater elevations in the previously designated A-zone have historically fluctuated by more than 10 feet, however little difference can be seen between A-zone wells next to the Old Mormon Slough and A-wells much further away from the slough. Secondly, while tidal influences of 4 feet have been measured in the slough, little corresponding fluctuations in A-zone wells next to the slough have been measured. Third, the A-zone groundwater gradient does not deflect or alter near the Old Mormon Slough. Finally, the bottom of the slough is blanketed with fine grain sediments having very low permeability and these sediments are generally in contact with low permeability clayey silt rather than the higher permeability sands. Given this information it is believed that the Old Mormon Slough has little or no influence on the A-zone of the shallow aquifer.

5.4 SITE CONTAMINATION

Identification and locations of the various types of TPH contamination found at the McCormick and Baxter site were identified as factors that would have to be considered for the conceptual design of an in-situ thermal treatment system. In order to determine the types of TPH at the site, chromatograms from TPH-Dx analyses from the EPA FASP and Region 9 laboratory were reviewed and compared to two different analytical standards. The first was the Florida TRPH standard, which consisted of a mixture of even numbered alkanes from C6 to C40, and the second was the XHc diesel fuel number 2 composite standard. By pattern matching or "fingerprinting" the chromatographs of TPH results from field samples to the standards run in the laboratories, the field team was able to identify 5 distinct fuel types (A through E) during the 1999 investigation and 1 additional fuel type (F) from the 2000 investigation. A discussion of the 5 fuel types is provided below.

> Product Type A- This fuel pattern was only detected at one location during the 1999 investigation and one location during the 2000 investigation but was observed in all samples collected from these locations with positive TPH-Dx results. The fuel pattern did not match that of diesel or creosote and could not be identified. In addition, PAHs and PCP were not detected in these samples.
>
> Product Type B- This fuel pattern was detected at one location sampled in 1999 and two locations sampled in 2000. The fuel pattern did not match that of diesel or creosote and could not be identified. PCP, low concentrations of PAHs (relative to the detected TPH), and low concentrations of diisoprpyl ether were also detected in samples from these locations. Based on a review of PCP and PAH results it is thought that this product might be a carrier for PCP.
>
> Product Type C and D- These fuel patterns were observed in numerous samples collected at the site during the 1999 and 2000 events and were almost identical except for a single peak found near C-10 in the type D chromatogram not found in the type C fingerprint. Both fuel types contain numerous PAH compounds, including naphthalene, and closely resemble the creosote standard analyzed with the 1999 soil samples. PCP and diisopropyl ether were also detected in a number of these samples, however not necessarily in the same samples.

Product Type E- This fuel pattern was only detected at one location from the 1999 event and was not detected during the 2000 event. The fuel pattern did not match that of diesel or creosote and could not be identified. In addition, PAHs and PCP were not detected at this location.

Product Type F- This pattern was only detected in the top two samples from one location during the 2000 event. The pattern did not resemble a petroleum product and associated samples contained extremely high concentrations of PCP and diisopropyl ether.

The CSM for site contamination involving NAPL has been further refined using SCAPS LIF data as well as analytical data from the EPA FASP and Region 9 laboratories. Plate 2 provides a visual representation of all sampling locations from the 2000 NAPL investigation and specifies locations and depths where VOCs and PCP were detected. The plate includes data collected from groundwater monitoring well sampling points as well as SCAPS LIF pushes, SCAPS soil sampling locations, and rotosonic borings.

The CSM for site contamination also provides a visual representation of the site-wide distribution of NAPL by using 5-foot thick slices of the McCormick and Baxter site subsurface. This representation can be seen in **Figures 5-1** through **5-40**, where **Figures 5-1** through **5-20** represent the compilation of LIF data from SCAPS push locations and **Figures 5-21** through **5-40** were prepared the same however data from rotosonic borings and monitoring well installations were used to supplement data below 110 feet bgs.

Similar to the discussion of site geology in Section 5.1, Plate 1 and Plates 3 through 12 provide cross sectional representations of the site and indicate locations where NAPL contamination has been observed or is likely, given the available data. The CSM for site contamination was refined through the compilation of data from numerous SCAPS LIF pushes, monitoring well data, and rotosonic borings. A review of Plates 6, 7, 10, and 11 provide a good picture of where much of the NAPL contamination at the site is located. These 4 plates and the remaining 6 plates also provide detailed information on the subsurface geology and can be used to begin developing contaminant fate and transport models as well as site remedial strategies.

Based on the scope of the 1999 NAPL investigation 9 data gaps were identified that needed to be addressed during the 2000 NAPL investigation in order to sufficiently characterize the site for determination of a final groundwater remedy. The data gaps included: determining if NAPL contamination had migrated south, north, and east of the McCormick and Baxter site boundary, further evaluating near surface contamination sources and a subsurface obstruction identified during the 1999 event, further investigating PCP contamination in the Cellon process area, and evaluating the extent of PCP and dioxin contamination in the A-zone aquifer.

6.0 CONCEPTUAL DESIGN DESICISIONS BASED ON 1999 AND 2000 NAPL FIELD INVESTIGATIONS

Following the completion of the 2000 investigation no new data gaps were identified and the pre-design characterization data collected during the 1999 and 2000 NAPL field investigations was considered sufficient to complete the evaluation of the in-situ thermal treatment technologies. The final conceptual design for the thermal treatment technology was submitted to EPA in November of 2001 (USACE 2001). The document provides a 10 percent conceptual design for in situ thermal remediation of NAPL at the site including fundamental engineering design and cost issues associated with the installation, operation, maintenance, and post-operational stages of a combined steam injection and electrical heating remediation strategy.

These technologies are aggressively used to remediate both the heavier creosote DNAPL components and the lighter LNAPLs such as diesel, and the approach is considered a viable option for the treatment of both NAPLs present in the subsurface at the site. The combined steam injection and electrical heating approach focuses on the remediation of the creosote DNAPL because it is found at greater depths and is more widespread than LNAPLs at the site. Although the depth and location of creosote DNAPL will dictate the engineering of the remedial design, it is assumed that additional NAPLs within the treatment areas will be remediated using this approach.

EPA separated the remedial action objectives (RAOs) for the treatment of the creosote contamination into two distinct actions as the site; the remediation of creosote existing as NAPL and the remediation of dissolved phase groundwater contamination. RAOs addressed in the thermal treatment conceptual design (USACE 2001) are meant to address the contaminants on site that exist as NAPL. Relevant RAOs for the treatment of contamination existing as NAPL include:

1) Remove NAPL to the maximum extent technically feasible to protect the E-zone water aquifer (drinking water aquifer)

2) Reduce the need for long term pump and treat by remediation of the source materials responsible for the dissolved phase contaminants in groundwater

Three scenarios for well field design are included in the conceptual design with the coverage and number of injection and extraction wells increasing from scenario 1 to scenario 3. The life cycle cost of scenario 1 (likely the least costly option) for thermal treatment has been estimated at $83.2 million. Given the enormous costs associated with the remediation of the McCormick and Baxter site several phased approaches have also been provided as alternatives.

Due to the enormous costs associated with these remedial strategies, five criteria were selected to prioritize areas of the McCormick and Baxter site for thermal treatment. The criteria were developed with input from the USEPA, USACE, California EPA and DTSC, and the California Regional Water Quality Control Board (RWQCB), as well as a number of technical advisors from various agencies and include:

- Relative amount of NAPL present
- Proximity of NAPL to drinking water risk receptors (i.e., the E-zone aquifer)
- Certainty of the data indicating the presence of mobile NAPL
- Potential for future changes in the land use and/or subsurface conditions that might facilitate the mobilization of currently immobile NAPL (e.g., increased pumping of drinking water in the E-zone downgradient of the site)
- Ease of access for follow-up remediation activities

To evaluate each of these five criteria a compilation of the data obtained during the 1999 and 2000 NAPL investigations was used. The relative amount of NAPL present at various depths and locations around the site was evaluated using a combination of the LIF data, visual inspection of cores from the SCAPS, and results from adjacent SCAPS pushes. LIF counts and wavelengths data were crucial in determining the presence or absence of creosote NAPL but could not be used alone. Instead, the LIF count and wavelength data was compared with visual inspection of SCAPS cores. For example, if a sample had an LIF count greater than 500 (indicating the presence of NAPL) but the wavelength was outside the observed windows of 467 to 476 nanometers and 480 to 499 nanometers (indicating a non creosote NAPL) the results were further evaluated. Visual inspections of the associated core were used to evaluate the presence of a non-creosote NAPL (and LNAPL such as diesel) or a potential naturally occurring interference such as calcite. Additionally, results from nearby SCAPS soil samples, LIF pushes, and CPT pushes, were used to evaluate the likelihood of finding creosote NAPL contamination. For example, if up gradient results indicated creosote NAPL present at a specific depth, but down gradient LIF data indicated the absence of creosote NAPL at and below that depth the results were scrutinized for false negatives and visually inspected cores were reviewed to confirm the absence of creosote NAPL.

To evaluate the proximity of NAPL to drinking water risk receptors LIF data, CPT results and visual core inspections were again used. The presence of NAPL was evaluated using the approach described in the previous paragraph. The proximity of this contamination to the E-zone (drinking water) aquifer was determined using visual core inspections and CPT results to evaluate preferential pathways for NAPL migration and sample depth information to estimate proximity to the E-zone aquifer at approximately 200 feet bgs.

To determine the certainty of the data indicating the presence of mobile NAPL the visual core inspections and LIF data were again used. The visual core inspections were the most significant piece of data to evaluate the presence of mobile NAPL because samples were considered to contain mobile NAPL if product could be poured off of the sample once it was retrieved at the surface. LIF counts and wavelength data were also used to help confirm the approximate quantity and type of NAPL the sample contained. Areas with confirmed mobile NAPL included the central portions of the Cellon and the main processing areas. These areas are considered the highest priority for thermal treatment due to the relative quantities and depths of mobile NAPL.

Potential for future changes in the land use and/or subsurface conditions that might facilitate the mobilization of currently immobile NAPL were also used to prioritize areas of treatment for the 3 treatment scenarios provided in the final conceptual design. Increased pumping in the E-zone aquifer down gradient of the McCormick and Baxter site has the potential to mobilize currently immobile NAPL components. Therefore, southern portions of the Cellon and the main processing areas are considered the second highest priority in the treatment scenarios. Although these areas have relatively less contamination identified as mobile NAPL they have been identified as areas of the site that would be impacted by down gradient pumping in the E-zone aquifer.

Finally, ease of access for follow-up remediation activities was considered when prioritizing areas of NAPL contamination for treatment. The groundwater at the site generally flows in a southeastern direction and sources of recharge exist to the north of the site (The Old Mormon Slough and the Stockton deepwater channel) and to the west of the site (San Joaquin River). For this reason, southern portions of the Cellon and the main processing areas were again considered the second highest priority in the treatment scenarios because NAPL contamination traveling southeast in these areas of the site would be increasing difficult to address as the contamination moved further off site. NAPL contamination found in the oily waste pond area in the western portion of the site and east main processing area were considered the lowest priority for thermal treatment since the relative amount of NAPL contamination was lower and the direction of preferential pathways for mobile NAPL did lead directly offsite.

7.0 CONCLUSIONS

The McCormick and Baxter site provides a good example of why it is difficult to adequately characterize complex NAPL sites using traditional sampling and analytical technologies and how the Triad Approach offers a faster and less expensive pathway to making project decisions. The large number of data points required for adequate characterization of the NAPL at the site and ultimately design an economically viable remediation system required the use of a non-traditional approach. Time and costs associated with a traditional approach and the inherent difficulty in locating NAPL in complex matrices required that a new approach be used for this site.

The McCormick and Baxter site is also a good example of how data from field based analytical technologies can be used in conjunction with modified mobile laboratory and fixed laboratory methods to make project decisions in near real time. Data generated with mobile laboratory and off-site laboratory methods provided better interpretation of field based results and provided the confirmation necessary to have confidence in the LIF and CPT interpretations. The field based analytical methods provided the density of data points necessary to make informed decisions at the site.

The modified methods used for the investigation also provide insight into the performance based measurement system (PBMS) that allows methods to be tailored to meet the specific needs of a project. Traditional analytical methods were modified to allow for quick turn around and subsequent use of real time data to make project decisions in the field. The data generated from the modified methods still provided the quality control and quality assurance measures necessary to use the data for it's intended purpose but also allowed for the rapid data generation necessary to keep the investigation moving. The PBMS approach also promotes determining the applicability of methods for the unique matrices present in real time so that the usability of data is evaluated as the project is progressing and not after the field mobilization has been completed.

The ultimate goal of developing a detailed CSM is to provide the decision makers with information necessary to make informed project decisions. In the case of the McCormick and Baxter site, development of a clean-up strategy has been difficult given our understanding of the site contaminant distribution, contaminant fate and transport, and the subsurface geology. The sheer size of the contaminant plumes, the number of contaminants of concern, the media involved, and the enormous costs associated with remedial strategies present project managers with difficult decisions. Fortunately, information obtained from 1999 and 2000 NAPL investigations in conjunction with data from numerous other investigations will provide project staff with the technical details necessary to understanding the sites unique challenges. Continued refinement of the geologic, hydrogeologic, and contamination CSMs for the McCormick and Baxter site will provide the basis for future project decisions.

The time and money saved using a dynamic approach to the field activities conducted in 1999 and 2000 has resulted in project cost savings and accelerated completion of the RI/FS component for DNAPL contamination at the site. In addition, much of the data collected during the dynamic field activities has provided crucial information for RD/RA activities including developing costs and engineering specifications for the proposed thermal treatment designs.

TABLE 1-1
MOBILE FIELD LABORATORY METHOD SUMMARY—SOIL

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument Detector
TPH by Fluorescence	ASTM D 6187 (SCAPS SOP)	NA	NA	NA	Fluorescence detector (photodiode array with optical multichannel analyzer)
TRPH	SCAPS SOP	Refrigeration	Sonication in Freon	Silica gel	Buck 404 Infrared Spectrophotometer
TPH-Dx	Region 9 SOP - Modified	Refrigeration	Vortex in hexane	NA	GC/FID

TABLE 1-2
MOBILE FIELD LABORATORY METHOD SUMMARY—GROUNDWATER

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument Detector
TPH-Dx	Region 9 SOP - Modified	Refrigeration	Vortex in hexane	NA	GC/FID

TABLE 1-3
FIXED LABORATORY METHOD SUMMARY—SOIL

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument/ Detector
TPH-Dx	Region 9 SOP	4 ± 2 °C	PFE	NA	GC/FID
PAHs and PCP (rapid and standard TAT)	Region 9 SOP - Modified	4 ± 2 °C	PFE	GPC	GC/MS
Dioxin/Furans	SW-846 1613B	4 ± 2 °C	Soxhlet	See analytical request form (Appendix D)	High-resolution GC/MS
PCBs	CLP SOW - Modified	4 ± 2 °C	PFE	Sulfuric acid/ permanganate, florisil	GC/ECD
Metals (As, Cu, Cr, Zn)	CLP RAS	None	Acid digestion	None	ICP/GFAA
Metals Speciation	Kerr Lab SOP	None	NA	NA	NA
TOC	Walkley-Black	4 ± 2 °C	Dean-Stark	None	Titration with Fe SO_4
Grain Size	ASTM D 422	None	NA	NA	NA
Density	ASTM D2937	None	NA	NA	NA
Porosity	API RP40	None	Toluene	None	NA
Permeability (Hydraulic Conductivity)	Kerr Lab SOP	None	NA	NA	Constant-temperature incubator with diaphragm metering pump, fraction collector, and Omega PX800 pressure transducers
NAPL Saturation (Oil and Grease)	PTS SOP	4 ± 2 °C	PTS SOP	NA	Analytical balance
Cation Exchange Capacity	SW-846 9081	None	Sodium acetate	NA	Atomic absorption

Notes:

GFAA - graphite furnace atomic absorption
ICP - inductively coupled plasma - atomic emission spectroscopy
NA - not applicable
PFE - pressurized fluid extraction
TAT - turn-around time

TABLE 1-4
FIXED LABORATORY METHOD SUMMARY—NAPL

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument/ Detector
TPH-Dx	SW-846 8015 Modified	Refrigeration	NA	NA	GC/FID
SVOC TAL with TICs	SW-846 8270C	Refrigeration	NA	NA	GC/MS
Viscosity	Kerr Lab SOP (ASTM D1296)	Refrigeration	NA	NA	Brookfield Rotational Voscometer Model DV-1
Density	Kerr Lab SOP	Refrigeration	NA	NA	Balance
Solubility	Kerr Lab SOP	Refrigeration	Methylene chloride	NA	GC/MS
Wettability	Kerr Lab SOP	Refrigeration	NA	NA	Visual inspection
Boiling point distribution/distillation (ASTM D86)	Kerr Lab SOP	Refrigeration	NA	NA	Thermometer
Oil-Water Interfacial Tension	Kerr Lab SOP (ASTM D971)	Refrigeration	NA	NA	Fisher Surface Tensiometer Model 20

Notes:

GC/FID - gas chromatograph/flame ionization detector
GC/MS - gas chromatograph/mass spectrophotometer
GPC - gel permeation chromatography
NA - not applicable

TABLE 2-1
PROJECT LABORATORIES

Laboratory	Methods	Matrix	Address And Contact
SCAPS Team	TRPH by Fluorescence TRPH by 418.1 Geotech/Stratigraphy	Soil Soil Soil	1645 S. 101st E. Ave. Tulsa, OK 74128 Contact: Eddie Mattioda Phone: (918) 669-7445
EPA Region 9 FASP	TPH-Dx	Soil, GW	Contact: Jeff Mays (Lockheed Martin); Liza Finley (EPA)
EPA Region 9 Laboratory	TPH-Dx SVOCs PCBs Metals Total and Dissolved Manganese Sulfate Chloride Nitrate Nitrite TOC	Soil Soil, GW Soil Soil GW GW GW GW GW GW	1337 S. 46th Street, Building 201 Richmond, CA 94804-4698 Contact: Nancy Wilson Phone: (510) 412-2377 Backup Contact: Rich Bauer Phone: (510) 412-2312 Reception: (510) 412-2300
Pacific Analytical Laboratories	Dioxin/Furans	Soil, GW	6349 Paseo del Lago Carlsbad, CA 92009 Contact: Steven Parsons Phone: (760) 931-1766 Fax: (760) 931-9479
EPA Robert S. Kerr Environmental Research Laboratory (Kerr Lab)	Density Viscosity Solubility Oil-water Interfacial Tension Wettability TPH-Dx SVOCs Permeability Metals Speciation Treatability Testing	NAPL, GW NAPL NAPL NAPL NAPL NAPL NAPL Soil Soil Soil	919 Kerr Research Drive Ada, OK 74820 Contact: Eva Davis Phone: (580)436-8548

TABLE 2-1 (Continued)
PROJECT LABORATORIES

Laboratory	Methods	Matrix	Address And Contact
Columbia Analytical Services	TPH-Dx SVOCs	NAPL NAPL	1317 S. 13th Ave., P.O. Box 479 Kelso, WA 98626 Contact: Diane Wiegle Phone: (360) 577-7222 Fax: (360) 636-1068
PTS Laboratories, Inc.	Boiling Point Distribution Grain Size Porosity Cation Exchange Capacity Density NAPL Saturation TOC	NAPL Soil Soil Soil Soil Soil Soil	8100 Secura Way Santa Fe Springs, CA 90670 Contact: Richard Young Phone: (562)907-3607 Fax: (562) 907-3610

TABLE 2-2
FIXED LABORATORY METHOD SUMMARY—SOIL

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument/ Detector
TPH-Dx	Region 9 SOP	4 ± 2 °C	PFE	NA	GC/FID
PAHs and PCP (rapid and standard TAT)	Region 9 SOP - Modified	4 ± 2 °C	PFE	GPC	GC/MS
Dioxin/Furans	SW-846 1613B	4 ± 2 °C	Soxhlet	See analytical request form (Appendix D)	High-resolution GC/MS
PCBs	CLP SOW - Modified	4 ± 2 °C	PFE	Sulfuric acid/ permanganate, florisil	GC/ECD
Metals (As, Cu, Cr, Zn)	CLP RAS	None	Acid digestion	None	ICP/GFAA
Metals Speciation	Kerr Lab SOP	None	NA	NA	NA
TOC	Walkley-Black	4 ± 2 °C	Dean-Stark	None	Titration with Fe SO_4
Grain Size	ASTM D 422	None	NA	NA	NA
Density	ASTM D2937	None	NA	NA	NA
Porosity	API RP40	None	Toluene	None	NA
Permeability (Hydraulic Conductivity)	Kerr Lab SOP	None	NA	NA	Constant-temperature incubator with diaphragm metering pump, fraction collector, and Omega PX800 pressure transducers
NAPL Saturation (Oil and Grease)	PTS SOP	4 ± 2 °C	PTS SOP	NA	Analytical balance
Cation Exchange Capacity	SW-846 9081	None	Sodium acetate	NA	Atomic absorption

Notes:

GFAA - graphite furnace atomic absorption
ICP - inductively coupled plasma - atomic emission spectroscopy
NA - not applicable
PFE - pressurized fluid extraction
TAT - turn-around time

TABLE 2.3
FIXED LABORATORY METHOD SUMMARY—NAPL

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument/ Detector
TPH-Dx	SW-846 8015 Modified	Refrigeration	NA	NA	GC/FID
SVOC TAL with TICs	SW-846 8270C	Refrigeration	NA	NA	GC/MS
Viscosity	Kerr Lab SOP (ASTM D1296)	Refrigeration	NA	NA	Brookfield Rotational Voscometer Model DV-1
Density	Kerr Lab SOP	Refrigeration	NA	NA	Balance
Solubility	Kerr Lab SOP	Refrigeration	Methylene chloride	NA	GC/MS
Wettability	Kerr Lab SOP	Refrigeration	NA	NA	Visual inspection
Boiling point distribution/distillation (ASTM D86)	Kerr Lab SOP	Refrigeration	NA	NA	Thermometer
Oil-Water Interfacial Tension	Kerr Lab SOP (ASTM D971)	Refrigeration	NA	NA	Fisher Surface Tensiometer Model 20

Notes:

GC/FID - gas chromatograph/flame ionization detector
GC/MS - gas chromatograph/mass spectrophotometer
GPC - gel permeation chromatography
NA - not applicable

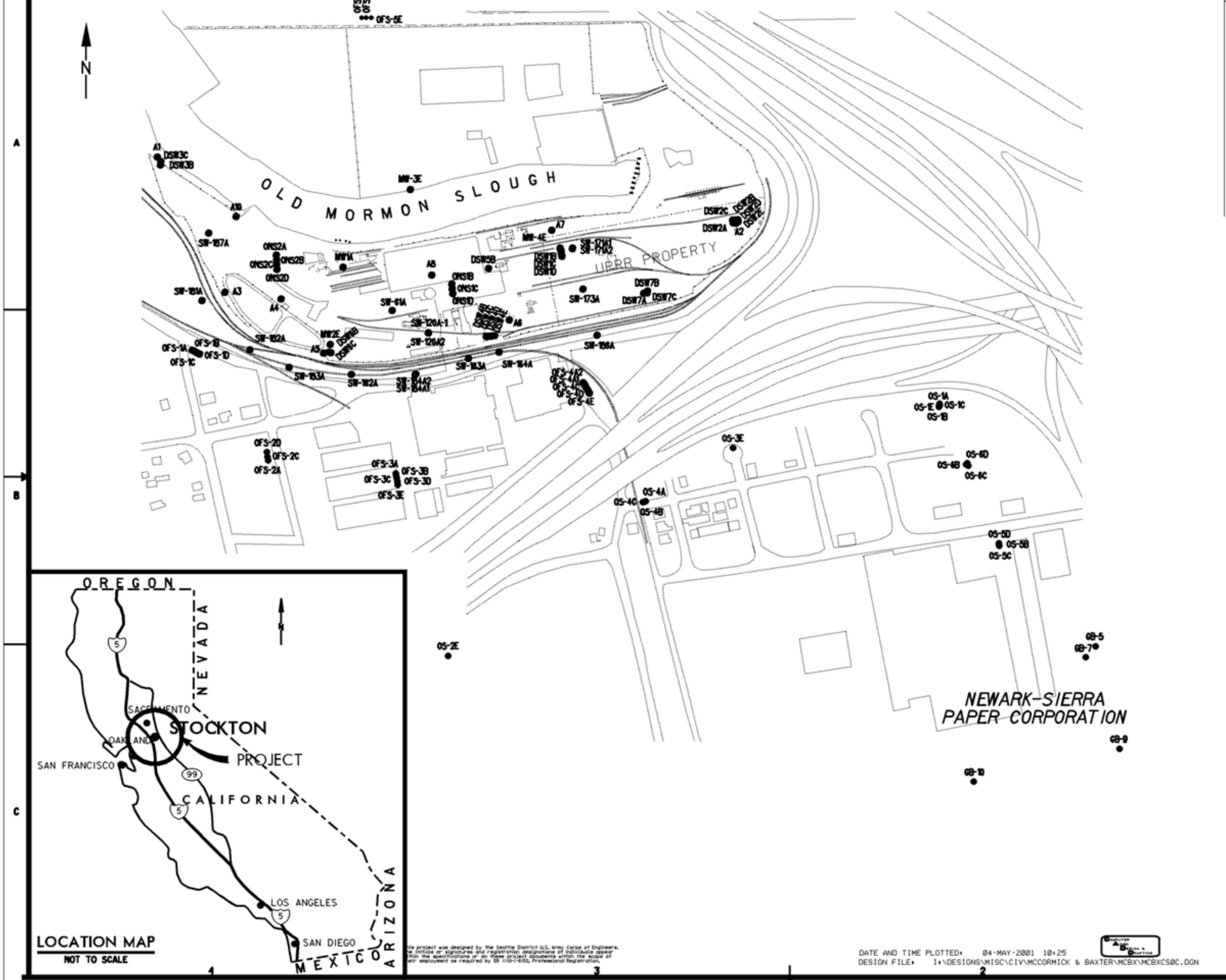
TABLE 2.4
FIXED LABORATORY METHOD SUMMARY—GROUNDWATER

Analyte	Method Reference	Preservation Method	Extraction Method	Cleanup Method	Instrument/ Detector
PAHs and PCP (rapid TAT)	SW-846 8270C	4 ± 2 °C	Continuous liquid/liquid	GPC	GC/MS
SVOC TAL (standard TAT)	SW-846 8270C	4 ± 2 °C	Continuous liquid/liquid	GPC	GC/MS
Dioxin/Furans	SW-846 1613B	4 ± 2 °C	Sep funnel	See analytical request form (Appendix D)	High Resolution GC/MS
TOC	EPA 415.1	4 ± 2 °C	NA	NA	Dohrman Total Organic Carbon Analyzer DC-190
Density	Kerr Lab SOP	4 ± 2 °C	NA	NA	Balance
Total and Dissolved Manganese	EPA 200.7	Nitric acid to < pH2, 4 ± 2 °C	Acid digestion	None	ICP-AES
Sulfate, Chloride, Nitrate, Nitrite	EPA 300 series	4 ± 2 °C	None	None	Dionex Ion Chromatograph/ DX120

Notes:

GC/FID - gas chromatograph/flame ionization detector
GC/MS - gas chromatograph/mass spectrophotometer
GPC - gel permeation chromatography
ICP-AES - inductively coupled plasma – atomic emission spectrometry
NA - not applicable
TAT - turn-around time

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



LEGEND

● OS-3E WELL LOCATION

1" = 400'

0 400'

his project was designed by the Seattle District U.S. Army Corps of Engineers.
he initials or signatures and registration designations of individuals appear
ithin the specifications or on these project documents within the scope of
heir employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 04-MAY-2001 10:25
DESIGN FILE: I:\DESIGNS\MISC\CIV\MCCORMICK & BAXTER\MCBX\MCBXCS0C.DGN

Computer Aided Design & Drafting

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE
FY00 NAPL INVESTIGATION

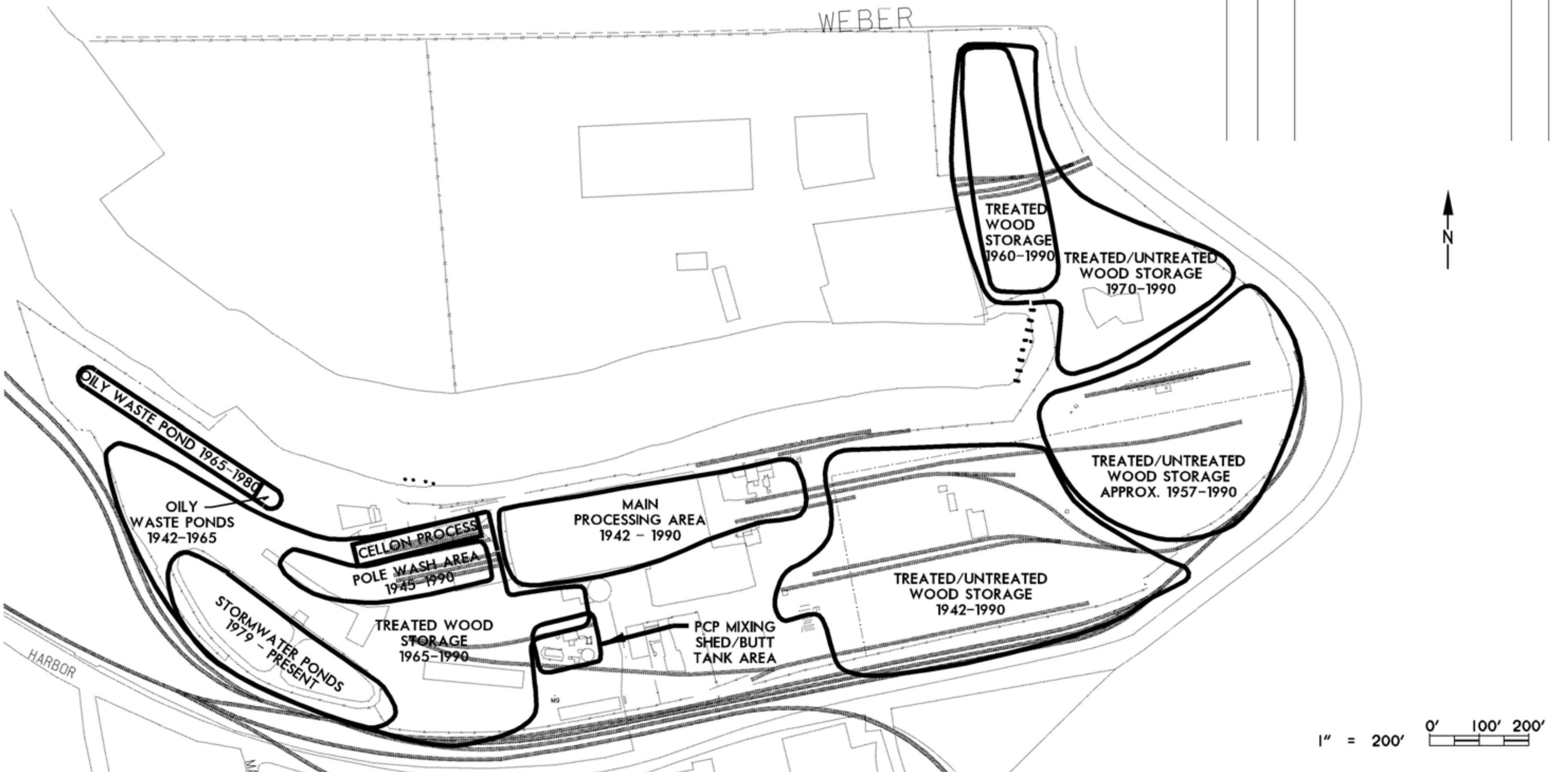
SITE LOCATION AND WELLS

STOCKTON CALIFORNIA

SIZE	INVITATION NO.	FILE NO.	DATE:	FIGURE
D				1-1
DSGN. SMITH		CHK. LYNCH	SHEET	

SCALE: 1" = 200'

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE
FY00 NAPL INVESTIGATION

PROCESS/SOURCE AREAS
IDENTIFIED IN THE RI

STOCKTON **CALIFORNIA**

SIZE	INVITATION NO.	FILE NO.	DATE:	FIGURE
D				1-2
DSGN. SMITH		CHK. LYNCH	SHEET	

This project was designed by the Seattle District U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear within the specifications or on these project documents within the scope of their employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 04-MAY-2001 10:23
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DATE AND TIME PLOTTED: 04-MAY-2001 10:23 DESIGN FILE: l:#designs#misc#civ#McCormick & Baxter#mcbx#mcbxcs0b.dgn

LEGEND

- ■ Sand and gravel
- □ Clay and silt
- ▦ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
4. Data from 0 to -100 feet are limited to quantitative SCAPS results. Due to limited data below -100 feet, all available boring logs, SCAPS data, and geophysical logs were used. The limits of the bounding area reflect variations in quantity and quality of data.

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McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
0 to -5 Feet Elevation

STOCKTON	**Figure 5-1**	CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
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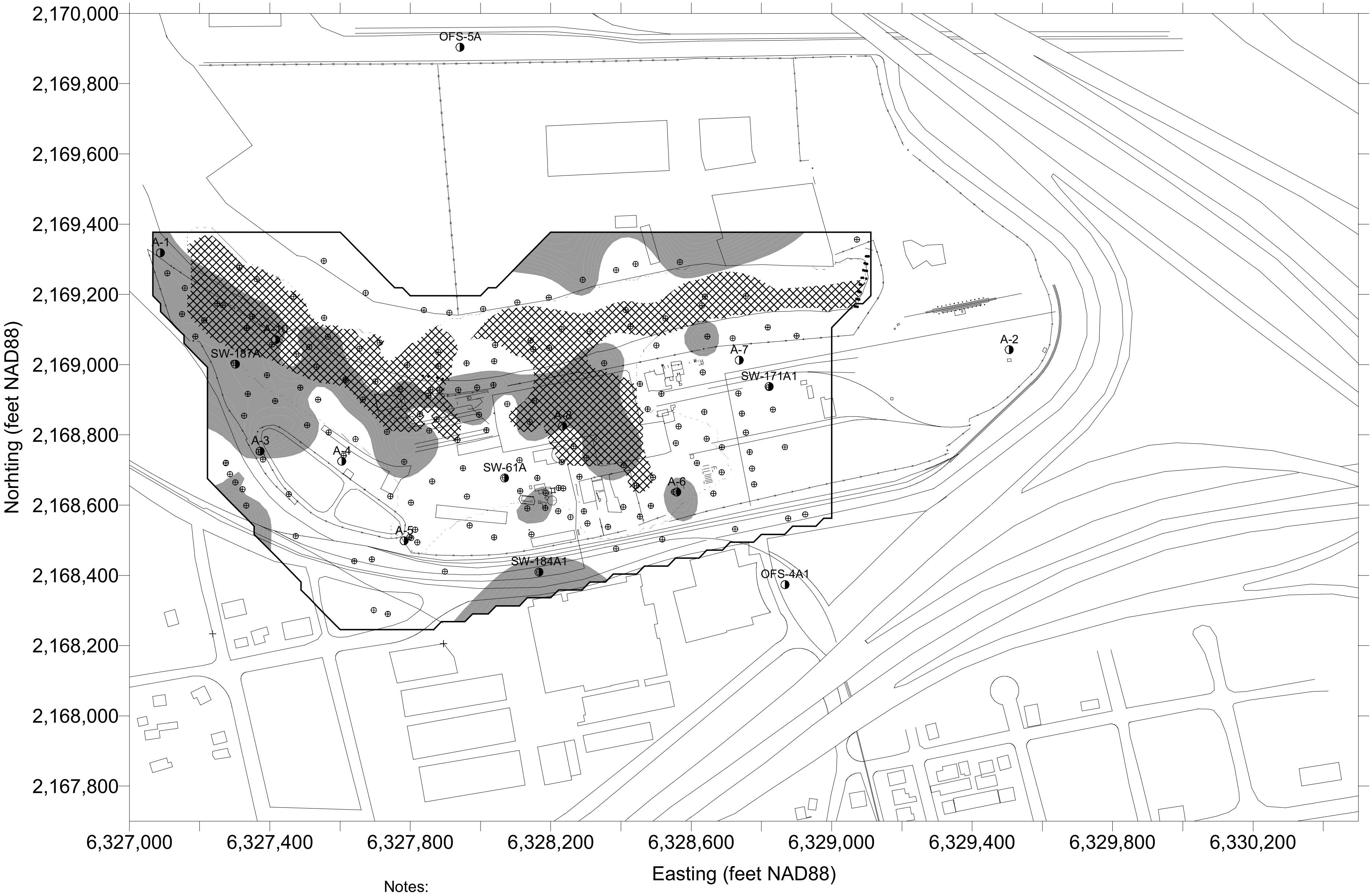
McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-5 to -10 Feet Elevation

STOCKTON	**Figure 5-2**	CALIFORNIA



LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◑	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
4. Data from 0 to -100 feet are limited to quantitative SCAPS results. Due to limited data below -100 feet, all available boring logs, SCAPS data, and geophysical logs were used. The limits of the bounding area reflect variations in quantity and quality of data.

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McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-10 to -15 Feet Elevation

STOCKTON	**Figure 5-3**	CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▨ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
4. Data from 0 to -100 feet are limited to quantitative SCAPS results. Due to limited data below -100 feet, all available boring logs, SCAPS data, and geophysical logs were used. The limits of the bounding area reflect variations in quantity and quality of data.

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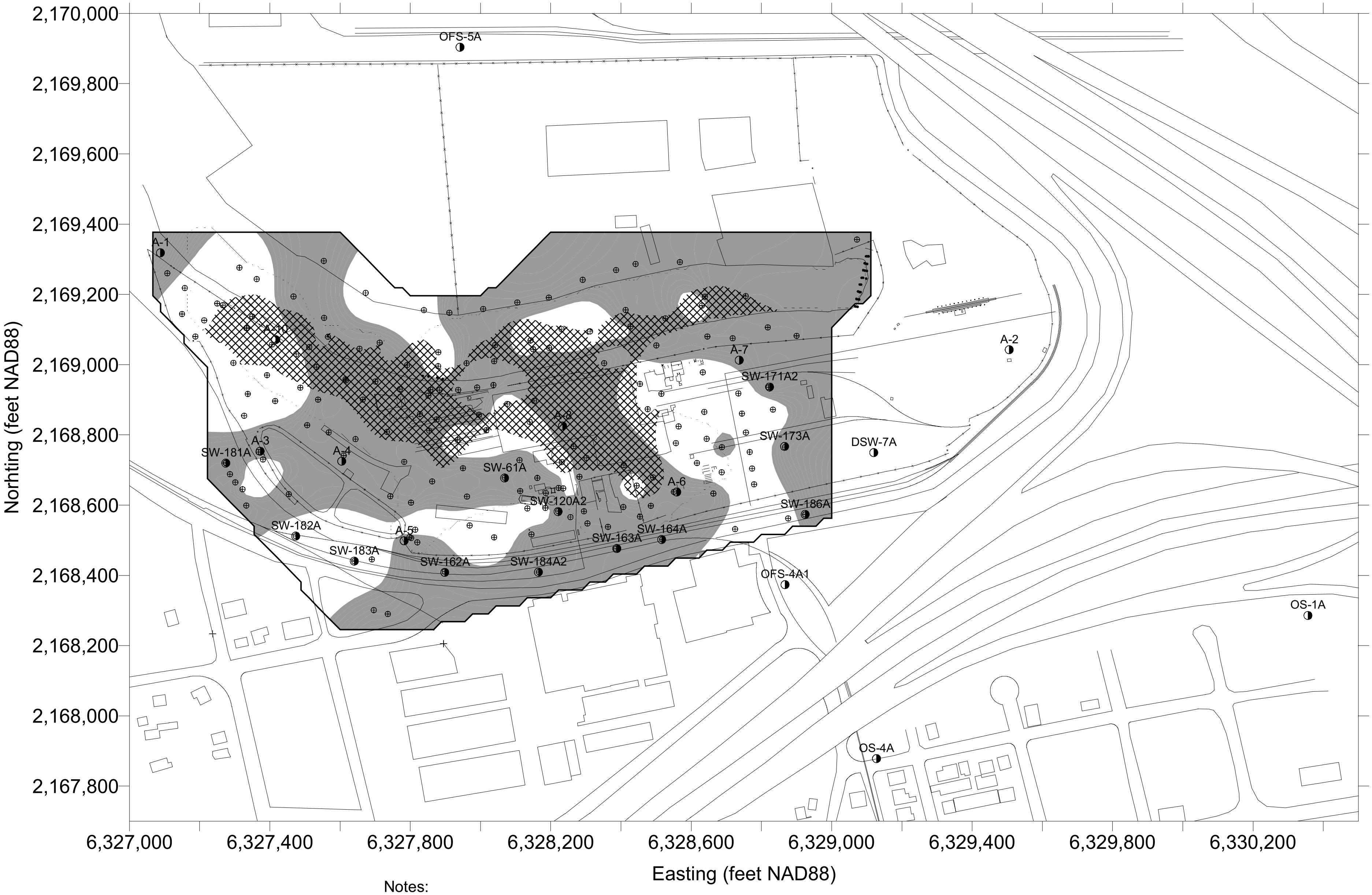
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-15 to -20 Feet Elevation

STOCKTON	**Figure 5-4**	CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
4. Data from 0 to -100 feet are limited to quantitative SCAPS results. Due to limited data below -100 feet, all available boring logs, SCAPS data, and geophysical logs were used. The limits of the bounding area reflect variations in quantity and quality of data.

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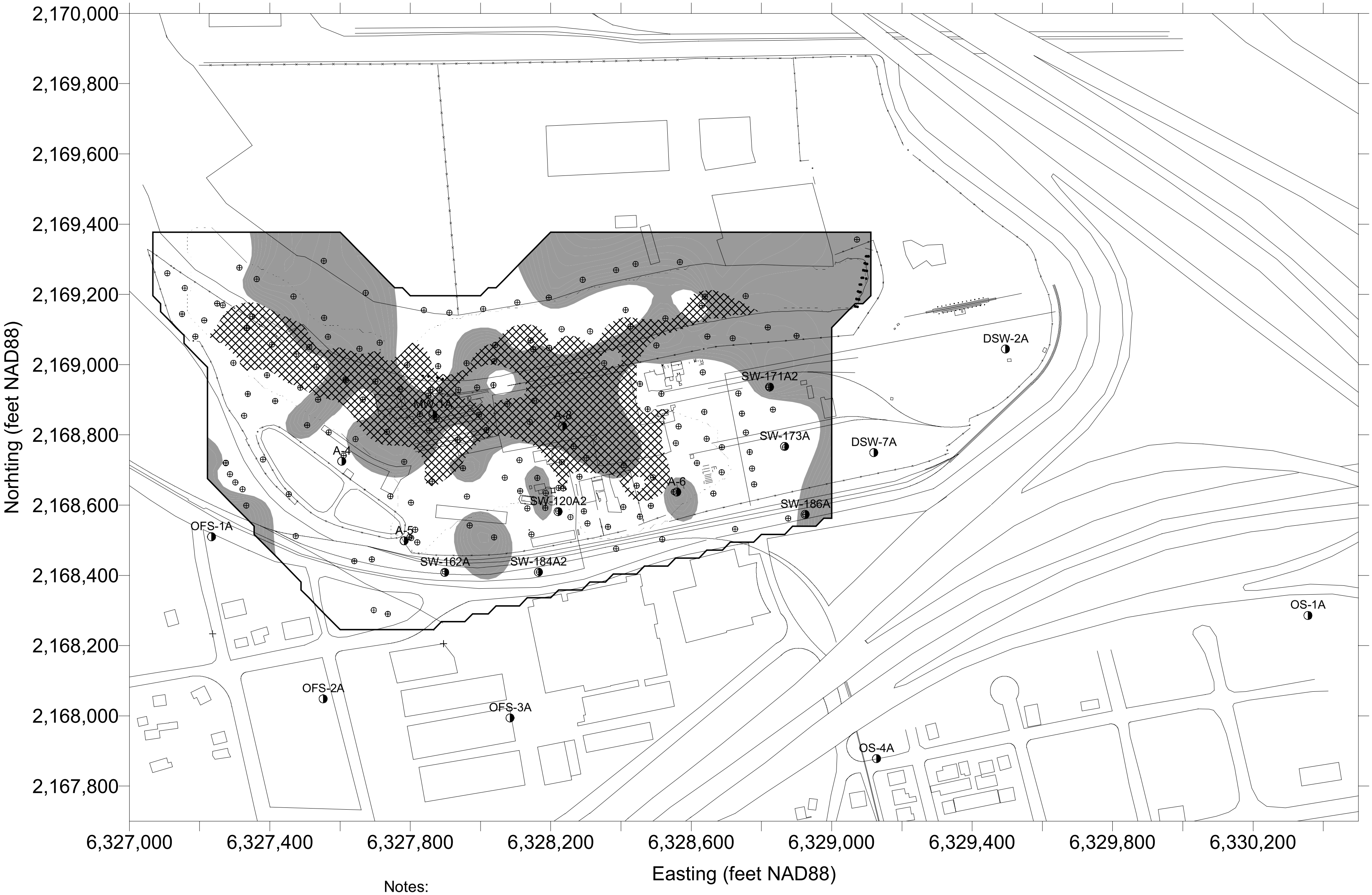
McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-20 to -25 Feet Elevation

STOCKTON	**Figure 5-5**	CALIFORNIA



LEGEND

▨ Sand and gravel
☐ Clay and silt
▩ NAPL potentially present
◐ Monitoring well wholly or partially screened in this elevation interval
⊕ Data points used in this analysis
⬠ Limits of confidence in stratigraphic interpolation

Notes:
1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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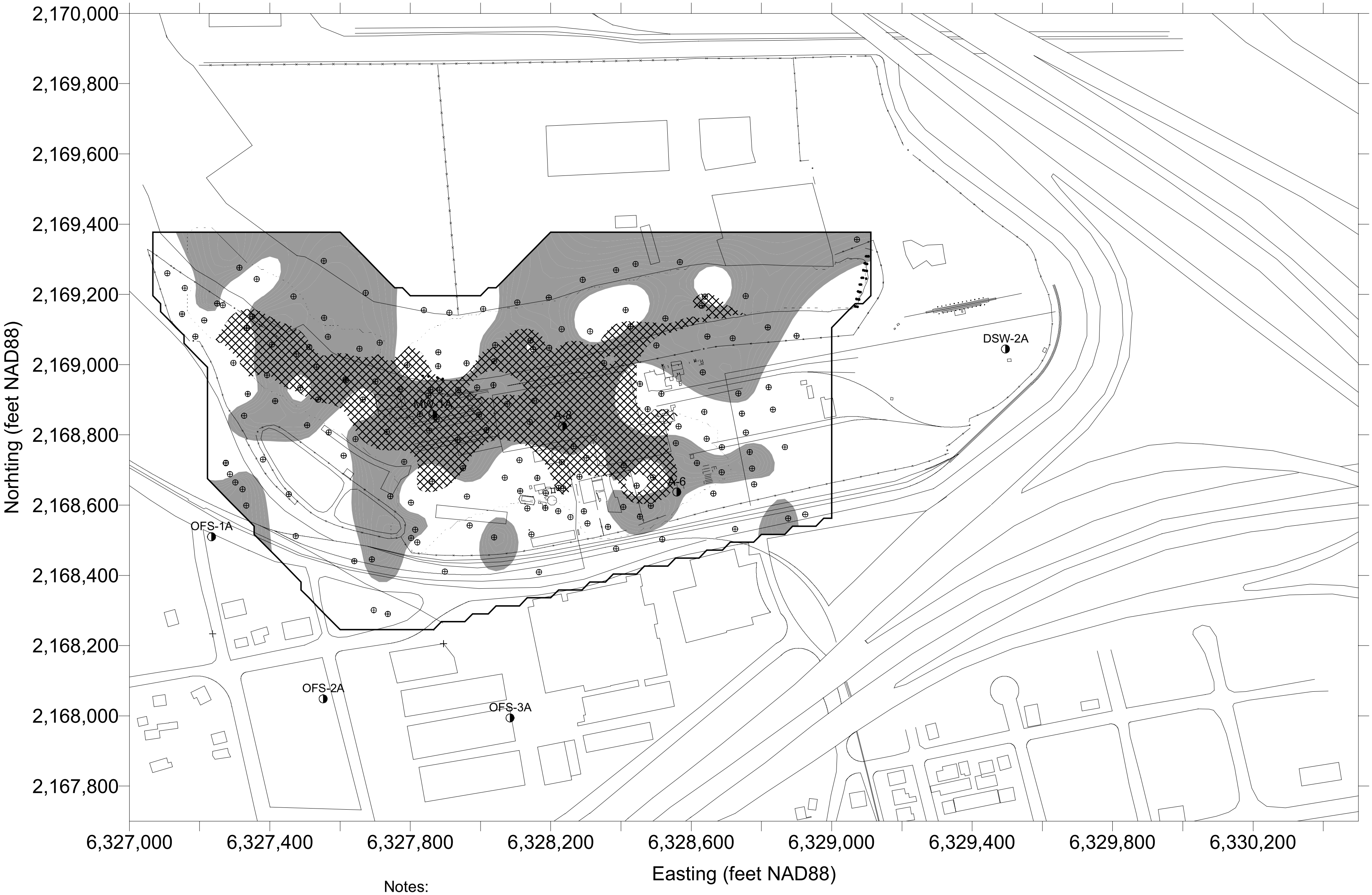
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-25 to -30 Feet Elevation

STOCKTON	**Figure 5-6**	CALIFORNIA



LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-30 to -35 Feet Elevation

STOCKTON **Figure 5-7** CALIFORNIA

LEGEND

■ Sand and gravel
□ Clay and silt
▩ NAPL potentially present
◑ Monitoring well wholly or partially screened in this elevation interval
⊕ Data points used in this analysis
⬠ Limits of confidence in stratigraphic interpolation

Notes:
1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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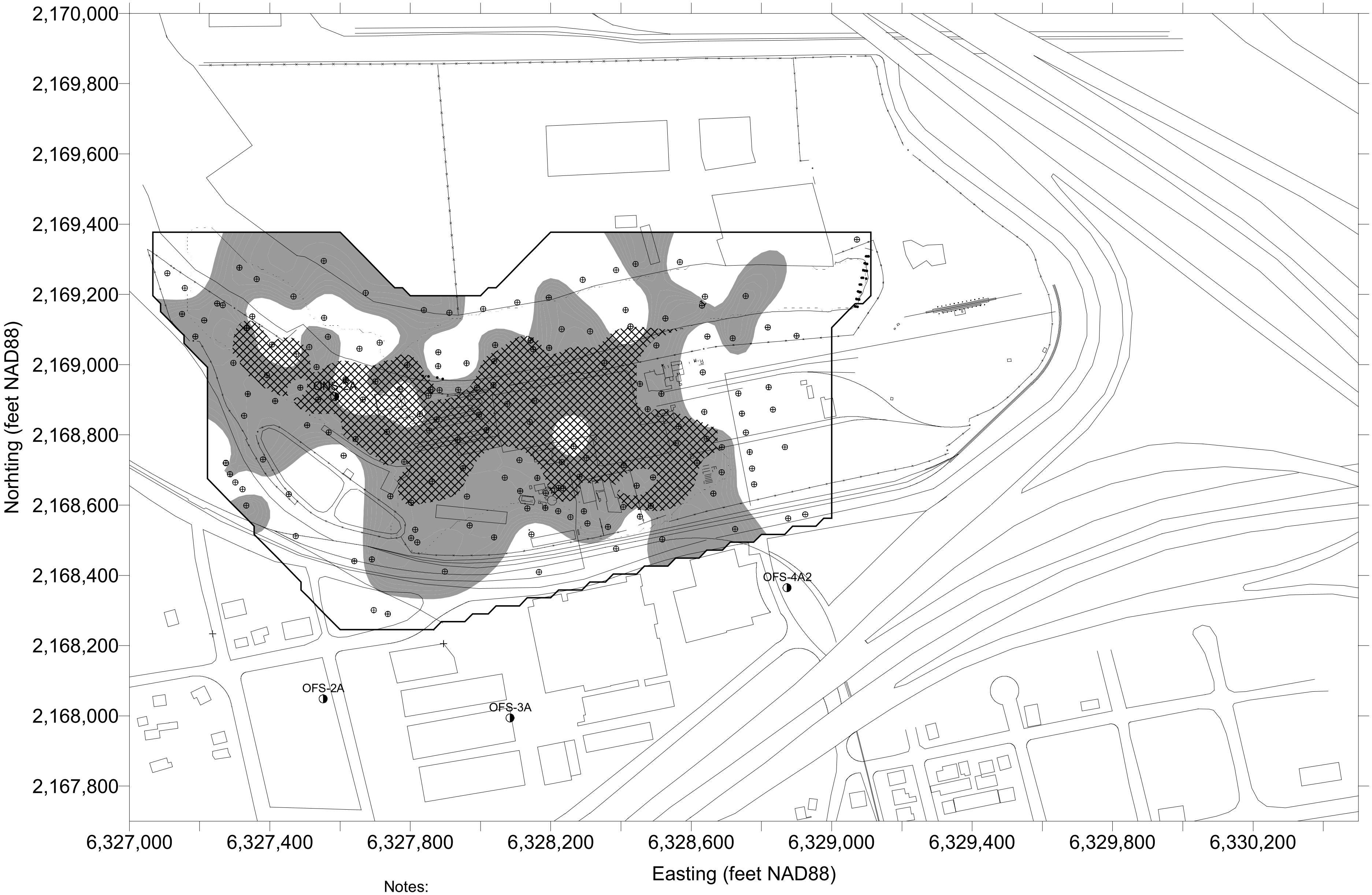
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-35 to -40 Feet Elevation

STOCKTON	**Figure 5-8**	CALIFORNIA



LEGEND

- ▩ Sand and gravel
- ☐ Clay and silt
- ▨ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-40 to -45 Feet Elevation

STOCKTON	**Figure 5-9**	CALIFORNIA

LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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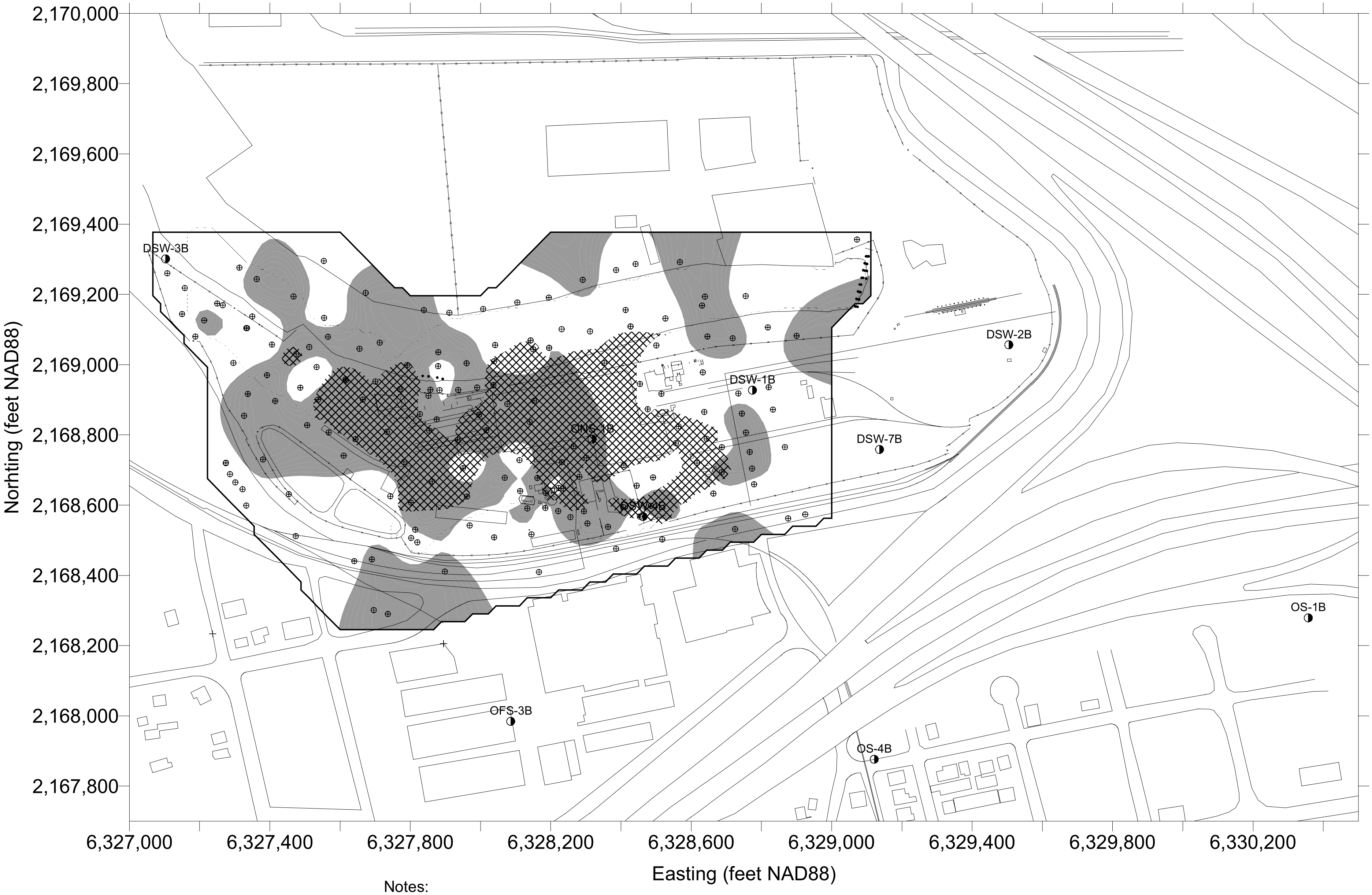
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-45 to -50 Feet Elevation

STOCKTON **Figure 5-10** CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-50 to -55 Feet Elevation

STOCKTON	**Figure 5-11**	CALIFORNIA

LEGEND

- ▆ Sand and gravel
- ☐ Clay and silt
- ▨ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-55 to -60 Feet Elevation

STOCKTON	**Figure 5-12**	CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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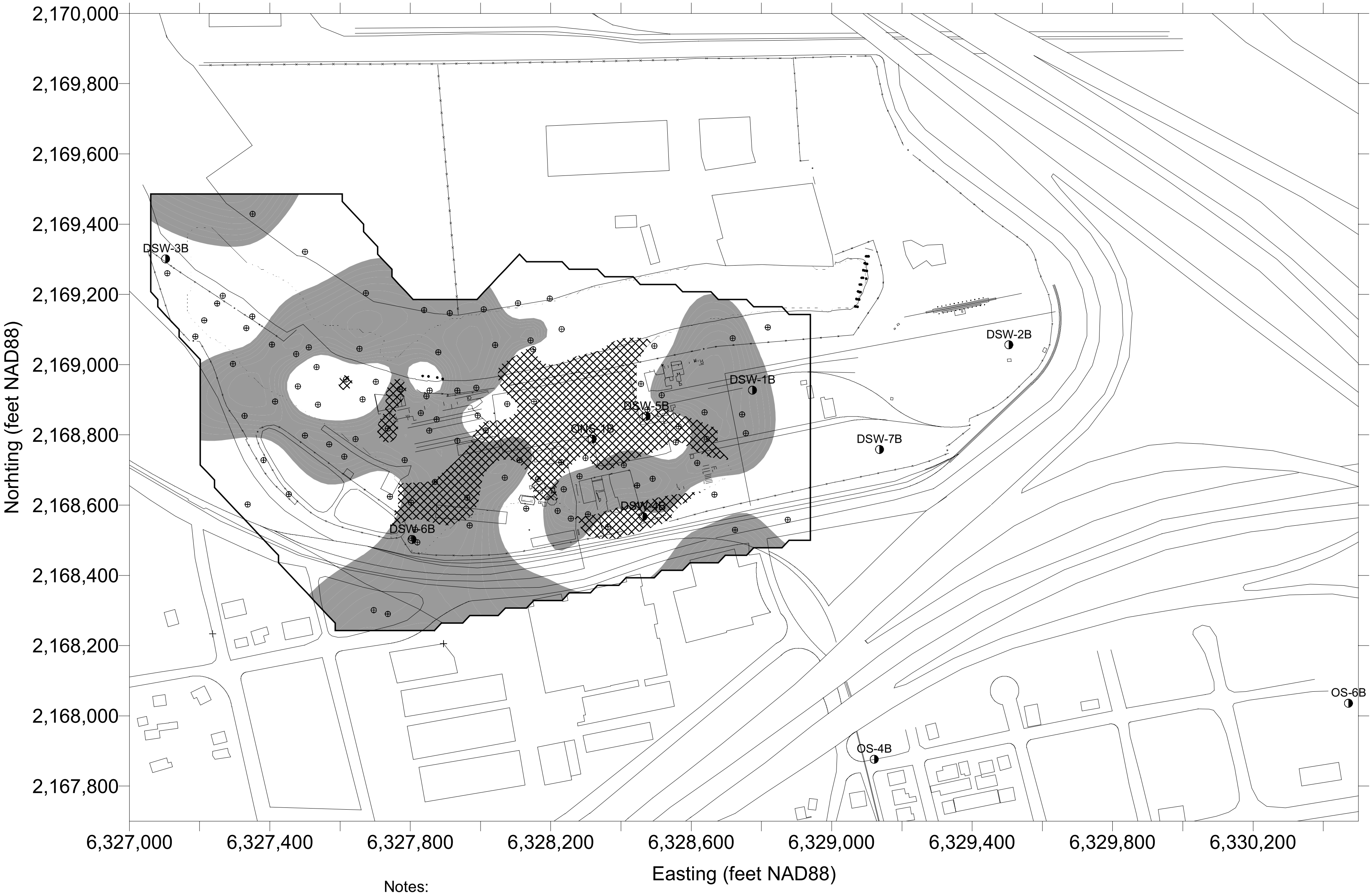
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-60 to -65 Feet Elevation

STOCKTON **Figure 5-13** CALIFORNIA



LEGEND

▩	Sand and gravel
☐	Clay and silt
▨	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-65 to -70 Feet Elevation

STOCKTON | **Figure 5-14** | CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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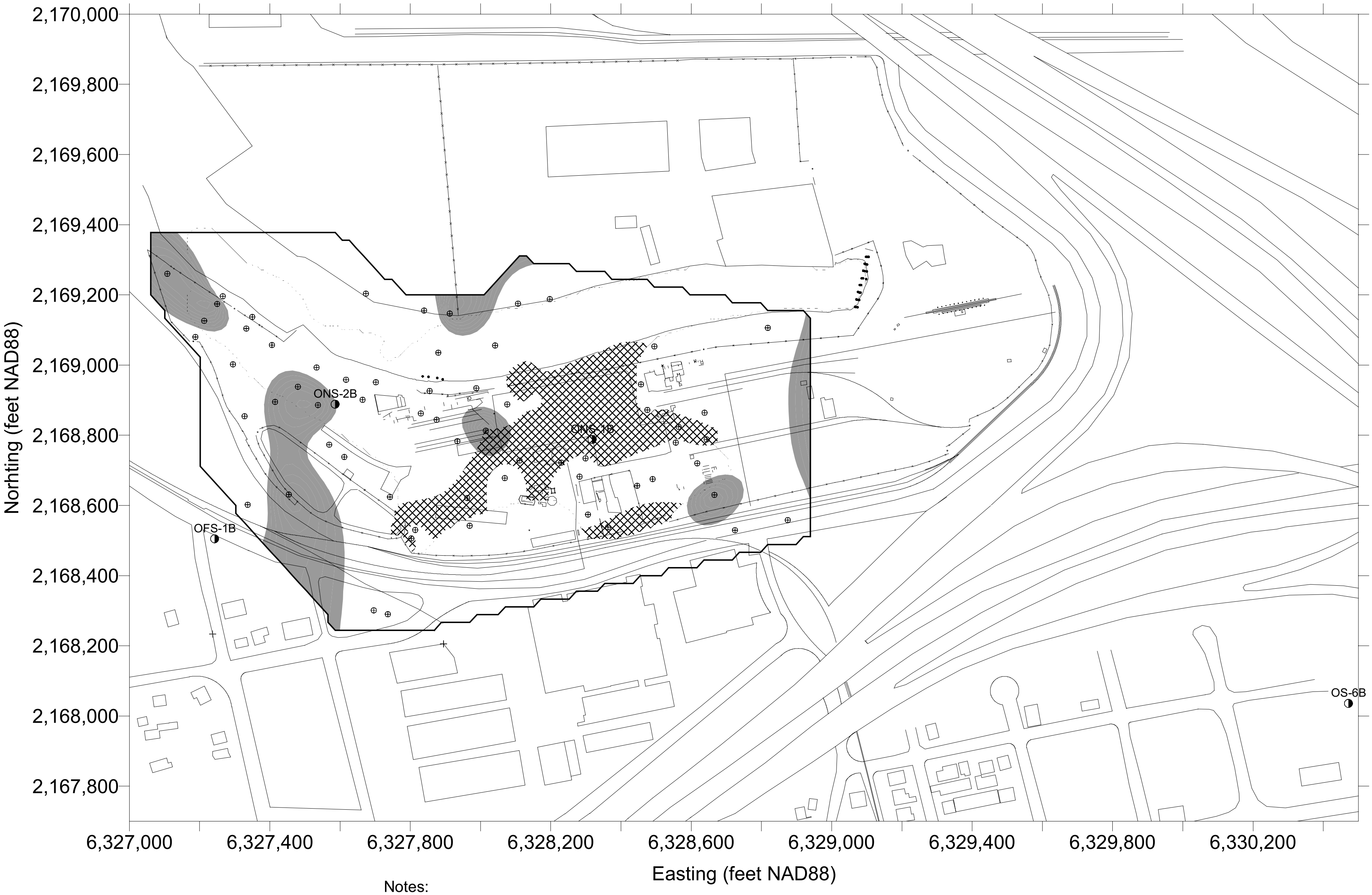
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-70 to -75 Feet Elevation

STOCKTON	Figure 5-15	CALIFORNIA



LEGEND

▒ Sand and gravel
☐ Clay and silt
▨ NAPL potentially present
◐ Monitoring well wholly or partially screened in this elevation interval
⊕ Data points used in this analysis
⬠ Limits of confidence in stratigraphic interpolation

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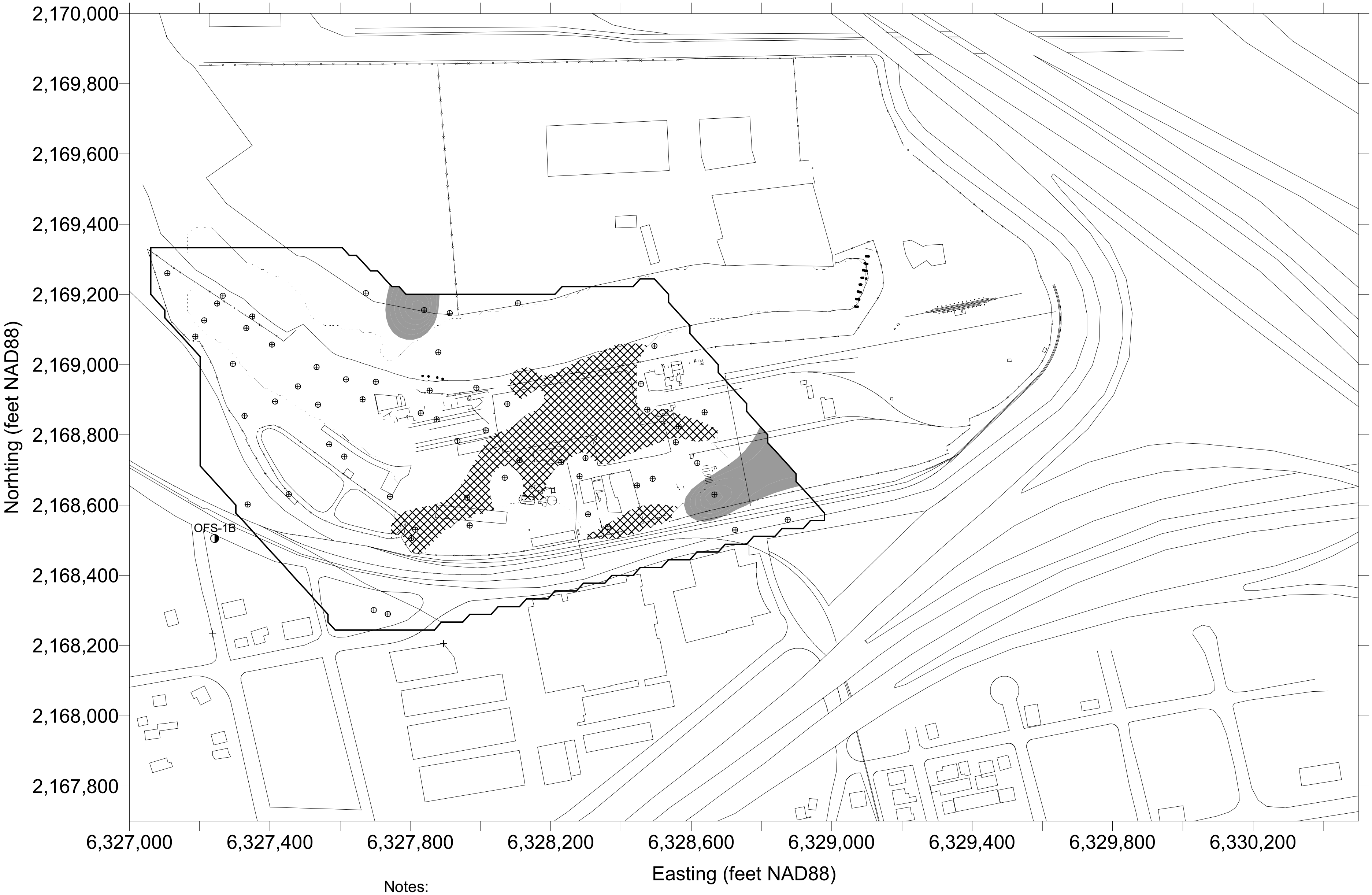
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-75 to -80 Feet Elevation

STOCKTON **Figure 5-16** CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-80 to -85 Feet Elevation

STOCKTON **Figure 5-17** CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-85 to -90 Feet Elevation

STOCKTON	**Figure 5-18**	CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-90 to -95 Feet Elevation

STOCKTON	**Figure 5-19**	CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-95 to -100 Feet Elevation

STOCKTON	**Figure 5-20**	CALIFORNIA

LEGEND

- ▓ Sand and gravel
- ☐ Clay and silt
- ▨ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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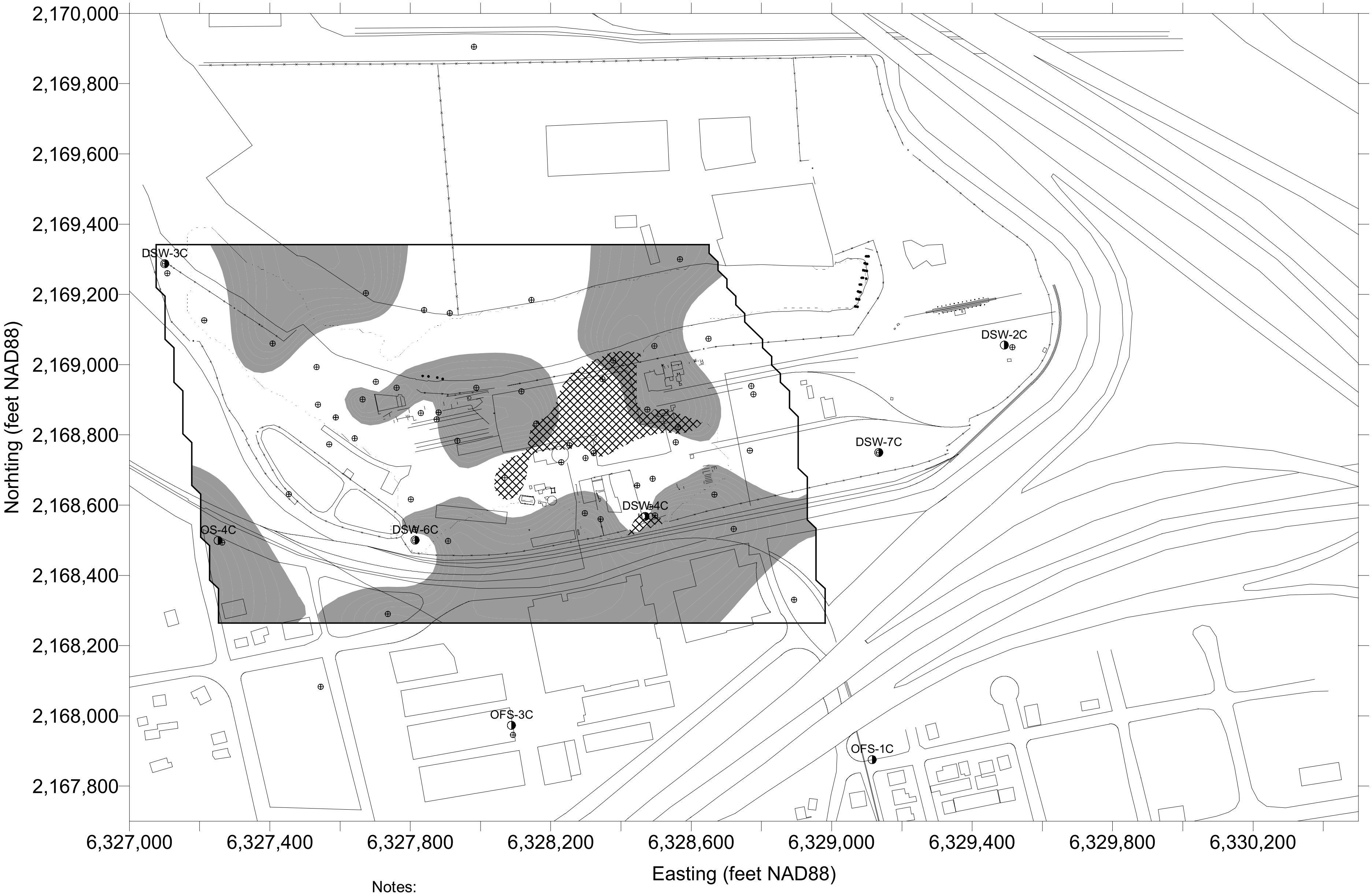
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-100 to -105 Feet Elevation

STOCKTON	Figure 5-21	CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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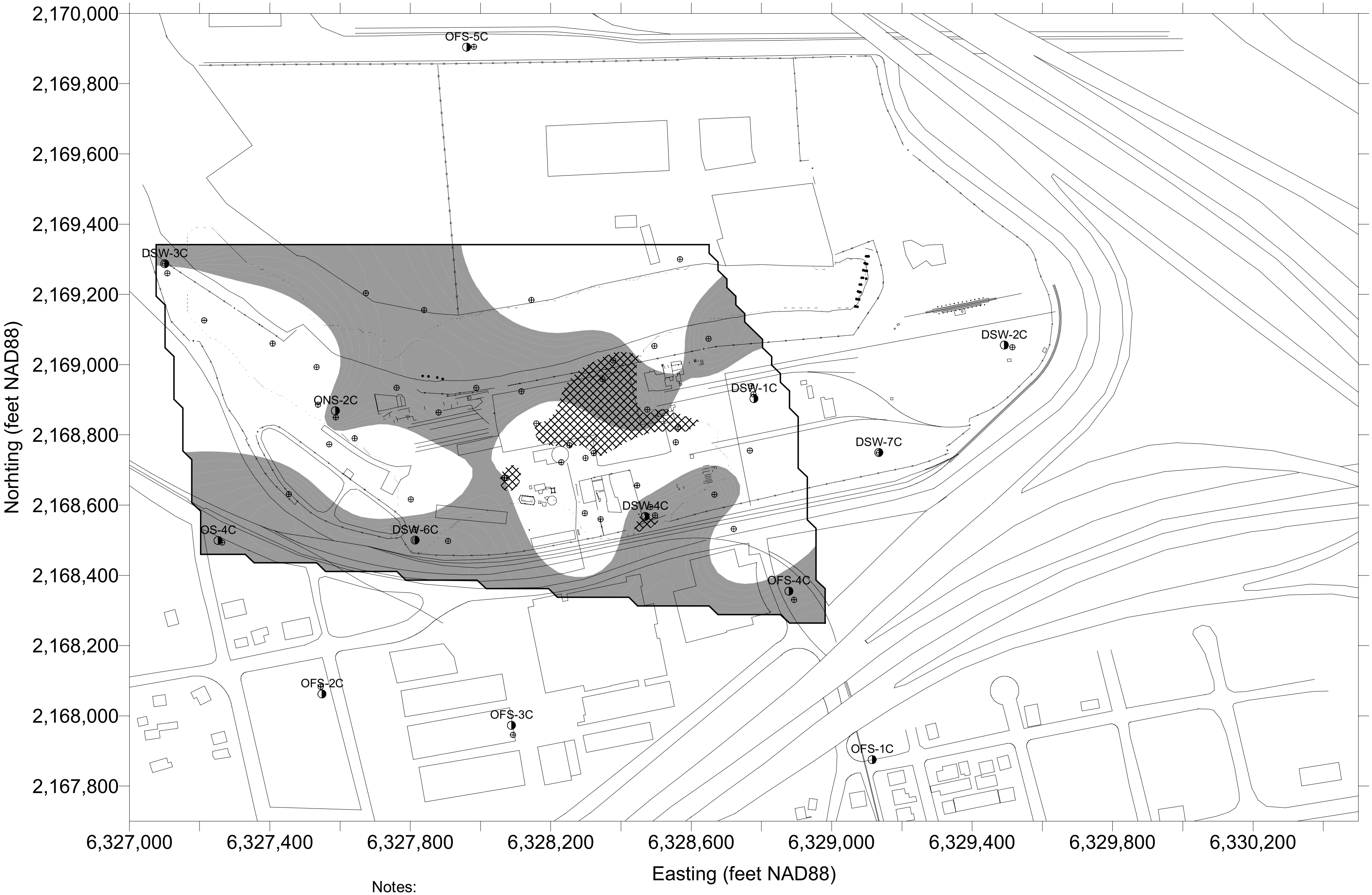
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-105 to -110 Feet Elevation

STOCKTON	**Figure 5-22**	CALIFORNIA



LEGEND

▇	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

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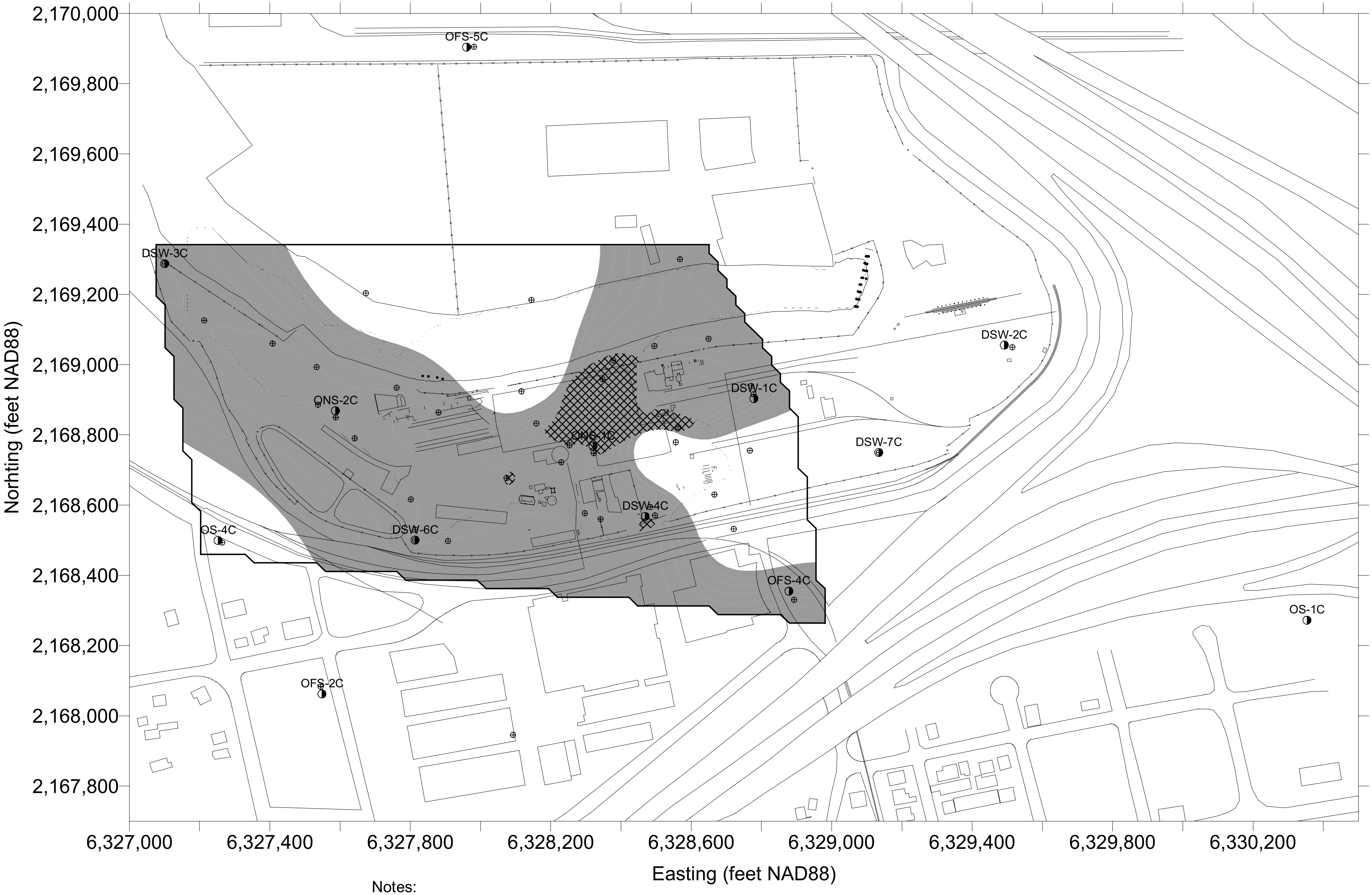
Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-110 to -115 Feet Elevation

STOCKTON	**Figure 5-23**	CALIFORNIA



LEGEND

▇	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
3. Cross-hatched regions are horizontal slices through a volume of space bounded by the top of NAPL and base of NAPL surfaces. NAPL is known to exist somewhere, but not necessarily everywhere, within the cross-hatched region, because NAPL is known to be present above and below this region.
4. Data from 0 to -100 feet are limited to quantitative SCAPS results. Due to limited data below -100 feet, all available boring logs, SCAPS data, and geophysical logs were used. The limits of the bounding area reflect variations in quantity and quality of data.

U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-115 to -120 Feet Elevation

STOCKTON **Figure 5-24** CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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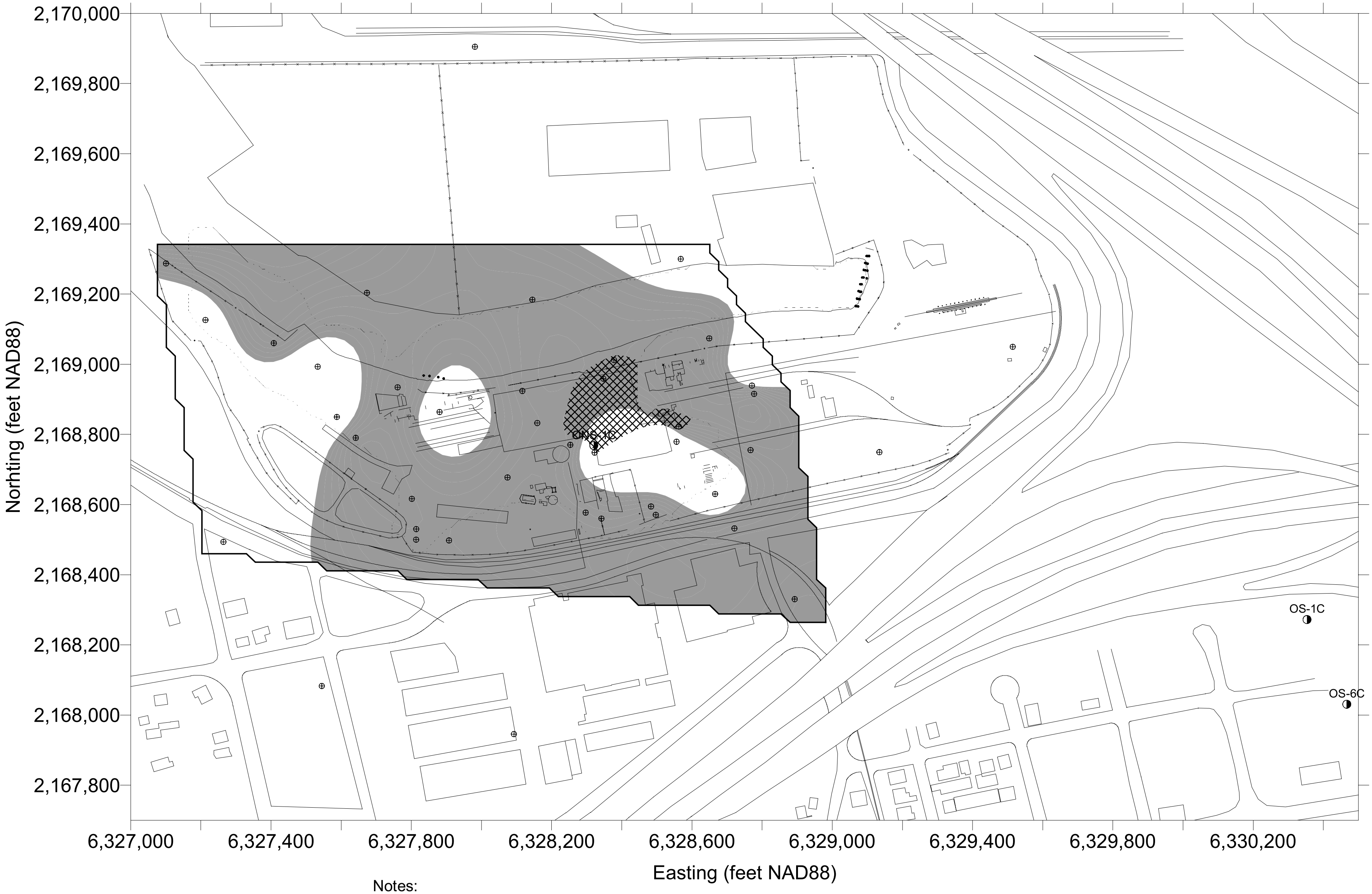
U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-120 to -125 Feet Elevation

STOCKTON	**Figure 5-25**	CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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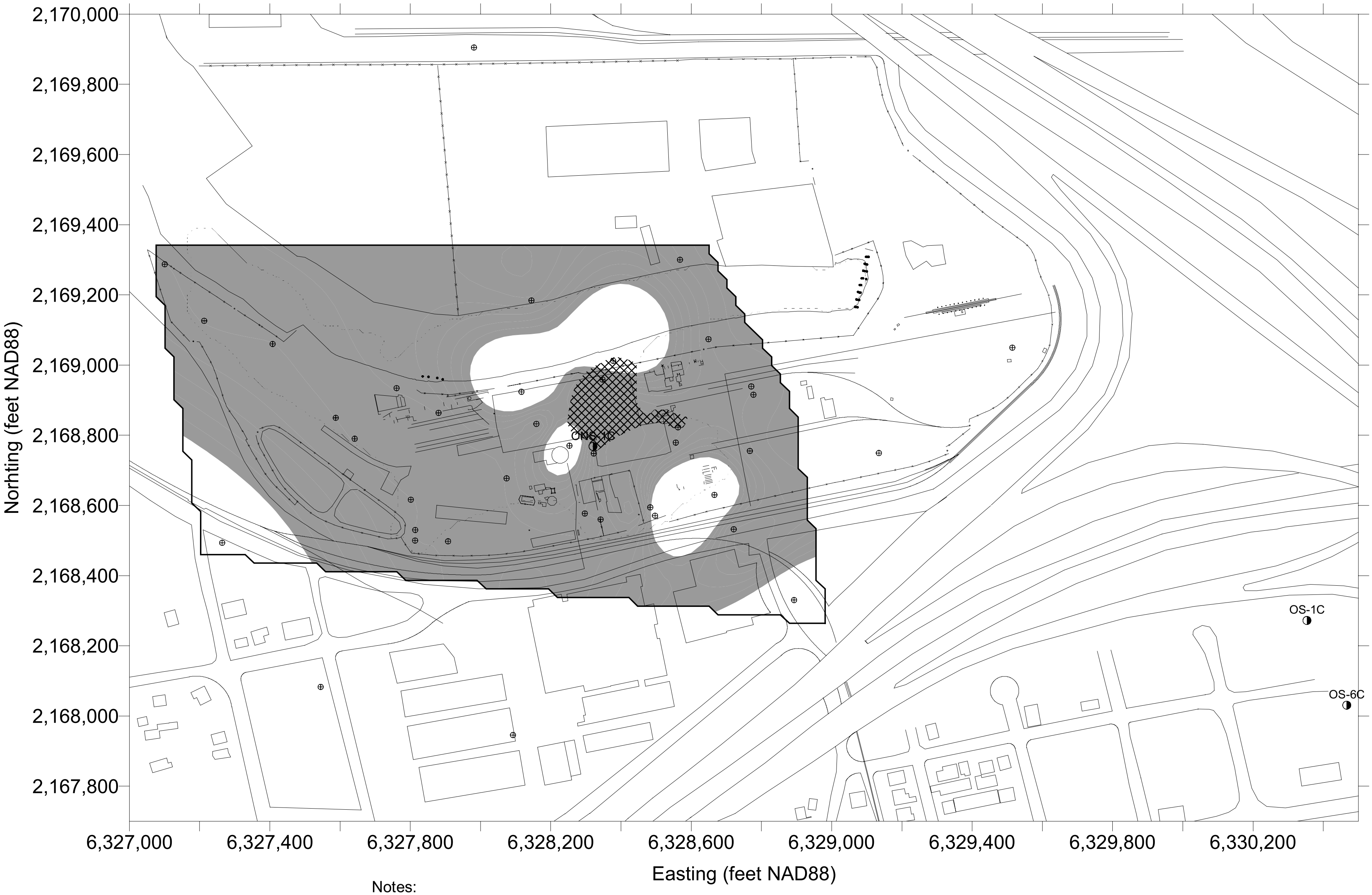
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-125 to -130 Feet Elevation

STOCKTON	**Figure 5-26**	CALIFORNIA



LEGEND

▩	Sand and gravel
☐	Clay and silt
▦	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
2. Contouring accomplished using the minimum curvature method in Surfer v. 7.
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McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-130 to -135 Feet Elevation

STOCKTON | **Figure 5-27** | CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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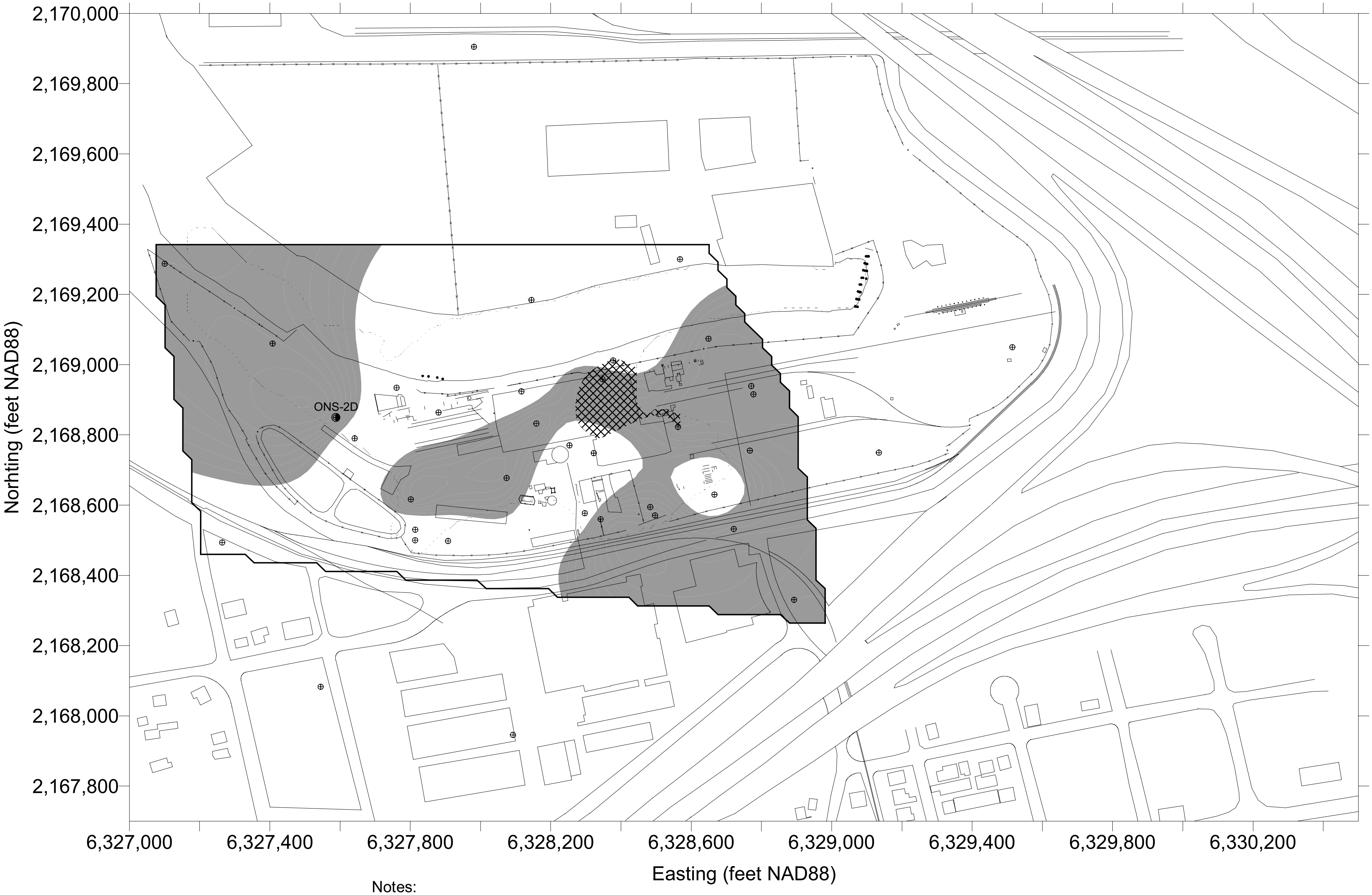
McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-135 To -140 Feet Elevation

STOCKTON	**Figure 5-28**	CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-140 to -145 Feet Elevation

STOCKTON	**Figure 5-29**	CALIFORNIA

LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◑	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-145 to -150 Feet Elevation

STOCKTON **Figure 5-30** CALIFORNIA

LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

1. A simplifying assumption was made that, for each 5 foot horizontal slice, a total of one foot of sand represented a potentially significant pathway. Thus, areas on the map identified as sand and gravel have a minimum of one foot of sand or gravel in that 5 foot horizontal slice.
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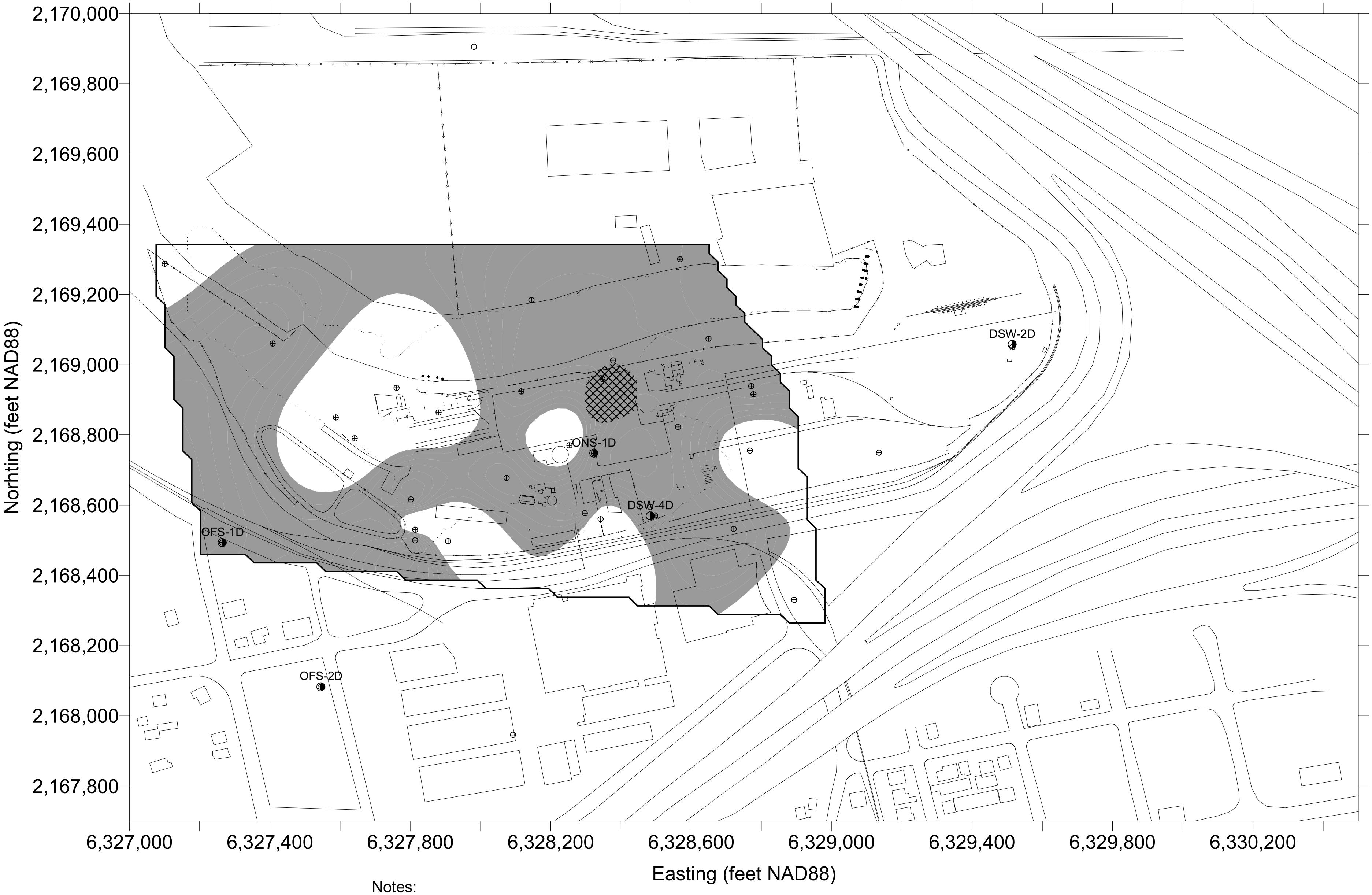
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-150 to -155 Feet Elevation

STOCKTON	**Figure 5-31**	CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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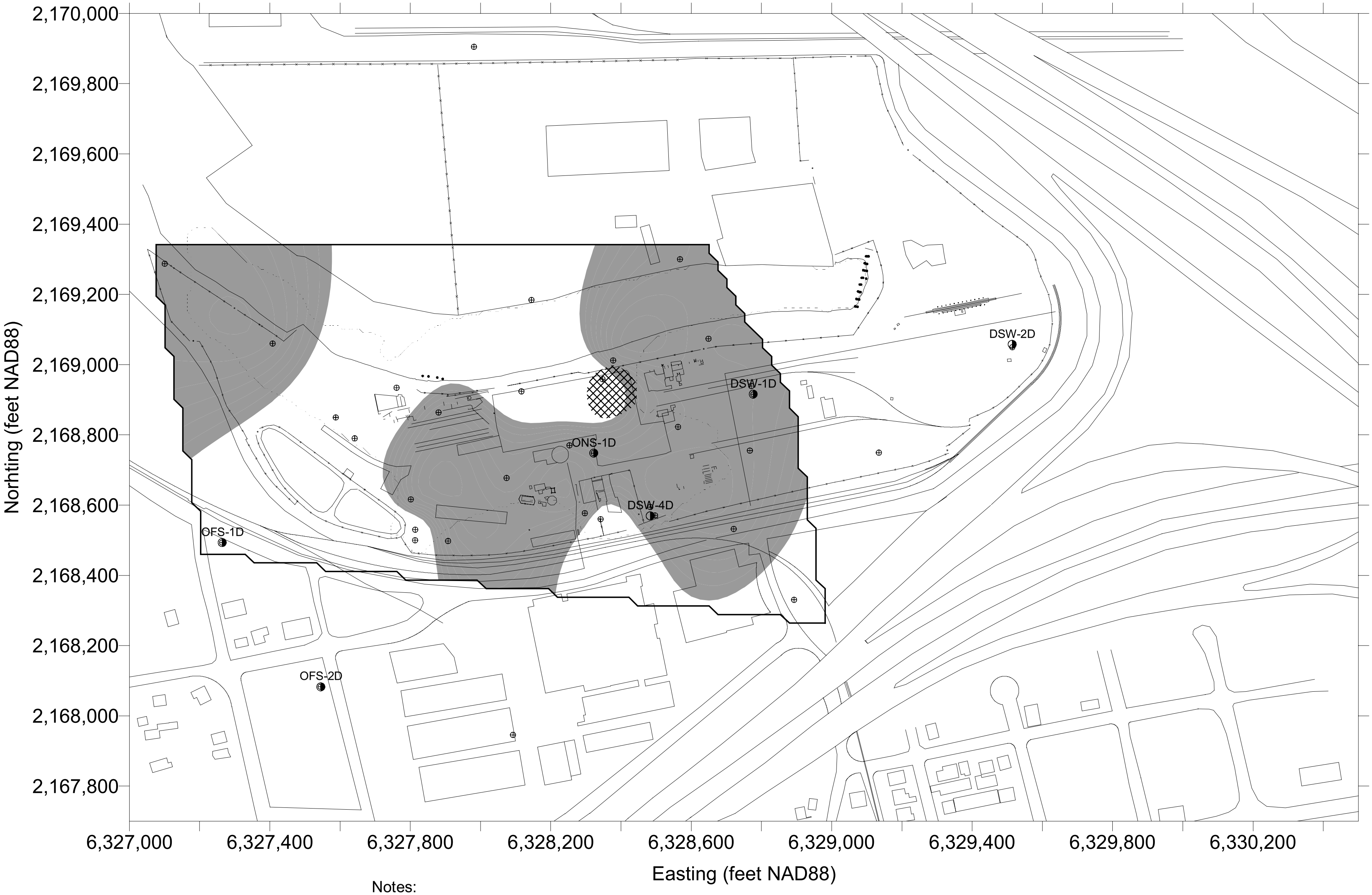
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-155 to -160 Feet Elevation

STOCKTON **Figure 5-32** CALIFORNIA



LEGEND

- ▨ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-160 to -165 Feet Elevation

STOCKTON	**Figure 5-33**	CALIFORNIA

LEGEND

- ■ Sand and gravel
- □ Clay and silt
- ▨ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-165 to -170 Feet Elevation

STOCKTON	**Figure 5-34**	CALIFORNIA

LEGEND

▩	Sand and gravel
☐	Clay and silt
▦	NAPL potentially present
◐	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

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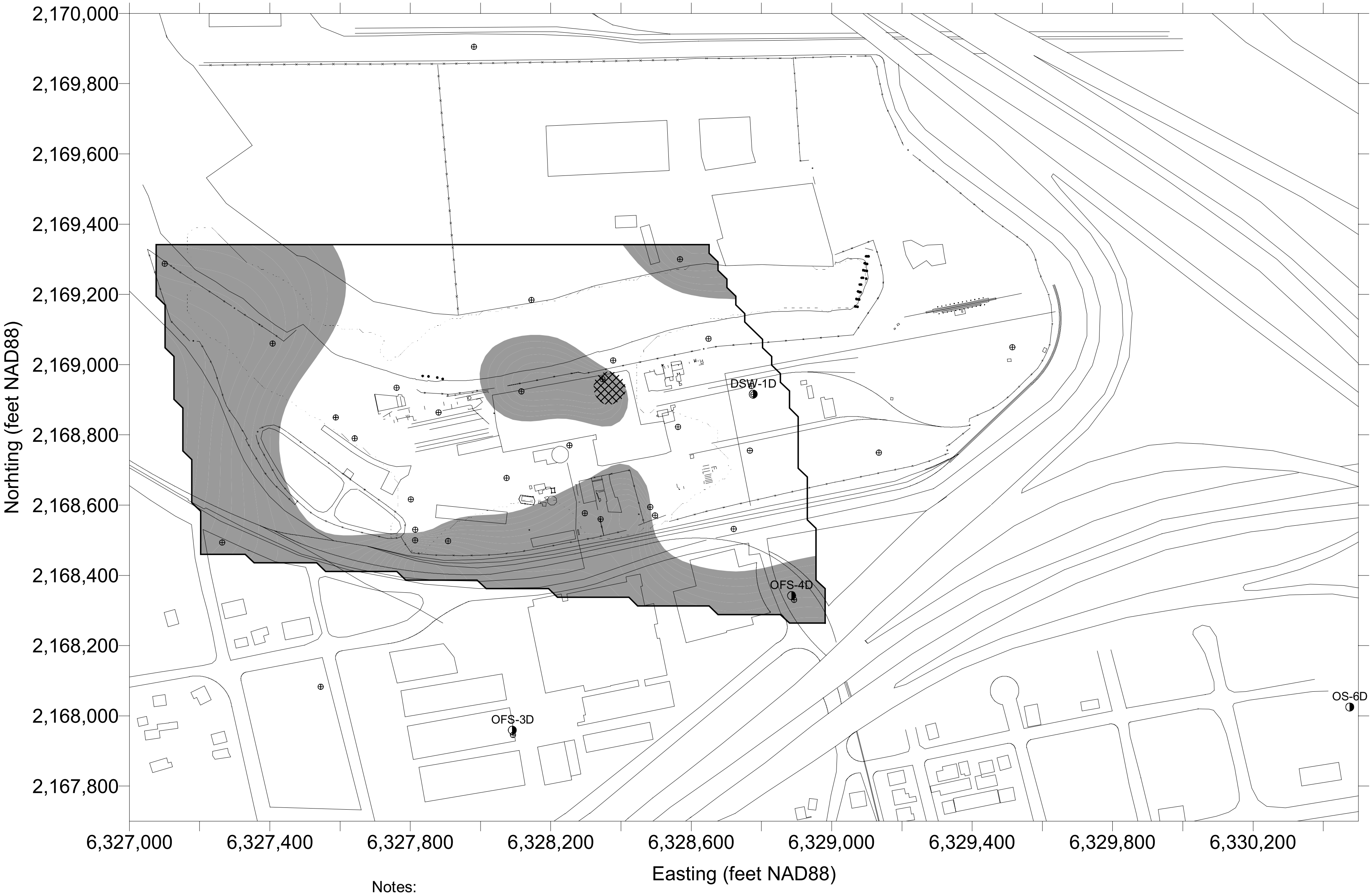
U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-170 to -175 Feet Elevation

STOCKTON **Figure 5-35** CALIFORNIA



LEGEND

- ▆ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-175 to -180 Feet Elevation

STOCKTON **Figure 5-36** CALIFORNIA

LEGEND

- ▩ Sand and gravel
- ☐ Clay and silt
- ▦ NAPL potentially present
- ◐ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-180 to -185 Feet Elevation

STOCKTON	**Figure 5-37**	CALIFORNIA

LEGEND

- ▆ Sand and gravel
- ☐ Clay and silt
- ▩ NAPL potentially present
- ◑ Monitoring well wholly or partially screened in this elevation interval
- ⊕ Data points used in this analysis
- ⬠ Limits of confidence in stratigraphic interpolation

Notes:

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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-185 to -190 Feet Elevation

STOCKTON	**Figure 5-38**	CALIFORNIA

LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◑	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

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U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-190 to -195 Feet Elevation

STOCKTON | **Figure 5-39** | CALIFORNIA

LEGEND

▨	Sand and gravel
☐	Clay and silt
▩	NAPL potentially present
◑	Monitoring well wholly or partially screened in this elevation interval
⊕	Data points used in this analysis
⬠	Limits of confidence in stratigraphic interpolation

Notes:

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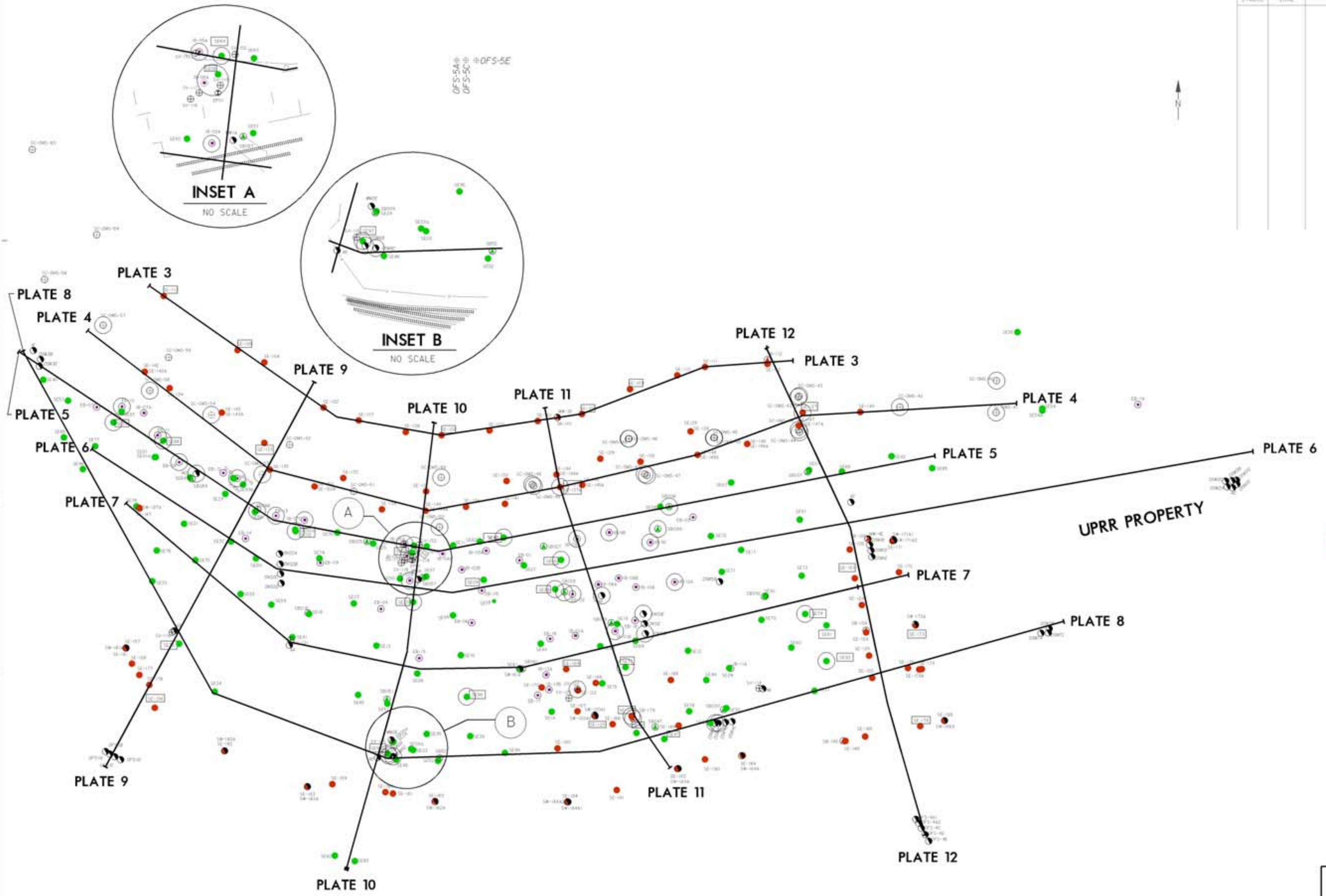
U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

McCormick and Baxter
Superfund Site
FY00 NAPL Investigation

Simplified Conceptual Geology
5 Foot Thick Horizontal Slice
-195 to -200 Feet Elevation

STOCKTON | **Figure 5-40** | CALIFORNIA

SYMBOL	ZONE	REVISIONS DESCRIPTION	DATE	BY



LEGEND

▭	SCAPS CONFIRMATION SOIL SAMPLES COLLECTED
○	NAPL OBSERVED IN BORING OR SCAPS SOIL SAMPLING EVENT
—	CROSS SECTION BOUNDARIES
◐	MONITORING WELL
⊕	RI SLOUGH SEDIMENT CORE
◉ ■	RI BORING
●	FY99 SCAPS LIF & CPT PUSH
▲	FY99 RS BORING
⊗	SURFACE SOIL SAMPLE
◐	FY00 MONITORING WELL
●	FY00 SCAPS LIF & CPT PUSH OR CPT ONLY PUSH
▲	FY00 RS BORING
⊕	FY00 SOIL SAMPLES (VOLATILES)

1" = 100' 100' 50' 0 100' 200'

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE

SITE MAP, SAMPLE LOCATIONS, AND CROSS SECTION LOCATIONS

STOCKTON CALIFORNIA

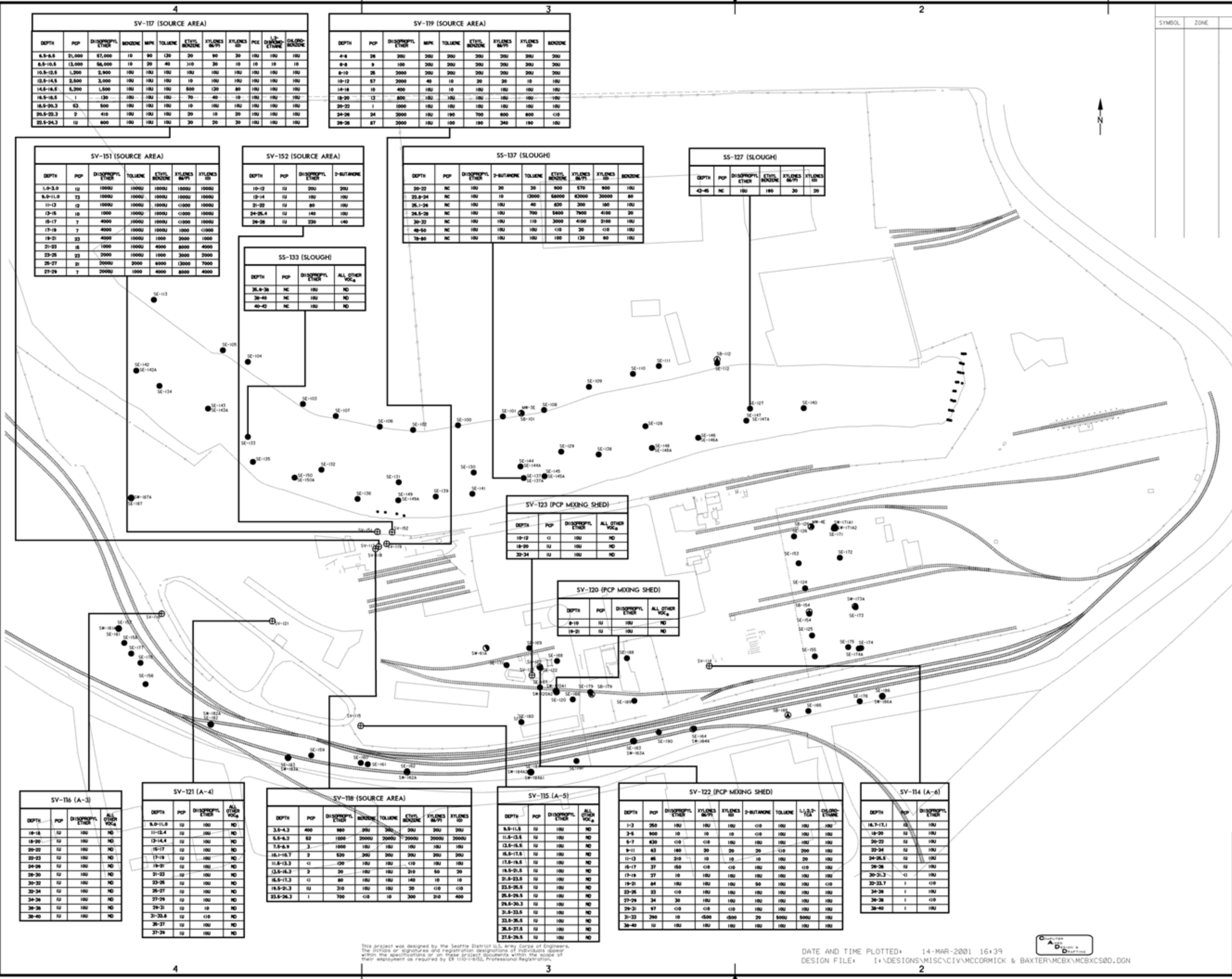
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D			08DEC00	1
DSGN. SMITH		CHK. LYNCH	SHEET	

This project was designed by the Seattle District U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear within the specifications or on these project documents within the scope of their employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 06-JUN-2001 13:42
DESIGN FILE: I:\DESIGNS\MISC\CIV\MCCORMICK & BAXTER\MCBX\MCBXCS0A.DGN

Computer Aided Design & Drafting

SYMBOL	ZONE	REVISIONS DESCRIPTION	DATE	BY



SV-117 (SOURCE AREA)

DEPTH	PCP	DIISOPROPYL ETHER	BENZENE	MIPK	TOLUENE	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)	PCE	1,2-DIBROMO-ETHANE	CHLORO-BENZENE
6.5-8.5	21,000	57,000	10	90	130	20	90	30	10U	10U	10U
8.5-10.5	13,000	56,000	10	20	40	<10	30	10	10	10	10
10.5-12.5	1,200	2,900	10U	10U	10U	10U	10U	10U	10U	10U	10U
12.5-14.5	2,500	3,000	10U	10U	10U	10	10U	10U	10U	10U	10U
14.5-16.5	5,200	1,500	10U	10U	10U	500	130	80	10U	10U	10U
16.5-18.5	1	130	10U	10U	10U	70	40	10	10U	10U	10U
18.5-20.3	53	500	10U	10U	10U	10	10U	10U	10U	10U	10U
20.5-22.3	2	410	10U	10U	10U	20	10	20	10U	10U	10U
22.5-24.3	1U	600	10U	10U	10U	30	20	30	10U	10U	10U

SV-119 (SOURCE AREA)

DEPTH	PCP	DIISOPROPYL ETHER	MIPK	TOLUENE	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)	BENZENE
4-6	26	20U	20U	20U	20U	20U	20U	20U
6-8	9	100	20U	20U	20U	20U	20U	20U
8-10	25	2000	20U	20U	20U	20U	20U	20U
10-12	57	2000	40	10	20	20	10	10U
14-16	10	400	10U	10	10U	10U	10U	10U
18-20	13	600	10U	10U	10U	10U	10U	10U
20-22	1	1000	10U	10U	10U	10U	10U	10U
24-26	24	2000	10U	190	700	600	600	<10
26-28	87	2000	10U	100	190	340	190	10U

SV-151 (SOURCE AREA)

DEPTH	PCP	DIISOPROPYL ETHER	TOLUENE	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)
1.0-3.0	1U	1000U	1000U	1000U	1000U	1000U
9.0-11.0	73	1000U	1000U	1000U	1000U	1000U
11-13	12	1000U	1000U	1000U	<1000	1000U
13-15	10	1000	1000U	1000U	<1000	1000U
15-17	7	4000	1000U	1000U	<1000	1000U
17-19	7	4000	1000U	1000U	1000	<1000
19-21	23	4000	1000U	1000	2000	1000
21-23	15	1000	1000U	4000	8000	4000
23-25	23	2000	1000U	1000	3000	2000
25-27	21	2000U	2000	6000	13000	7000
27-29	7	2000U	1000	4000	8000	4000

SV-152 (SOURCE AREA)

DEPTH	PCP	DIISOPROPYL ETHER	2-BUTANONE
10-12	1U	20U	20U
12-14	1U	10U	10U
21-22	1U	80	10U
24-25.4	1U	140	10U
26-28	1U	230	<40

SS-133 (SLOUGH)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
35.6-36	NC	10U	ND
38-40	NC	10U	ND
40-42	NC	10U	ND

SS-137 (SLOUGH)

DEPTH	PCP	DIISOPROPYL ETHER	2-BUTANONE	TOLUENE	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)	BENZENE
20-22	NC	10U	20	20	900	570	900	10U
22.6-24	NC	10U	10	13000	58000	63000	30000	80
25.1-26	NC	10U	10U	40	620	300	160	10U
24.5-28	NC	10U	10U	700	5600	7900	4100	20
30-32	NC	10U	10U	110	3000	4100	2100	10U
48-50	NC	10U	10U	10U	<10	20	<10	10U
78-80	NC	10U	10U	10U	100	130	60	10U

SS-127 (SLOUGH)

DEPTH	PCP	DIISOPROPYL ETHER	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)
43-45	NC	10U	180	30	20

SV-123 (PCP MIXING SHED)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
10-12	<1	10U	ND
18-20	1U	10U	ND
32-34	1U	10U	ND

SV-120 (PCP MIXING SHED)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
8-10	1U	10U	ND
19-21	1U	10U	ND

LEGEND

◐	MONITORING WELL
▲	RS BORING
●	SCAPS UF AND CPT PUSH
⊕	SCAPS
U	NOT DETECTED
ND	NOT DETECTED
PCP	PENTACHLOROPHENOL
VOCs	VOLATILE ORGANIC COMPOUNDS
1,1,2,2-TCA	1,1,2,2 - TRICHLOROETHANE
XYLENES (M,P)	META- AND PARA- XYLENE
XYLENES (O)	ORTHO- XYLENE

NOTES:

1. ALL UNITS IN μg/kg (PARTS PER BILLION)
2. ALL DEPTHS IN FEET BELOW GROUND SURFACE

1" = 100' 100' 50' 0 100' 200'

SV-116 (A-3)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
16-18	1U	10U	ND
18-20	1U	10U	ND
20-22	1U	10U	ND
22-23	1U	10U	ND
24-26	1U	10U	ND
28-30	1U	10U	ND
30-32	1U	10U	ND
32-34	1U	10U	ND
34-36	1U	10U	ND
36-38	1U	10U	ND
38-40	1U	10U	ND

SV-121 (A-4)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
9.0-11.0	1U	10U	ND
11-12.4	1U	10U	ND
13-14.4	1U	10U	ND
15-17	1U	10U	ND
17-19	1U	10U	ND
19-21	1U	10U	ND
21-23	1U	10U	ND
23-25	1U	10U	ND
25-27	1U	10U	ND
27-29	1U	10U	ND
29-31	1U	10	ND
31-32.8	1U	<10	ND
35-37	1U	10U	ND
37-39	1U	10U	ND

SV-118 (SOURCE AREA)

DEPTH	PCP	DIISOPROPYL ETHER	BENZENE	TOLUENE	ETHYL BENZENE	XYLENES (M/P)	XYLENES (O)
3.5-4.3	400	980	20U	20U	20U	20U	20U
5.5-6.3	63	1000	2000U	2000U	2000U	2000U	2000U
7.5-8.9	3	1000	10U	10U	10U	10U	10U
10.1-10.7	2	520	20U	20U	20U	20U	20U
11.5-13.3	<1	120	10U	10U	<10	10U	10U
13.5-15.3	2	20	10U	10U	210	50	20
15.5-17.3	<1	80	10U	10U	140	10	10
19.5-21.3	1U	310	10U	10U	20	<10	<10
23.5-26.3	1	700	<10	10	300	210	400

SV-115 (A-5)

DEPTH	PCP	DIISOPROPYL ETHER	ALL OTHER VOCs
9.5-11.5	1U	10U	ND
11.5-13.5	1U	10U	ND
13.5-15.5	1U	10U	ND
15.5-17.5	1U	10U	ND
17.5-19.5	1U	10U	ND
19.5-21.5	1U	10U	ND
21.5-23.5	1U	10U	ND
23.5-25.5	1U	10U	ND
25.5-29.5	1U	10U	ND
29.5-30.3	1U	10U	ND
31.5-33.5	1U	10U	ND
33.5-35.5	1U	10U	ND
35.5-37.5	1U	10U	ND
37.5-39.5	1U	10U	ND

SV-122 (PCP MIXING SHED)

DEPTH	PCP	DIISOPROPYL ETHER	XYLENES (M/P)	XYLENES (O)	2-BUTANONE	TOLUENE	1,1,2,2-TCA	CHLORO-ETHANE
1-3	250	10U	10U	10U	<10	10U	10U	10U
3-5	900	10	10	10	<10	10U	10U	10U
5-7	630	<10	<10	10U	10U	10U	10U	10U
9-11	63	180	20	20	20	<10	200	10U
11-13	65	210	10	10	10	10U	20	10U
15-17	37	150	<10	<10	10U	10U	<10	10U
17-19	27	10	10U	10U	10U	10U	10U	10U
19-21	64	10U	10U	10U	50	10U	10U	<10
23-25	23	<10	10U	10U	10U	10U	10U	10U
27-29	34	30	10U	10U	10U	10U	10U	10U
29-31	97	<10	<10	<10	10U	10U	10U	10U
31-33	390	10	<500	<500	20	500U	500U	10U
36-40	1U	10U	10U	10U	10U	10U	10U	10U

SV-114 (A-6)

DEPTH	PCP	DIISOPROPYL ETHER
16.7-17.1	1U	10U
18-20	1U	10U
20-22	1U	10U
22-24	1U	10U
24-25.5	1U	10U
26-28	1U	10U
30-31.3	<1	10U
32-33.7	1	<10
34-36	1	10U
36-38	1	<10
38-40	1	10U

This project was designed by the Seattle District U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear within the specifications or on these project documents within the scope of their employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 14-MAR-2001 16:39
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COMPUTER AIDED DESIGN & DRAFTING

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE
FY00 PCP SOURCE INVESTIGATION

DETECTED COMPOUNDS (VOLATILE ORGANIC
COMPOUNDS AND PENTACHLOROPHENOL)

STOCKTON CALIFORNIA

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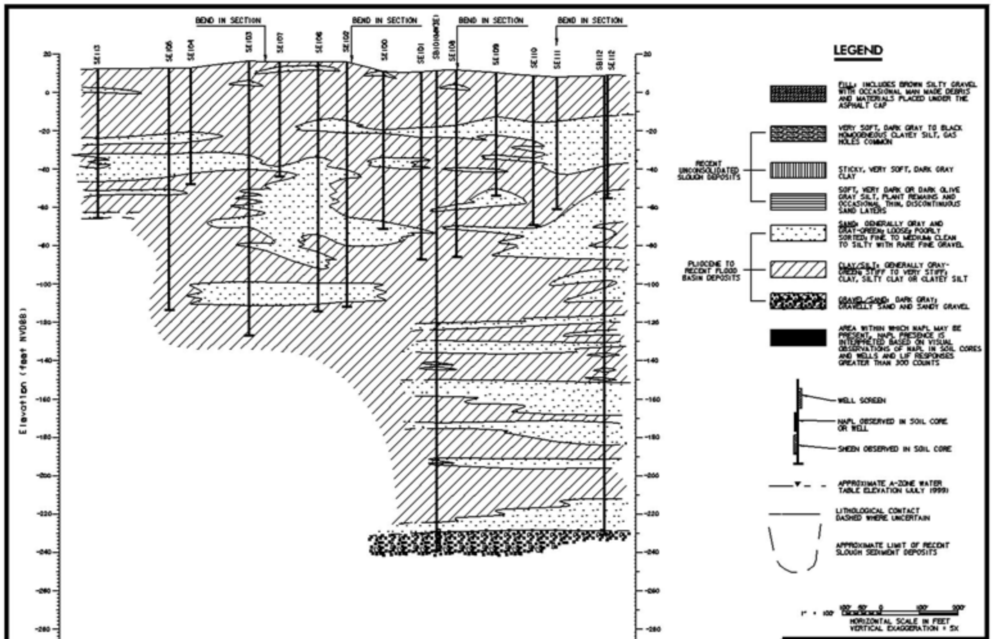

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MCCORMICK & BAXTER SUPERFUND SITE

WEST - EAST PROFILE
SE113 SE112

STOCKTON CALIFORNIA

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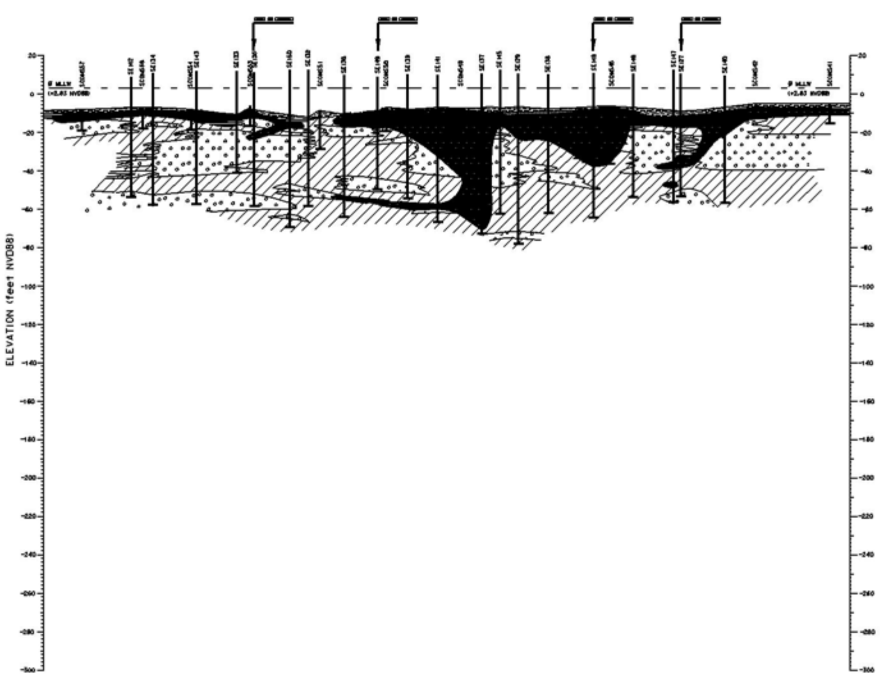

LEGEND

	▩	FILL: INCLUDES BROWN SILTY GRAVEL WITH OCCASIONAL MAN MADE DEBRIS AND MATERIALS PLACED UNDER THE ASPHALT CAP
RECENT UNCONSOLIDATED SLOUGH DEPOSITS	▩	VERY SOFT, DARK GRAY TO BLACK HOMOGENEOUS CLAYEY SILT, GAS HOLES COMMON
	▥	STICKY, VERY SOFT, DARK GRAY CLAY
	▤	SOFT, VERY DARK OR DARK OLIVE GRAY SILT, PLANT REMAINS AND OCCASIONAL THIN, DISCONTINUOUS SAND LAYERS
PLIOCENE TO RECENT FLOOD BASIN DEPOSITS	⬚	SAND: GENERALLY GRAY AND GRAY-GREEN; LOOSE; POORLY SORTED; FINE TO MEDIUM; CLEAN TO SILTY WITH RARE FINE GRAVEL
	▨	CLAY/SILT: GENERALLY GRAY-GREEN; STIFF TO VERY STIFF; CLAY, SILTY CLAY OR CLAYEY SILT
	▩	GRAVEL/SAND: DARK GRAY; GRAVELLY SAND AND SANDY GRAVEL
	■	AREA WITHIN WHICH NAPL MAY BE PRESENT. NAPL PRESENCE IS INTERPRETED BASED ON VISUAL OBSERVATIONS OF NAPL IN SOIL CORES AND WELLS AND LIF RESPONSES GREATER THAN 300 COUNTS

1" = 100'   100' 50' 0 100' 200'

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 5X

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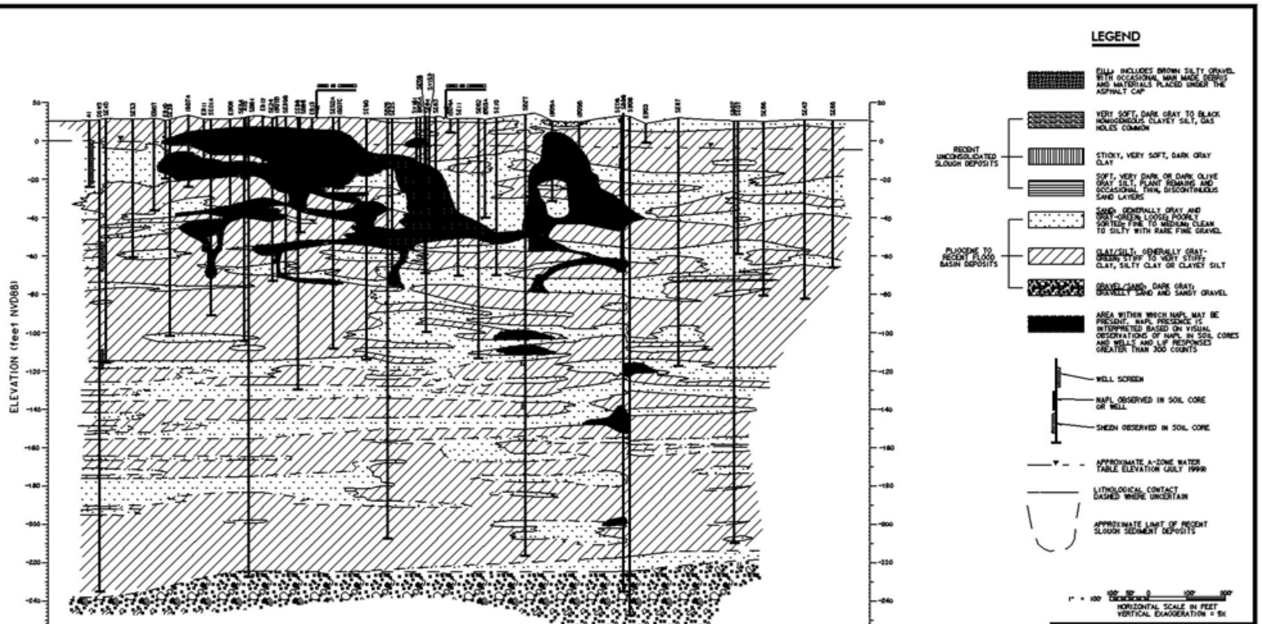
WEST - EAST PROFILE
SCOMS57 - SCOMS41

STOCKTON CALIFORNIA

08DEC00 4

DAMBRS SMITH



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WEST – EAST PROFILE A1 TO SE65

STOCKTON CALIFORNIA

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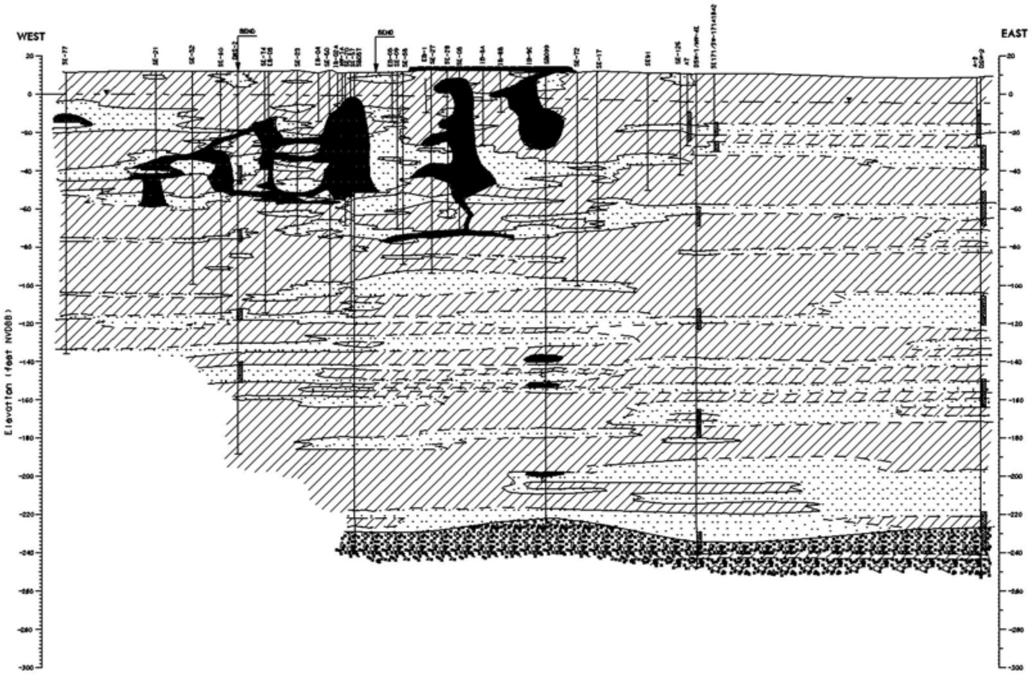
SMITH		LYNCH		



LEGEND

▩ **FILL:** INCLUDES BROWN SILTY GRAVEL WITH OCCASIONAL MAN MADE DEBRIS AND MATERIALS PLACED UNDER THE ASPHALT CAP

RECENT UNCONSOLIDATED SLOUGH DEPOSITS
- ▩ VERY SOFT, DARK GRAY TO BLACK HOMOGENEOUS CLAYEY SILT, GAS HOLES COMMON
- ▥ STICKY, VERY SOFT, DARK GRAY CLAY
- ▤ SOFT, VERY DARK OR DARK OLIVE GRAY SILT, PLANT REMAINS AND OCCASIONAL THIN, DISCONTINUOUS SAND LAYERS

PLIOCENE TO RECENT FLOOD BASIN DEPOSITS
- ░ **SAND:** GENERALLY GRAY AND GRAY-GREEN; LOOSE; POORLY SORTED; FINE TO MEDIUM; CLEAN TO SILTY WITH RARE FINE GRAVEL
- ▨ **CLAY/SILT:** GENERALLY GRAY-GREEN; STIFF TO VERY STIFF; CLAY, SILTY CLAY OR CLAYEY SILT
- ▩ **GRAVEL/SAND:** DARK GRAY; GRAVELLY SAND AND SANDY GRAVEL

■ AREA WITHIN WHICH NAPL MAY BE PRESENT. NAPL PRESENCE IS INTERPRETED BASED ON VISUAL OBSERVATIONS OF NAPL IN SOIL CORES AND WELLS AND LIF RESPONSES GREATER THAN 300 COUNTS

WELL SCREEN

NAPL OBSERVED IN SOIL CORE OR WELL

SHEEN OBSERVED IN SOIL CORE

—▼– – APPROXIMATE A-ZONE WATER TABLE ELEVATION (JULY 1999)

— LITHOLOGICAL CONTACT DASHED WHERE UNCERTAIN

APPROXIMATE LIMIT OF RECENT SLOUGH SEDIMENT DEPOSITS

1" = 100' 100' 50' 0 100' 200'

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 5X

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MCCORMICK & BAXTER SUPERFUND SITE

WEST - EAST PROFILE SE77 TO DSW-2

STOCKTON CALIFORNIA

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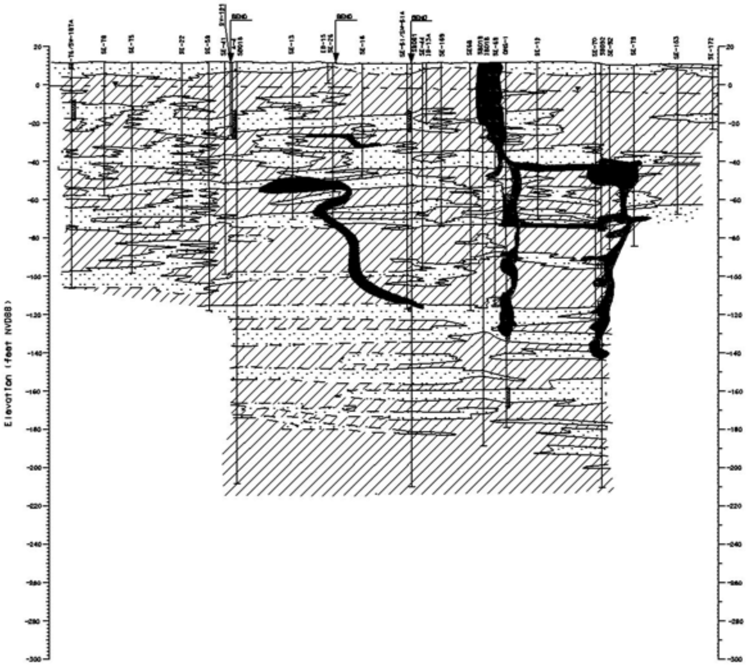
SMITH		LYNCH		



LEGEND

	▩	FILL: INCLUDES BROWN SILTY GRAVEL WITH OCCASIONAL MAN MADE DEBRIS AND MATERIALS PLACED UNDER THE ASPHALT CAP
RECENT UNCONSOLIDATED SLOUGH DEPOSITS	▩	VERY SOFT, DARK GRAY TO BLACK HOMOGENEOUS CLAYEY SILT, GAS HOLES COMMON
	▥	STICKY, VERY SOFT, DARK GRAY CLAY
	▤	SOFT, VERY DARK OR DARK OLIVE GRAY SILT, PLANT REMAINS AND OCCASIONAL THIN, DISCONTINUOUS SAND LAYERS
PLIOCENE TO RECENT FLOOD BASIN DEPOSITS	░	SAND: GENERALLY GRAY AND GRAY-GREEN, LOOSE, POORLY SORTED, FINE TO MEDIUM, CLEAN TO SILTY WITH RARE FINE GRAVEL
	▨	CLAY/SILT: GENERALLY GRAY-GREEN, STIFF TO VERY STIFF, CLAY, SILTY CLAY OR CLAYEY SILT
	▩	GRAVEL/SAND: DARK GRAY, GRAVELLY SAND AND SANDY GRAVEL
	■	AREA WITHIN WHICH NAPL MAY BE PRESENT. NAPL PRESENCE IS INTERPRETED BASED ON VISUAL OBSERVATIONS OF NAPL IN SOIL CORES AND WELLS AND LIF RESPONSES GREATER THAN 300 COUNTS

WELL SCREEN

NAPL OBSERVED IN SOIL CORE OR WELL

SHEEN OBSERVED IN SOIL CORE

APPROXIMATE A-ZONE WATER TABLE ELEVATION (JULY 1999)

LITHOLOGICAL CONTACT DASHED WHERE UNCERTAIN

APPROXIMATE LIMIT OF RECENT SLOUGH SEDIMENT DEPOSITS

1" = 100'   100' 50' 0 100' 200'

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 5X

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MCCORMICK & BAXTER SUPERFUND SITE

WEST EAST PROFILE
SE76 TO SE79

STOCKTON CALIFORNIA

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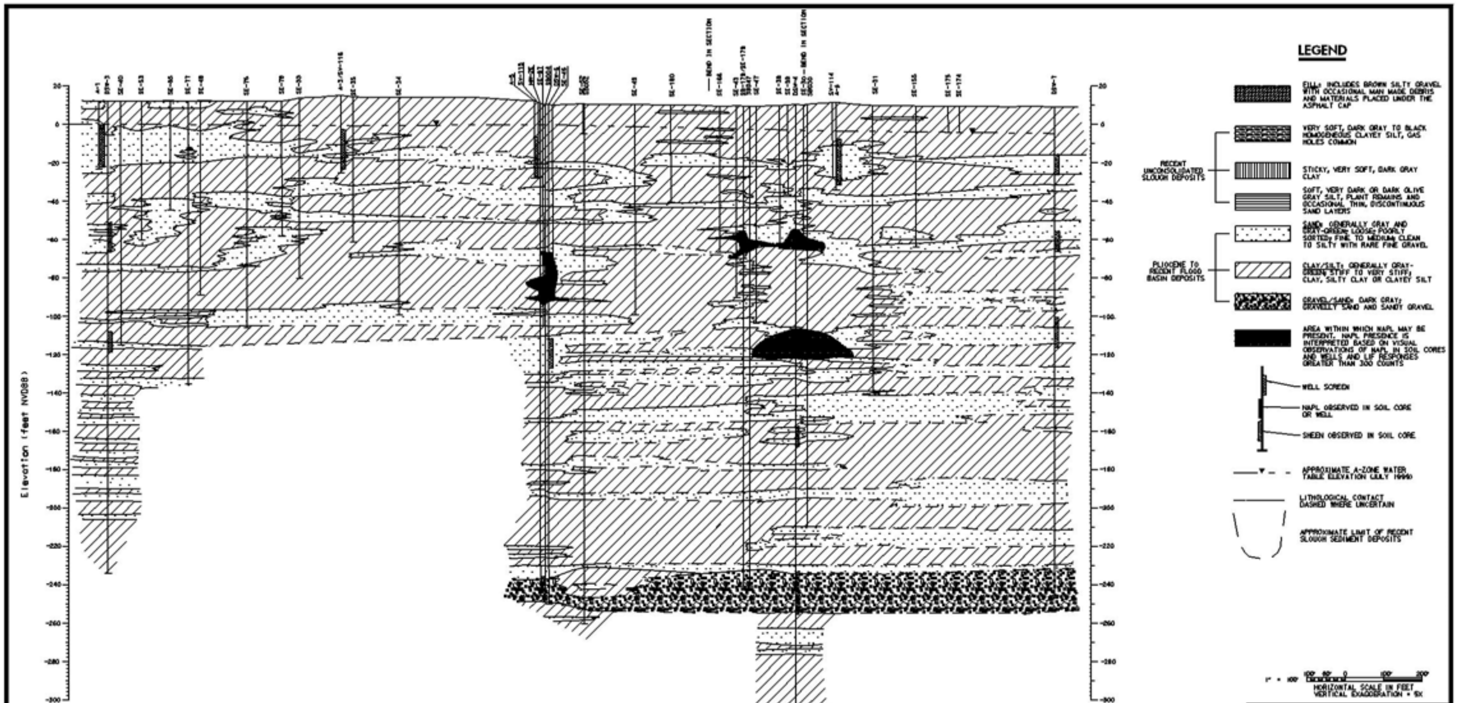
SMITH		LYNCH		



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MCCORMICK & BAXTER SUPERFUND SITE

WEST - EAST PROFILE
A1 TO DSW-7

STOCKTON CALIFORNIA

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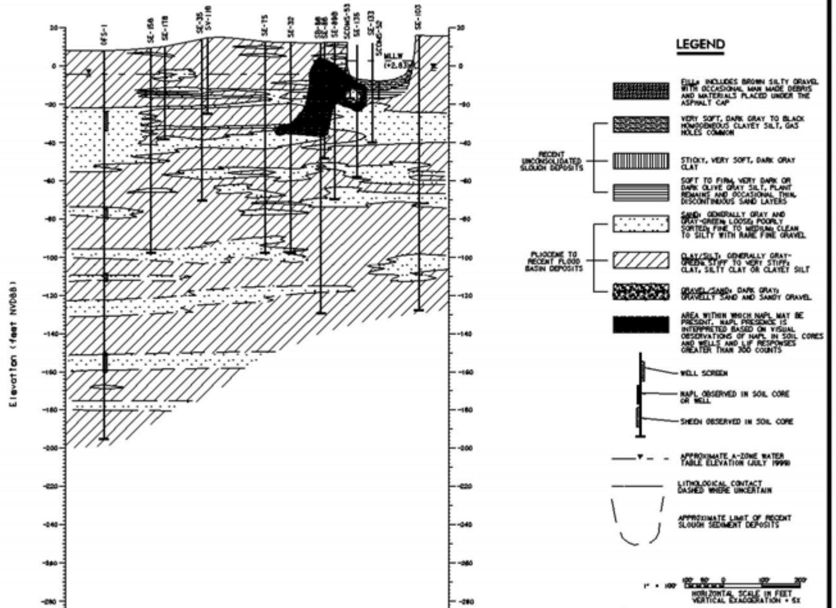

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MCCORMICK & BAXTER SUPERFUND SITE

SOUTH NORTH PROFILE
OFS-1 TO SE-103

STOCKTON CALIFORNIA

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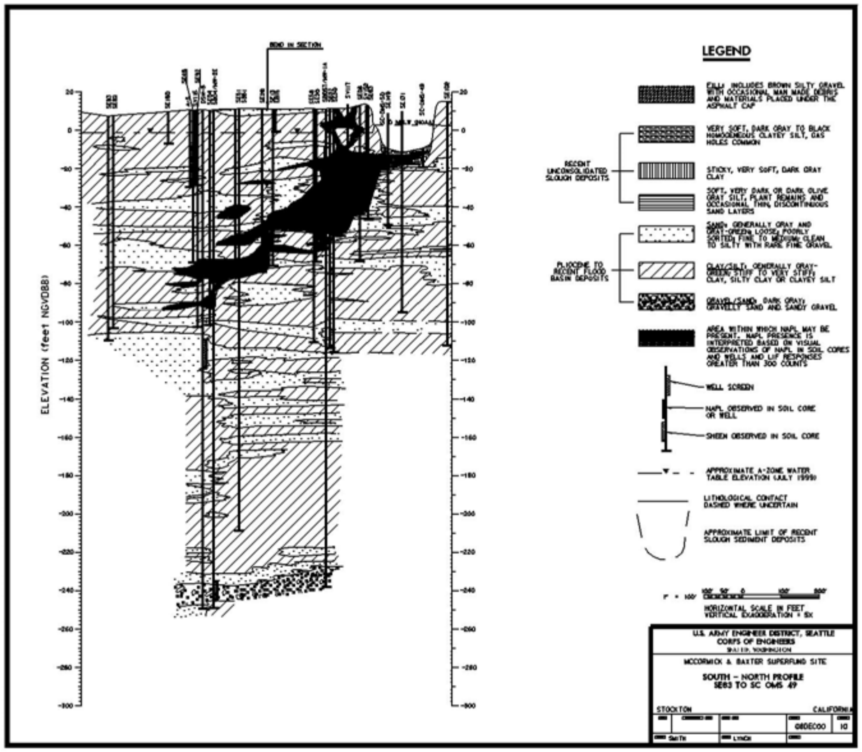

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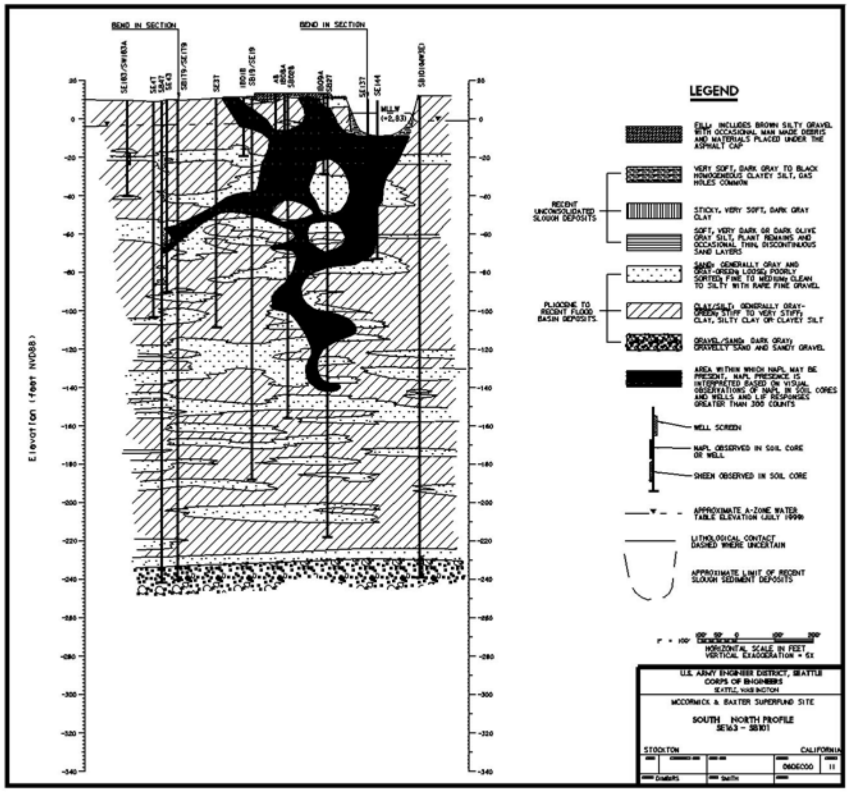
MCCORMICK & BAXTER SUPERFUND SITE

SOUTH – NORTH PROFILE
SE83 TO SC OMS 49

STOCKTON CALIFORNIA

08DEC00 10

SMITH LYNCH



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MCCORMICK & BAXTER SUPERFUND SITE

SOUTH NORTH PROFILE
SE163 – SB101

STOCKTON CALIFORNIA

06DEC00 11

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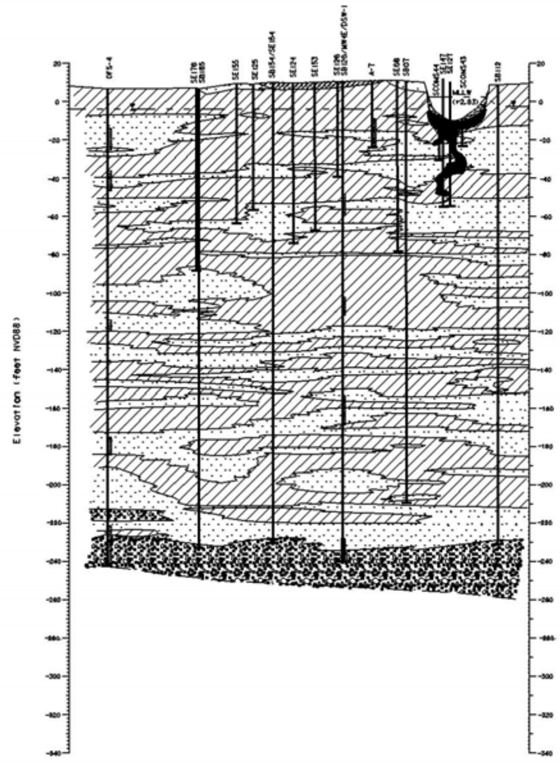

LEGEND

RECENT UNCONSOLIDATED SLOUGH DEPOSITS:

PLIOCENE TO RECENT FLOOD BASIN DEPOSITS:

▩	FILL: INCLUDES BROWN SILTY GRAVEL WITH OCCASIONAL MAN MADE DEBRIS AND MATERIALS PLACED UNDER THE ASPHALT CAP
▦	VERY SOFT, DARK GRAY TO BLACK HOMOGENEOUS CLAYEY SILT, GAS HOLES COMMON
▥	STICKY, VERY SOFT, DARK GRAY CLAY
▤	SOFT TO FIRM, VERY DARK OR DARK OLIVE GRAY SILT, PLANT REMAINS AND OCCASIONAL THIN, DISCONTINUOUS SAND LAYERS
░	SAND: GENERALLY GRAY AND GRAY-GREEN; LOOSE; POORLY SORTED; FINE TO MEDIUM; CLEAN TO SILTY WITH RARE FINE GRAVEL
▨	CLAY/SILT: GENERALLY GRAY-GREEN; STIFF TO VERY STIFF; CLAY, SILTY CLAY OR CLAYEY SILT
▓	GRAVEL/SAND: DARK GRAY; GRAVELLY SAND AND SANDY GRAVEL
■	AREA WITHIN WHICH NAPL MAY BE PRESENT. NAPL PRESENCE IS INTERPRETED BASED ON VISUAL OBSERVATIONS OF NAPL IN SOIL CORES AND WELLS AND LIF RESPONSES GREATER THAN 300 COUNTS

WELL SCREEN

NAPL OBSERVED IN SOIL CORE OR WELL

SHEEN OBSERVED IN SOIL CORE

APPROXIMATE A-ZONE WATER TABLE ELEVATION (JULY 1999)

LITHOLOGICAL CONTACT DASHED WHERE UNCERTAIN

APPROXIMATE LIMIT OF RECENT SLOUGH SEDIMENT DEPOSITS

1" = 100' 100' 50' 0 100' 200'
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 5x

U.S. ARMY ENGINEER DISTRICT, SEATTLE
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MCCORMICK & BAXTER SUPERFUND SITE

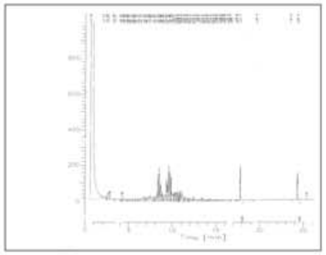
SOUTH - NORTH PROFILE
OFS-4 TO SB112

STOCKTON CALIFORNIA

080EC00 12

DIMBIRS SMITH

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY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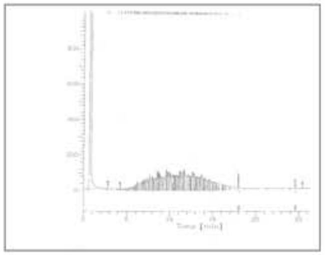
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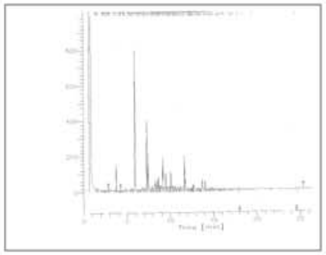
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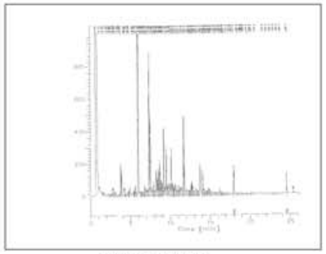
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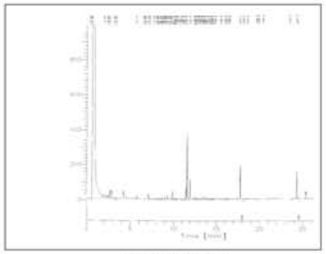
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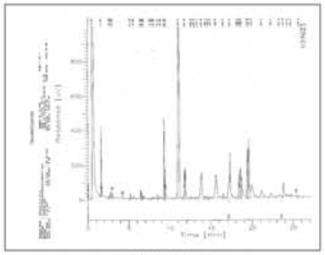
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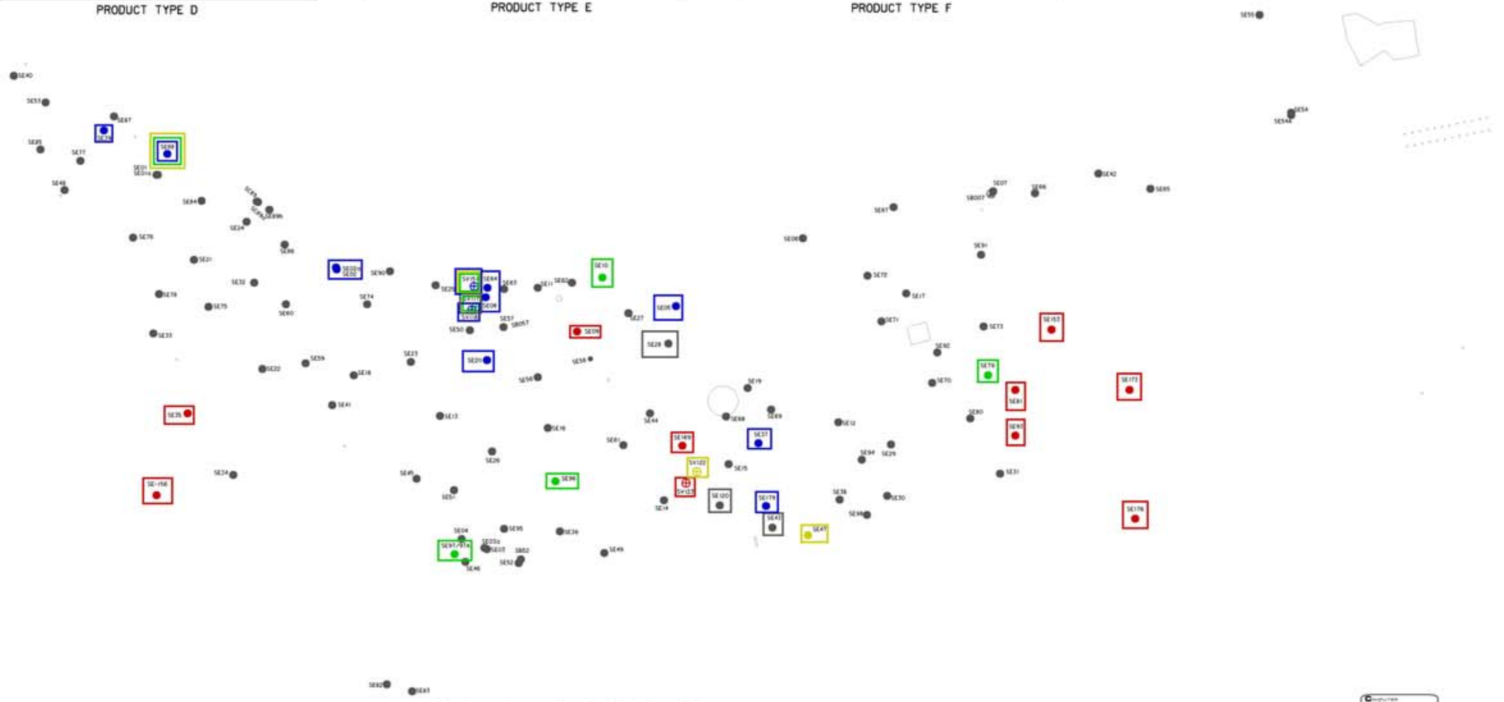

LEGEND

☐	PRODUCT TYPE A
🟨	PRODUCT TYPE B
🟩	PRODUCT TYPE C
🟦	PRODUCT TYPE D
☐	PRODUCT TYPE E
☐	PRODUCT TYPE F
🟥	NOT DETECTED
SE55 ●	SCAPS LIF AND CPT PUSH LOCATION

1" = 100' 100' 50' 0 100' 200'

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DATE AND TIME PLOTTED: 14-MAR-2001 16:15
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SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE

SITE MAP WITH PRODUCT TYPES

STOCKTON CALIFORNIA

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D			08DEC00	13
DSGN. SMITH		CHK. LYNCH	SHEET	