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**GROUNDWATER REMEDIAL  
INVESTIGATION REPORT  
(REVISION 1.0)  
ASCON LANDFILL SITE  
HUNTINGTON BEACH, CALIFORNIA**

*Submitted to:*

**California Department of Toxic Substances Control**

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Project Number: SB0320

June 14, 2007

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## EXECUTIVE SUMMARY

The Ascon Landfill Site (Site) is a 38-acre parcel located in Huntington Beach, California. The Site was operated as a waste disposal facility from approximately 1938 through 1984. The primary types of wastes disposed of at the Site were drilling muds and oilfield wastes (crude oil and tar). Other hydrocarbons which are known to have been disposed at the Site include fuel oils, phenolic wastes, mercaptans, styrene, and synthetic rubber. In addition, chromic and sulfuric acids, aluminum slag, and magnesium and potassium chloride were reportedly deposited in the landfill.

Wastes were placed directly upon the native sediments or in surface impoundments such as lagoons and pits. Eight pits have been identified on the Site, all of which have been covered with one exception (Pit F). There are currently five lagoons on the Site. Soil and fill materials were used to form containment berms and to cover the areas where wastes were disposed. An earthen berm, 10 to 20 feet high, has been constructed around much of the Site perimeter to contain the surface impoundments located in the interior of the Site. Consequently, most of the Site is 10 to 20 feet higher than adjacent areas.

A Groundwater Remedial Investigation (RI) was conducted at the Site. The primary objectives of the Groundwater RI were to assess groundwater quality conditions beneath and adjacent to the Site and to determine risk to public health, safety, and welfare and to the environment posed by hazardous substances in groundwater at or from the Site. Information used to assess the Site groundwater conditions was collected during past investigations, conducted as early as the 1980s, up to recent investigations completed in 2003, 2004, and 2006 conducted as part of the Groundwater RI. The recent investigation included the completion of multiple rounds of groundwater level gauging and gauging of non-aqueous phase liquid (NAPL), a groundwater/surface water interaction study (tidal study), installation of five new monitoring wells, a hydropunch groundwater sampling investigation in the Pit F area, completion of five groundwater sampling events, and a NAPL sampling event.

Regional and Site hydrogeology were evaluated during the RI. The Site is located in the southwest portion of the Orange County Groundwater Basin, approximately 2,000 feet from the Pacific Ocean. The Site is located in an area of the basin known as the Talbert Gap. The Talbert Aquifer, located approximately 80-90 feet below the surface

of the Site, was historically an important groundwater source in the area; however, groundwater production was abandoned in the area due to significant deterioration of groundwater quality from seawater intrusion. Currently, the area of seawater intrusion extends three miles inland from the Site, and as a result there is no groundwater production of any kind (drinking water, agricultural, industrial) within three miles of the Site.

Site hydrostratigraphy is important to understand with regard to the location of the waste material and the potential migration of contaminants to groundwater. Soil materials beneath the Site generally consist of non-native fill and waste materials that occur above native Holocene-age alluvium. At the top of the native Holocene-age alluvium unit, a fine-grained clay/silt layer generally extends across the Site. Below the fine-grained clay/silt layer is a unit consisting of mainly fine-grained sands. Shallow groundwater occurs in these fine-grained sands and has been interpreted to be a regionally defined aquifer referred to as the Semi-Perched Aquifer (SPA). The top of the SPA occurs at the base of the fine-grained clay/silt unit. Regionally, groundwater in the SPA is considered to be under unconfined conditions. However, Site observations indicate confined or semi-confined groundwater conditions beneath the Site with the fine-grained clay/silt layer, which underlies the fill and waste materials, acting as a confining bed. The fine-grained clay/silt unit is thought to impede the downward movement of wastes and contaminants to the groundwater occurring in the SPA. A relatively small occurrence of perched groundwater occurs above the SPA (i.e., above the groundwater potentiometric surface) beneath the Site. The perched water generally occurs in the waste and fill material and is referred to as the Perched Zone. Liquids in the Perched Zone occur in thin and discontinuous layers of permeable fill and waste materials.

The occurrence of both dissolved phase contaminants and NAPL contaminants was investigated during the RI. The occurrence of dissolved phase contaminants was evaluated by groundwater sampling and laboratory analysis. The occurrence of NAPL was evaluated by gauging (i.e., measuring thickness or presence of NAPL) and NAPL sampling.

Groundwater sampling at the Site has occurred during numerous groundwater investigations conducted at the Site since 1982. More recent groundwater quality data were collected during a sampling event completed by PNL in June-August 2002, four

quarterly monitoring events completed in 2004, a hydropunch groundwater sampling event conducted in the Pit F area in May 2006, and a groundwater sampling event conducted in December 2006 as part of the Groundwater RI. The results of the recent groundwater sampling conducted at the Site indicate the following:

- Groundwater beneath the Site has been significantly degraded as the result of seawater intrusion. The shallow groundwater contains very high total dissolved concentrations consisting mainly of dissolved sodium and chloride. Total Dissolved Solids (TDS) concentrations were measured up to 26,000 milligrams per liter (mg/l) which is approximately 80% of typical concentrations in seawater. State Maximum Contaminant Levels for drinking water (MCLs)<sup>1</sup> for chloride, sulfate, and TDS are significantly exceeded across the Site.
- The lateral and vertical extent of dissolved phase contaminants (mostly fuel hydrocarbon contamination) is limited in the shallow groundwater. Comparison of MCLs with concentrations of Volatile Organic Compounds (VOCs) detected in the shallow groundwater indicates that two VOCs were detected above MCLs - benzene and 1,4-dichlorobenzene. Benzene was detected above its MCL of 1 microgram per liter (ug/l) in two monitoring wells, and 1,4-dichlorobenzene was detected slightly above its MCL of 5 ug/l in one monitoring well. Semi Volatile Organic Compounds (SVOCs) were detected at only two onsite monitoring well locations. The SVOCs detected have no MCLs.
- Selenium concentrations above the MCL were detected across the Site in the shallow groundwater. The likely source of the selenium in groundwater is seawater recharge from the Huntington Beach Flood Control Channel.
- The emergent chemical compounds 1,4-dioxane, N-nitrosodimethylamine (NDMA), perchlorate, and chromium VI were analyzed for in selected samples. Results indicate that these compounds were either not detected or detected at low concentrations.

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<sup>1</sup> Throughout this report and for each compound, the applicable MCL is the more conservative (lower) of the California State MCL or the federal MCL, if any.

Gauging results in 2004 indicate that NAPL occurs across the Site in some monitoring wells including 16 wells considered completed in the SPA. Analysis of boring logs and well construction diagrams indicates that the occurrence of NAPL in many of these monitoring wells is likely the artifact of well construction and that NAPL has migrated through the well annulus and then to the groundwater surface in the wells. Consequently, it is assumed that NAPL in the Site subsurface generally occurs above or within the top portions of the fine-grained clay/silt layer and not in the SPA. Chemical analyses indicate that the overall composition of the NAPL is an apparent mixture of several hydrocarbon fractions including gasoline or gasoline-range hydrocarbons, diesel, native crude oil, and a kerosene-like fraction. This interpretation is consistent with the disposal history of the Site including the possible disposal of oil-based drilling muds.

Results of the groundwater sampling and NAPL gauging and analysis indicate that groundwater contamination is limited. The limited extent of the groundwater contamination, tied with the fact that wastes have been present on the Site for a long time period, indicates that contaminant transport is being impeded. The relatively small amount of dissolved phase contamination is likely attributable to a combination of factors including: (1) the presence of the clay/silt layer that extends across the Site; (2) the confined or semi-confined nature of the groundwater occurring beneath the Site; (3) the apparent occurrence of some contaminant attenuation in the groundwater, and (4) upward vertical gradients in the SPA beneath the Site. The limited amount of NAPL in the SPA is also likely attributable to a combination of factors including the presence of the fine-grained clay/silt layer discussed previously and the relatively low mobility of the NAPL.

Another key objective of the RI was to evaluate potential groundwater/surface water interaction and the potential for contaminants to reach surface water. Results of the investigation indicate that interaction of groundwater beneath the Site and surface water bodies is not significant. The relatively large distances between the Site and the Pacific Ocean and the Santa Ana River, and the predominantly northward groundwater flow direction in the Site area preclude the discharge of Site groundwater into these surface water bodies. In addition, based on groundwater flow directions and the Site-specific tidal study, the shallow groundwater beneath the Site does not discharge to the Huntington Beach Flood Control Channel that is located adjacent to the southwest portion of the Site.

Based on the groundwater data collected between 2002 and 2006, a risk assessment was conducted using EPA and Cal EPA guidance. Three exposure pathways were evaluated in the groundwater risk assessment including surface water/groundwater interaction, drinking water, and vapor intrusion. Results of the risk assessment indicated that the only complete exposure pathway was the vapor intrusion pathway. Analyses of the vapor intrusion pathway indicated that the estimated potential incremental cancer risk to future onsite residents was  $4 \times 10^{-6}$ . Benzene was the primary contributor to the future onsite residential risk, and the incremental cancer risk is based on the maximum detected concentration of benzene solely in one well. All other chemical-specific risk and noncancer hazards were below  $1 \times 10^{-6}$  and 1, respectively, for both future residential and commercial land use.

Based on the results of the Groundwater RI, it is recommended that a semi-annual groundwater monitoring program should be implemented for an interim period until a long-term, post-remediation program is established with the objective of verifying the lack of offsite migration of contaminants. Other recommendations involve work related to: (a) further evaluating former locations of monitoring wells; (b) installation of three new monitoring wells to replace wells destroyed in 2005 and/or to better establish a perimeter well network; and (c) properly destroying a former oil well in Lagoon 5.

## **1. INTRODUCTION**

### **1.1 Preface**

This Groundwater Remedial Investigation (RI) Report-Revision 1.0 was prepared for the Ascon Landfill Site (Site) located at 21641 Magnolia Street at Hamilton Avenue in Huntington Beach, California (Figure 1-1). The report was prepared by Geosyntec Consultants (GeoSyntec, or Geosyntec) in accordance with the Groundwater Remedial Investigation/Feasibility Study (RI/FS) Workplan – Revision 1.0 (Groundwater RI/FS Workplan) dated October 24, 2003 (GeoSyntec, 2003a). The workplan was conditionally approved by the Department of Toxic Substance Control (DTSC) in their letter dated February 3, 2004.

Three addendum workplans were also prepared and approved by DTSC as part of the RI investigation. The first addendum workplan entitled Non-Aqueous Phase Liquid (NAPL) Sampling dated October 22, 2004, was conditionally approved by DTSC in their letter dated November 19, 2004. The second addendum workplan, entitled Groundwater RI/FS Workplan Revision 1.0 Addendum – Further Pit F Groundwater Investigation dated April 20, 2006, was conditionally approved by DTSC in their letter May 8, 2006. The third addendum workplan, entitled Addendum Workplan for Additional Groundwater Monitoring dated November 14, 2006, was conditionally approved by DTSC in their letter dated November 22, 2006.

The groundwater RI work was performed per the requirements of the Imminent and Substantial Endangerment Determination and Consent Order between the DTSC and Settling Parties Docket No. I&SE-CO 02/03-007 (Consent Order -effective January 8, 2003).

A previous version of this Groundwater RI Report dated February 28, 2005, was submitted to DTSC. This current version of the report (i.e., Revision-1.0) incorporates DTSC comments presented in their letters dated June 3, 2005, and January 12, 2006, and incorporates additional information collected after submittal of the February 2005 report. Additional information includes the results of the Supplementary Groundwater Investigation in the Pit F Area (GeoSyntec, 2006a), the results of the groundwater sampling event completed in December 2006 (Geosyntec, 2007), and a summary of well destruction work completed as part of the Emergency Action conducted in 2005.



## 1.2 **Purpose**

The purpose of the groundwater RI investigation is to assess groundwater conditions beneath and adjacent to the Site. Information used was collected during past investigations conducted in the 1980s and 1990s, as well as the recent field investigation conducted between the years 2002 and 2006. The specific objectives of the groundwater RI are:

- Determine the nature and extent of hazardous substance contamination of groundwater at the Site as it may affect air, soil, and surface water.
- Identify all actual and potential exposure pathways and routes through environmental media.
- Determine risk to public health, safety, or welfare or to the environment posed by the threatened or actual release of hazardous substances at or from the Site.
- Collect information necessary to prepare a FS (to be included in the combined FS for soil/waste and groundwater, herein referred to as the Second Feasibility Study [SFS]) and Remedial Action Plan (RAP).<sup>2</sup>

## 1.3 **Report Format and Organization**

The Groundwater RI report has been prepared in general accordance with the format specified in the Groundwater RI Workplan and in general accordance with EPA guidance manual *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). The report is organized as follows:

- Executive Summary.
- Section 1.0 – “Introduction.”

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<sup>2</sup> A combined RAP for groundwater and soil/waste as per the Draft RAP proposal submitted to DTSC on November 5, 2004, and accepted by DTSC per the letter dated December 29, 2004.

- Section 2.0 – “Project Background.” This section includes a discussion of Site history, Site operations, waste types disposed, and past investigations.
- Section 3.0 – “General Physical Setting.” This section includes a discussion of Site topography, surrounding land uses and zoning, natural resources, climate, surface water, biology, geology, and hydrogeology.
- Section 4.0 – “Groundwater RI/FS Field Activities.” A general outline of the field tasks performed in accordance with the Groundwater RI/FS Workplan is presented.
- Section 5.0 – “Regional and Site Hydrogeology.” This section presents information regarding the regional and Site hydrogeology, Site monitoring well network, Site hydrostratigraphy, groundwater gradients and flow directions, and groundwater/surface water interaction.
- Section 6.0 – “Nature and Extent of Groundwater Contamination.” This section presents a summary of groundwater analytical results and a discussion of non-aqueous phase liquids (NAPL). This section also presents an evaluation of the potential for transport of contaminants in groundwater.
- Section 7.0 – “Risk Assessment.” The groundwater risk assessment analysis evaluates potential risks to public health, safety, or welfare or to the environment from groundwater. Potential groundwater pathways evaluated include groundwater/surface water interaction, drinking water, and vapor intrusion.
- Section 8.0 – “Summary and Conclusions.” Salient findings and conclusions of the investigation are presented.
- Section 9.0 - “Recommendations.” Recommendations for further GW RI work and groundwater monitoring are presented.
- “References” listing the documents used to compile this workplan.

The report also includes the following appendices:

- Appendix A – Boring Logs and Well Construction Diagrams
- Appendix B – CPT Locations and CPT Laboratory Results (1997 and 2002)
- Appendix C – GeoSyntec’s Well Installation and Geophysical Survey Report dated July 28, 2004. Geosyntec’s Geophysical Investigation, Lagoon 5, February 15, 2006 (also included in Appendix F of Emergency Action Completion Report, PNL, 2006).
- Appendix D – Laboratory Results for 2004 and 2004 Validation Reports
- Appendix E - Tidal Influence Study Letter Report dated July 7, 2003, and Tidal Influence Study Data
- Appendix F – Nunez Engineering Surveyor Reports
- Appendix G – Pre-2002 Groundwater Level Contour Maps
- Appendix H – Summary of Pre-2002 Groundwater Sampling Data
- Appendix I – Laboratory Reports for NAPL Samples
- Appendix J – Supporting Risk Calculations
- Appendix K – GeoSyntec’s Supplementary Groundwater Investigation in the Pit F Area (Revision 1.0) dated June 14, 2007.

## **2. PROJECT BACKGROUND**

### **2.1 Site Description**

The Ascon Landfill Site is a square parcel of land located at 21641 Magnolia Street in Huntington Beach, California. The Site is at the southwestern corner of the intersection of Hamilton Avenue and Magnolia Street, approximately ½ mile north of Huntington Beach State Park and the Pacific Ocean (Figures 1-1 and 2-1). The Site is approximately 38 acres and enclosed by a perimeter chain link fence with three 20-foot wide locked gates. The gate at the northwest corner of the Site provides access from Hamilton Avenue, and the second and third gates provide access from Magnolia Street in the southeastern portion of the Site. Hazardous waste and California Proposition 65 signs are posted on the perimeter fence and at the gates at the Site. A pedestrian gate is located mid-length on the fence along Hamilton Avenue.

The Site, no longer in operation, consists of five visible impoundments (referred to as Lagoons 1 through 5), one covered pit (referred to as Pit F), and seven former pits that are no longer visible. The approximate locations of the lagoons and other significant features are presented on Figure 2-2. As part of the Site maintenance and safety program, in May 2003, fencing was installed around Lagoon 3 and bird netting was installed over Lagoons 1 and 2 to keep birds out of the waste and water that seasonally ponds within these lagoons. During January 2004, vegetation at the Site was trimmed, trash and debris that had accumulated on the Site were removed, and fencing around Pit F was improved. In July 2004, temporary fencing was placed around Lagoons 4 and 5, and to provide additional security, chain link fencing was placed around Lagoons 4 and 5 in March 2006 and around Lagoons 1 and 2 in July 2006.

There is a small storage shed located northwest of Pit F. There is an oil production lease property onsite along the west perimeter. Until July 2004, a 2-acre oil production lease existed near the east perimeter of the Site. The oil production well (Krik Well No. 80) and associated tank storage in this area were removed during clean-up operations in response to a crude oil release from the well that had occurred on March 17, 2004. Krik Well No. 80 was owned and operated by Gregory Miral under a mineral lease predating Cannery Hamilton Properties, LLC (CHP) ownership of the land (CHP is the current Site owner). The U.S. EPA Region IX issued the Order For Removal, Mitigation or Prevention of a Substantial Threat of Oil Discharge, EPA Docket No. OPA 9-2004-0004 to Miral and CHP. Although Miral did not, CHP did respond to the

order by performing the remedial actions required by the order. The well was abandoned by the California Department of Conservation, Division of Oil, Gas & Geothermal Resources (DOGGR) on March 27, 2004, and oil production ceased at the Well No. 80 site. The remedial action was completed on July 17, 2004.

In July 2005, an Emergency Action was undertaken, under DTSC oversight, to strengthen the north berm (along Hamilton Ave.) consisting of removal of some of the drilling mud from the northernmost lagoons (Lagoons 4 and 5) and Site winterization, including installation of a toe drain along the toe of the north berm and a storm water collection system. As part of this action, 15 groundwater monitoring points located in the northern areas of the Site that would have hindered the waste removal from and near Lagoons 4 and 5 were properly destroyed.

## **2.2 Site History**

This section outlines historical ownership of the Site and the results of aerial photograph reviews by ESE (1997) and past investigators. ESE developed the Site history from information presented in various documents, primarily Radian (1988) and ISCO Industries/ITARA Engineers (1992). The following Site history was excerpted from ESE (1997) and updated as appropriate.

The Site was originally operated as a landfill by the Garrish Brothers, from approximately 1938 to 1950, and by the Steverson Bros., Inc. from 1950 until 1984. In 1984, ASCON Properties, Inc. purchased the Site and began negotiations with the DTSC to cleanup the Site as part of a land redevelopment effort. ASCON Properties was unsuccessful in its attempts to remediate and develop the property and filed bankruptcy in 1989.

NESI Investment Group acquired ownership through a foreclosure sale in July 1990. During 1993, the NESI Investment Group filed bankruptcy, and Signal Mortgage Company acquired the Site in May 1993 through foreclosure. In 1995, Signal Mortgage Company entered into an agreement with Savannah Resources Corporation, a predecessor of California/Nevada Development, LLC (CND), to work with the DTSC on the RI/FS and RAP under a Voluntary Cleanup Agreement (VCA). However, following completion of the soil/waste RI and FS, CND withdrew from the VCA in 2001 and had no further involvement with the Site. In 2003, CHP purchased the Site and is the current owner.

Project Navigator, Ltd. (PNL) completed a limited review of historical aerial photographs of the Site as part of the SFS work (PNL, personnel communication, 2005). Observations were made, and the presence of discernable Site features are tabulated from 1928 through 2006, as indicated in the inserted table below.

Year	1928	1947	1953	1958	1959	1961	1967	1972	1976	1979	1983	1999	2002	2006
Agricultural field to south	X	X												
Northern former lagoons			X	X	X	X	X	X						
Southern former lagoon				X	X	X	X	X						
Pit A			X	X	X	X	X	?		?				
Pit B			X	X	X	X	X	?		?				
Pit C				X	X		X	?		?				
Pit D				X	X		X	?		?				
Pit E				X	X	X	X	?		?				
Pit F				X	X	X	X	?	X	?	X	X	X	X
Pit G				X	X		X	?	X	?				
Pit H			X	X			X	?		?				
Flood control channel						X	X	X	X	X	X	X	X	X
Residential to east							X	X	X	X	X	X	X	X
Lagoons 1-5										X <sup>3</sup>	X	X	X	X
Offsite structures (northwest)											X	X	X	X

Based on the review of historic aerial photos, it appears that essentially the entire Ascon Landfill Site, except for the perimeter berm and the areas used for oil-and-gas pumping operations, was used at some time for waste disposal. There is evidence that up to eight discrete disposal pits (Pits A-H) existed in the northwest and southeast portions of the Site. The location of these pits is shown on Figure 2-2. With the exception of Pit F, these pits appear to have been subsequently backfilled with construction debris and fill material, as have the former lagoons.

### 2.3 Site Operations

The Site was operated as a waste disposal facility from approximately 1938 through 1984. Much of the waste disposed of on the Site in its early years came from oil drilling operations and included drilling muds, wastewater brines, and other drilling

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<sup>3</sup> Lagoons 1, 2, and 3 appear as one lagoon in the 1979 aerial photo.

wastes. Records show that from 1957 to 1971 chromic acid, sulfuric acid, aluminum slag, fuel oils, styrene, and other wastes were also disposed on the Site. From 1971 to 1984 inert solid wastes such as abandoned vehicles, asphalt, concrete, metal, soil, and wood were disposed on the Site. The Site stopped receiving waste commercially in 1984. In 1997, old drums, vehicles, motorcycles, trailers, and piles of cut firewood were found scattered throughout the Site. There was an unauthorized firewood operation on portions of the Site in 1996 and 1997. Currently, all of the drums are contained within or near a fenced compound on Site, and the vehicles and some of the other debris have been removed from the Site.

Based on aerial photograph interpretation, the wastes contained at the Site were placed directly upon the native sediments, and soil was used for forming berms for the lagoons and pits. The drilling mud and oil-saturated wastes have been found to be present throughout most of the Site, with the exception of the western margin and southeastern corner of the property. The thickness of the waste varies from a few feet to as much as 20 feet. Soil and construction debris, consisting of wood, brick, concrete, and asphalt were placed over much of the waste material and can be seen around the edges and extending into several of the lagoons. It is estimated that solid debris and waste materials combined thickness throughout the Site is from about 5 to 25 feet.

A chronology of events at the Ascon Landfill Site, including pit locations and history, is presented in Tables 2-1 and 2-2. These tables identify the major types of wastes that were handled at the Site by year and include some company names associated with specific types of wastes handled at the Site. Table 2-1 identifies when the Site ceased accepting various types of wastes. The majority of the information presented in Tables 2-1 and 2-2 and in this section was obtained from reviewing previous investigation reports, viewing aerial photographs, and visiting the Site. Many of the original sources of historical information such as topographic maps, records, and city documents used to develop the Site history and layout presented in these reports were not preserved and therefore cannot be definitively established.

As described in Sections 2.1 and 2.2, the primary types of waste handling units used at the Site were pits and surface impoundments (lagoons). The review of aerial photographs has identified a total of eight pits (Pits A through H). In 1964, the operators of the Site were ordered by Orange County Water Pollution District to cease and desist disposal operations in the waste pits. Subsequent reports indicate the

covering of the waste pits with imported fill material. By the early 1970s, all waste pits were covered except for Pit F (Figure 2-2).

## **2.4 Historical Oil Field Operations on the Site**

Available information from the DOGGR (unpublished files) for non-operating oil wells formerly located on the Ascon Landfill Site is summarized in Table 2-3 (PNL, personal communication, 2005). Two wells, Pacific Ranch #1 and #1A, were formerly located in the area of Lagoon 5. DOGGR records show that Pacific Ranch #1A was abandoned in 1924. Records indicate that Pacific Ranch #1 Well was converted into a water well (Table 2-3). A geophysical survey investigation was conducted to locate these two former wells and is appended to this report in Appendix C. Deeble 1 was located east of Pit E and was abandoned in 1953. DOGGR records show that the Krik 1 Well (i.e., Krik 80 Well), located northeast of Pit F, was abandoned in March 2004 (see Section 2.1 for further information).

In addition to the above former oils wells located on the Site, there are 2 active wells located on very western portion of the Site (SCOC 40 and SCOC 41). These wells have most recently been owned and operated by South Coast Oil Corporation (SCOC).

## **2.5 Waste Types Disposed at the Site**

The total number of waste types that were accepted at the Ascon Landfill Site is not known. Past investigators have summarized the documented types of wastes possibly disposed of at the Site. Radian (1988) reviewed a report by Ecology and Environment (1982) and concluded that the primary types of wastes disposed at the Site were drilling muds and oilfield wastes. These made up the largest volume of wastes accepted at the Site. The wastes that may have been disposed of at the Site include:

- Drilling muds and oilfield wastes;
- Chromic and sulfuric acids;
- Aluminum slag,
- Magnesium and potassium chloride;
- Corrosive material (acid sludges);
- Mercaptans;
- Styrene;
- Styrene tars;



- Dion iso-styrene monomer (sic);
- Polyester resin fractions;
- Phenolic wastes;
- Synthetic rubber;
- Fuel oil (unusable/out of specification);
- Oily wastes; and
- Construction debris (soil, concrete, asphalt, wood, metal, abandoned vehicles, etc.).

## **2.6 Past Groundwater Investigations and Reports**

Since 1966, there have been numerous investigations conducted at the Ascon Landfill Site. The primary scope of these investigations was to characterize the surface materials, subsurface wastes, soils, air, soil vapors, background soils, groundwater, and surface water in the Huntington Beach Flood Control Channel. Results from the key investigations conducted prior to 1997, including groundwater investigations, were incorporated into the ESE (1997) RI report. The ESE (1997) Remedial Investigation Report was reviewed and approved by DTSC. Key groundwater investigations conducted up to 1997 included:

- Ecology and Environment Inc., 1983, Monitoring Well Installation/Sampling Report, July 7, 1983.
- Woodward Clyde Consultants, 1983, Sub-Surface Exploration and Monitoring Well Installation at the Proposed Ryan Waste Energy Plant Site: Report prepared for Bechtel Power Corporation.
- Radian Corporation (Radian), 1988, Volume 1, Final Site Characterization Report for ASCON Site, Huntington Beach, California.
- ISCO Industries/ITARA Engineers, 1992, Draft Remedial Investigation Report, May 11, 1992.
- Environmental Science and Engineering, 1997, Remedial Investigation Report, Ascon Property.

No groundwater work was conducted at the Site following work in 1997 until the year 2002. In 2002 PNL completed an additional hydrogeologic assessment that was summarized in the following key documents:

- Groundwater Assessment Report of Findings and Recommendations (GARFR), August 30, 2002 (PNL, 2002a).
- The Technical Memorandum (TM) No. 1 Report of Findings (PNL, 2003).

The investigations and results presented in the above documents are summarized in Section 4.0 and Section 6.0. The above PNL documents were not approved by DTSC.

### 3. GENERAL PHYSICAL SETTING

The information presented in this section was excerpted from the RI report (ESE, 1997) and the FS report (Environ, 2000) and updated where appropriate. Additional information may be found in the RI and FS reports and their respective appendices.

#### 3.1 Topography and Surface Features

The Ascon Landfill Site is a fenced and vacant property consisting of surface features indicative of its past use as a waste disposal site. Facilities and surface features, such as a drum storage area, decontamination pad and storage containers, office trailer, and drainage swales and storm water retention basins, associated with the on-going activities at the Site under the Consent Agreement are also present at the Site. The current locations and configurations of the lagoons and disposal pits, as well as other significant features such as structures and oil production wells that operate adjacent to the Site, are shown on Figures 2-1 and 2-2.

Piles of construction debris (primarily concrete and asphalt) are spread out on the surface throughout the Site. There are fences around the perimeters of Pit F, Lagoons 1, 2, 3, 4, and 5, and a drum storage area. Structures presently at the Site include a small metal shed adjacent to Pit F, a storage container next to an equipment decontamination pad in the southeast portion of the Site, and a temporary project office (trailer). The equipment decontamination pad is located southwest of Pit E. Access to the Site is obtained through three gates: two on Magnolia Street approximately 900 feet and 1,100 feet south of Hamilton Avenue and on Hamilton Avenue approximately 1,200 feet west of Magnolia Street (Figure 2-2). A pedestrian gate is also located along Hamilton Avenue to provide access for Southern California Edison to power poles located inside of the fence.

The Site is located in a low-lying coastal area that gently slopes to the south/southeast toward the Pacific Ocean. The surface topography of adjacent properties is generally flat with elevations ranging from 5 to 10 feet above mean sea level (MSL, California Department of Water Resources [CDWR], 1967; U.S. Geological Survey Newport Beach Quadrangle [USGS], 1965). The natural topography of the Site has been disturbed extensively over the years by the operation of the landfill and waste disposal activities described in Sections 2.2 and 2.3. An earthen berm, 10 to 20 feet high, has been constructed around much of the Site perimeter to contain surface impoundments

and storage areas in the interior of the Site. Elevation across the Site ranges from approximately 3 feet above MSL at the southeast corner to approximately 25 feet above MSL near the center of the Site.

### **3.2 Adjacent Land Uses**

The Ascon Landfill Site is located in an area of residential, recreational, commercial, and industrial land use (Figure 2-1). The immediately adjacent land uses identified on Figure 2-1 are:

- North: Edison Community Park and William Kettler Elementary School
- Northeast: Edison High School
- East: Single Family Homes
- South: Plains All American Pipeline Oil Storage Tanks, Green Belt
- Southwest: Huntington Beach Flood Control Channel, AES Corporation (AES; formerly SCE) Fuel Oil Tanks, Light Industry, AES (formerly SCE) Huntington Beach Power Generation Station
- West: Light Industry, Oil Production
- Northwest: Single Family Homes

Other land uses in the vicinity of the Site are detached single-family homes, recreation areas (parks and Huntington Beach State Park), wetlands (Talbert Marsh), recreational vehicle storage, mobile home trailer park, light industry, and an elementary school (Eader). Approximately 31,000 people live within 1 ½ miles of the Site.

### **3.3 Natural Resources**

Natural resources in the vicinity of the Site consist of beaches and wetlands. Petroleum reserves exist beneath the surface, and South Coast Oil Corporation (SCOC), or its successor, maintains oil production operations onsite along the western Site perimeter (see Section 2.4). Previous investigators identified no other significant natural resources.

### **3.4 City of Huntington Beach General Plan Zoning**

The area surrounding the Site is generally zoned by the City of Huntington Beach (City) for industrial, residential, and community facilities (parks, schools) land uses. The zoning designations for the properties adjacent to the Site are:

- North: OS-P- Community Facilities: Recreational District (Edison Community Park)
- Northeast: P(RL)- Educational (Edison High School)
- East: RL - Low Density Residential
- Southeast: RL - Low Density Residential
- South: P - Public (Fuel Oil Tanks)
- Southwest: P - Public (AES Power Plant)
- West: I - Light Industrial
- Northwest: RL – Low Density Residential

The Ascon Landfill Site is located within an area designated by the City as the Magnolia Pacific Specific Plan (Specific Plan 10 of the General Plan). Any future development of the Site is subject to this plan and other applicable City of Huntington Beach development regulations. The plan was adopted in November 1992 by the City for the Ascon Landfill Site and provides for development of the Site as a residential neighborhood with up to 502 units, although residential development is not a projected land use for the Site.

In 1993, a development agreement was entered between the Signal Mortgage Company and the City of Huntington Beach giving Signal Mortgage Company the right to develop the property upon completion of Site cleanup. Work under this agreement did not materialize.

### **3.5 Surface Water And Storm Water**

#### **3.5.1 Surface Water**

There are no surface water bodies on the Site. The major surface waters in the area of the Site are the Pacific Ocean (½ mile south); Santa Ana River (1 mile east); and the Orange County Flood Control Channel System, Huntington Beach Flood Control Channel (adjacent and southwest). The Huntington Beach Flood Control Channel

borders the Ascon Landfill Site at the southwest corner (Figures 1-1 and 2-1). The channel extends in a northwesterly direction and roughly parallels the coastline. The channel merges with the Talbert Flood Control Channel between Magnolia and Brookhurst Streets. From this point, the merged channel enters the Talbert Marsh Wetlands and flows eventually into the Pacific Ocean.

The Huntington Beach Flood Control Channel was constructed during 1965 with earthen berms and an unlined bottom. The estimated elevation of the top of the berms is 10 feet above MSL, and the elevation of the bottom is 1 foot below MSL. Vertical sheet piling was installed along both sides of the channel in the spring of 2003 to increase the capacity of the channel.

### **3.5.2 Storm Water**

Due to historical Site operations, the Site is topographically higher than the surrounding area. An earthen berm surrounds much of the Site. Within the Site, storm water from rainfall tends to collect in Lagoons 1 through 5, swales, v-ditches, and a retention basin located in the southeast corner of the Site. The storm water that collects in the lagoons has been sampled and analyzed in the past and will be discussed in the SFS report. The potential for storm water to flow onto the Site is low because the Site elevation ranges from approximately 2 to 20 feet above the surrounding grade.

Seepage from the external berm along Hamilton Avenue and Magnolia Street apparently occurred in the past, following major storm events. The 2004-2005 winter brought record-breaking precipitation to Southern California and the Site: the wettest season in the Site's recorded history. The lagoons, including Lagoons 4 and 5 behind the Hamilton berm (north berm), filled with storm water requiring pumping, treatment, and discharge under permit of approximately 3.8 million gallons of water to Orange County Sanitation District (OCSD) to mitigate the potential of an uncontrolled release of water that had come into contact with waste material inside the lagoons. Routine Site inspections during that period revealed the presence of surface cracks in the north berm and potential water seeps from the Site along Hamilton Avenue.

A Surface Water Management Plan was prepared and submitted to DTSC in January 2004 and was implemented onsite. A State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES), General Permit No. CAS000002, Waste Discharge Requirements (WDRs) for Discharges of Storm Water

Runoff Associated with Construction Activity was applied for and secured for the Emergency Action work conducted at the Site between July 2005 and January 2006. In compliance with the Construction NPDES permit, a Construction Storm Water Pollution Prevention Plan (SWPPP) was prepared and followed for the Ascon Emergency Action work. An Industrial NPDES permit (General Permit for Discharge of Storm Water Associated with Industrial Activities {Excluding Construction Activities} issued by the SWRCB under the NPDES General Permit No. CAS000001), was applied for the Site upon completion of the Emergency Action. An Industrial SWPPP was prepared for the Site in compliance with the Industrial NPDES permit. Best management practices and monitoring are in compliance with the Industrial NPDES permit and SWPPP. Storm water controls at the Site are discussed in the Emergency Action Completion Report (PNL, 2006).

The Ascon Landfill Site was reported in the prior FS (Environ, 2000) to be located within a defined Flood Hazard Area as indicated on a 100 and 500 Year Flood Map obtained from the City of Huntington Beach, California (Environ, 2000). Improvements in the adjacent Huntington Beach Flood Control Channel, including the reconfiguration of the channel with sheet piling, have resulted in the Site being removed from the 100-year flood plain designation. A sector of the February 2004 map (Map #06059C0263H) from the Federal Emergency Management Agency (FEMA) indicates the Site still remains in the 500-year flood plain.<sup>4</sup>

### **3.6 Climate**

The climate of the Huntington Beach area, like most of southern California, is controlled by the strength and position of a semi-permanent high-pressure cell over the eastern Pacific Ocean. This high-pressure cell creates a repetitive pattern of frequent early morning cloudiness, afternoon sunshine, daytime onshore breezes, and minor temperature fluctuations throughout the year.

As presented in the prior Environ FS (Environ, 2000), historic climate data are available for 59 complete years between 1931 and 1995 for the Newport Beach station located at 33° N, 117° W at an elevation of 9 feet above MSL (WorldClimate.com, 2000). According to these data, the annual average temperature for the area is 61.2° Fahrenheit

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<sup>4</sup> Note that former references to “100-year” and “500-year” floods have been revised by FEMA to “1% annual chance” and “0.2% annual chance” floods, respectively.

(F) with a high average monthly temperature of 68.5° F occurring in August and a low average monthly temperature of 55.0° F in January. Rainfall occurs mostly from November through April as generally mid-latitude storms move through the area. An average of approximately 11.9 inches of rain falls each year. Summers are often completely dry, with the exception of occasional rainfall from thundershowers of tropical origin.

Local meteorological conditions generally conform to the regional pattern of strong onshore winds during the day, especially in summer, and weak offshore winds at night, especially in winter. South Coast Air Quality Management District (SCAQMD) catalogues meteorological data from several data collection locations throughout its district.

### **3.7 Biological Survey**

Dudek and Associates conducted a biological survey of the Ascon Landfill Site in July 1996 (Dudek & Associates, 1996) and an update in December 2004. The December 2004 update will be presented in the SFS. Both the original survey and the update concluded that the Site is highly disturbed and does not generally support native plant communities. Two native plant communities including baccharis scrub and disturbed coastal salt marsh are found onsite. The dominant vegetation is ornamental and ruderal (weedy).

No sensitive wildlife species were observed onsite. Sensitive plant species were limited to two individuals of spiny rush (California Native Plant Society [CNPS] List 4—“Plant of Limited Distribution”) and many individuals of southern tarplant (CNPS List 1B—“Rare or Endangered in California and Elsewhere”).

### **3.8 General Geology and Hydrogeology**

The Site is in the southwest portion of the Coastal Plain of Orange County, which is bordered by the Santa Ana Mountains on the east, the San Joaquin Hills to the south, and the Pacific Ocean to the west. The coastal plain is a part of a deep northwest trending inland syncline about 20 miles in width. The inland synclinal trough consists of a thick sequence of permeable and impermeable sediments that form the Orange County Ground Water Basin in this area.



The Ascon Landfill Site is located within the physiographic feature known as the Santa Ana Gap or the Talbert Gap, which is located between the Huntington Beach Mesa and the Newport Mesa (Figure 3-1). The Pacific Ocean is approximately 2/5 miles to the south, the Huntington Beach Mesa is approximately 1-¼ miles to the northwest, and the Santa Ana River and Newport Mesa are approximately 1-¼ miles to the east. The Site is also within the northwest-trending Newport-Inglewood Fault Zone, immediately north of the “South Branch” (Figure 3-1). Movement along the fault zone has resulted in complex stratigraphy in Pleistocene or older-age sediments (California Department of Water Resources [CDWR], 1967). The line of low hills (or mesas) and intervening valleys (or gaps including the Talbert Gap) occurring along the coast are associated with the Newport-Inglewood structural zone (Figure 3-1).

The Talbert Gap was formed during the Pleistocene age when sea-level retreat and the ancestral Santa Ana River eroded the uplifted mesas. At the end of the ice age, the sea level rose and the gap was filled with approximately 150 ft of mixed alluvial and coastal sediments of Holocene age. These Holocene-age sediments consist of an upper unit and a lower unit. As discussed in Section 5.0, the upper unit forms the Semi-Perched Aquifer (SPA) and consists of clays, silts, fine sands, and peat beds. The lower unit forms the Talbert Aquifer and consists of sands and gravels. Below the Holocene age units is the Pleistocene age San Pedro Formation.

The Huntington Beach Mesa and the Newport Mesa located adjacent to the Talbert Gap are directly underlain by Pleistocene age marine deposits which are underlain by San Pedro Formation. The San Pedro Formation does outcrop at the surface in some areas of the Newport Mesa (CDWR, 1967). The Chico Hills, the Santa Ana Mountains, and the San Joaquin Hills that border the Coastal Plain (Figure 3-1) are underlain by older Tertiary age sedimentary rock and basement rocks. CDWR (1967) has defined these units as non-water bearing formations.

### **3.9 Contaminant Sources**

The primary types of wastes disposed of at the Site were drilling muds, possibly including oil-based muds (PNL, personal communication, 2005), and oilfield wastes (crude oil and tar). Other hydrocarbons known to have been disposed at the Site include fuel oils, phenolic wastes, mercaptans, styrene, and synthetic rubber. In addition, chromic and sulfuric acids, aluminum slag, and magnesium and potassium

chloride were reportedly deposited in the landfill. The waste materials were deposited on the Site over an approximate 30-year period, from 1938 to 1971.

The wastes were disposed at the Site in pits and surface impoundments (lagoons). The pits and lagoons are considered the main source of contaminants to groundwater at the Site. Descriptions of waste material and pit and lagoon locations are summarized in Sections 2.2, 2.3, and 2.5. In addition to the pits and lagoons, some fill materials and native soils have been impacted by contaminants. Subsequently, these impacted materials should also be considered potential contaminants sources to groundwater.

#### **4. GROUNDWATER RI/FS FIELD ACTIVITIES**

As discussed in Section 2.6, there have been numerous hydrogeologic investigations conducted on the Site in the last approximately 25 years. Work has generally been categorized as Pre-2002 work, work conducted in 2002 by PNL, and more recent work conducted between 2003 and 2006 by Geosyntec. Specific hydrogeologic reports that summarize the results of the different investigations are listed in Section 2.6.

The groundwater monitoring network consisted of 60 monitoring locations in 2004 (Figure 4-1). During the Emergency Action in 2005, a total of 15 locations were destroyed. The monitoring locations destroyed were generally located in the northern portion of the Site. Figure 4-2 shows the locations that were destroyed during the 2005 Emergency Action work and the current monitoring network. A total of 26 Cone Penetration Test (CPT) locations were also completed at the Site. The following methodology sections generally describe the hydrogeologic assessment work performed in the Pre-2002 years and in 2002 (Sections 4.1 through 4.3). Work conducted in accordance with the Groundwater RI/FS Workplan-Revision 1.0 is described in the Field Sampling Plan (FSP) of the workplan (GeoSyntec, 2003a) and the two addendum RI Workplans (GeoSyntec, 2006a and 2006c), and is outlined below in Section 4.4. Monitoring well location surveying work is described in Section 4.5.

##### **4.1 Pre-2002 Well Installation and Groundwater Sampling Work**

From 1983 to 1992 a total of 20 monitoring wells were installed across the Site. Boring logs and well construction diagrams for these wells are presented in Appendix A, and well diameter and screen level elevations are summarized in Table 4-1. Monitoring well locations are shown in Figure 4-1. The monitoring wells were installed as follows.

- Ecology and Environment installed eight wells (AW-1 through AW-8) in 1982 using hollow stem drilling methodology (Ecology and Environment, 1983). Two wells installed by Ecology and Environment, AW-6 and AW-7, are believed to have been paved over during work involving widening of Hamilton Avenue (Figure 4-1). Geophysical evaluation of these locations is described in Section 4.4.

- Woodward Clyde Consultants installed five monitoring wells (B-2 and B-4 through B-7) using hollow stem drilling methodology (Woodward Clyde Consultants, 1983).
- Radian installed five wells (MW-4, MW-9, MW-13, MW-14, and MW-15) in 1988 using hollow stem auger drilling methodology (Radian, 1988).
- ISCO Industries/ITARA Engineers installed two wells (NMW-1 and NMW-2) in 1991 (ISCO/ITARA, 1992). During well installation operations, surface conductor casings were installed using a bucket auger rig. Monitoring well casing was subsequently installed using hollow stem auger drilling methodology (Appendix A).

Selected monitoring wells were sampled in 1982, 1983, 1988, 1991, and 1997. A table of wells sampled is presented in Table 4-2. Ecology and Environment collected groundwater samples from AW-1 through AW-8 with a “suction” lift pump in 1982 (Ecology & Environment, 1983). Woodward Clyde Consultants collected groundwater samples from B-2 and B-4 through B-7 in 1983. The method of sampling used by Woodward Clyde Consultants is not known. Radian collected groundwater samples from 12 monitoring wells in 1988 (Table 4-2). Radian used bailers to purge and sample the wells. ISCO Industries/ITARA Engineers collected samples from NMW-1 and NMW-2 in 1991. The method of sampling is unknown.

ESE sampled nine wells in February 1997 (Table 4-2). One well (AW-3) was purged with a submersible pump and then sampled with a bailer. The remaining eight wells were purged and sampled with a “rented” submersible pump. Quality Assurance/Quality Control (QA/QC) sample results indicated that significant equipment contamination occurred during sampling, and all nine wells were resampled in March 1997 (ESE, 1997). ESE (1997) does not indicate the method of sampling in the March 1997 sampling event.

Water samples collected during the different investigations were generally sampled for Volatile Organic Compounds (VOCs), Semi Volatile Organic Compounds (SVOCs), and metals. Selected wells were also sampled for general mineral constituents, pesticides, ammonia, cyanide, sulfide, and Total Petroleum Hydrocarbons (TPH). Table 4-2 generally describes the analyses conducted during each investigation.

#### **4.2 PNL 2002 Monitoring Well Installation, Groundwater Sampling, and Water Level/NAPL Investigation**

In 2002 PNL completed additional hydrogeologic assessment work in which three offsite monitoring wells (MW-16, MW-17, and MW-18), twenty five small diameter geoprobe wells (GP-1 through GP-25), and ten piezometers (P-1 through P-10) were installed (Figure 4-1). The offsite wells and piezometers were installed using hollow stem auger drilling methodology. The geoprobe wells were installed using a direct-push sampling rig. Boring logs and well construction diagrams for these wells are presented in Appendix A, and well diameter and screen level elevations are summarized in Table 4-1.

The well installation and development procedures for the offsite wells (MW-16, MW-17, and MW-18) are presented in the GARFR (PNL, 2002a). The GARFR investigation was conducted in accordance with a DTSC approved work plan dated May 3, 2002 (PNL, 2002b). The location of the three offsite monitoring wells were based on groundwater samples collected using hydropunch technology at offsite CPT locations (see Section 4.3). The installation procedures for the piezometers and geoprobe wells are summarized in the Technical Memorandum (TM) No. 1 Report of Findings (PNL, 2003). The TM No. 1 investigation was conducted in accordance with a DTSC approved work plan dated July 10, 2002 (PNL, 2002c).

PNL completed numerous water level and NAPL gauging events between June 2002 and October 2002. The results of the gauging are presented in Section 5.5. PNL also completed a groundwater sampling program at the Site between June 2002 and August 2002. PNL sampled a total of 16 wells during the groundwater sampling program including the three new offsite wells (Table 4-2). During sampling, wells were purged with a submersible pump and sampled with a disposable bailer. Groundwater samples were transported to Del Mar Analytical Laboratories for chemical analyses. The laboratory analyses completed included:

- VOCs (EPA Method 8260);
- SVOCs (EPA Method 8270);
- TPH (EPA Method 8015M);
- Title 22 Metals (EPA Method 6010);
- Arsenic (EPA Method 7060);
- Lead (EPA Method (7421);

- Mercury (EPA Method (7470); and
- Chromium VI (EPA Method 7199).

The groundwater sampling and analytical program completed by PNL is discussed in detail in the GARFR (PNL, 2002a).

#### **4.3 Cone Penetration Testing Surveys Conducted in 1997 and 2002**

Cone Penetration Testing (CPT) is a process where subsurface soil characteristics are estimated by driving a small electronic device into the ground and measuring changes in different parameters such as tip resistance, resistivity, and pore pressure to identify soil materials. In addition, groundwater samples are collected with a hydropunch apparatus fitted to the CPT. Groundwater samples collected using a hydropunch are generally used for screening and/or planning purposes and not for characterization purposes.

A total of 26 CPTs have been completed at onsite and offsite locations. A map showing the CPT locations is shown on Figure B-1 in Appendix B. ESE (1997) completed eight CPTs (CPT-1 through CPT-8) in the 1997 investigation. PNL (2002a) completed a total of 18 CPT locations (CPT-9 through CPT-26).

#### **4.4 Groundwater RI Investigation Conducted in 2003-2006**

Based on the Site Conceptual Model and pathway analysis presented in the Groundwater RI/FS Workplan-Revision 1.0 and DTSC's request for additional site characterization information, various field activities were conducted during 2003 through 2006 by Geosyntec as part of the Groundwater RI to address data gaps. Field methodology and procedures were conducted in general accordance with the FSP presented in the GW RI/FS Workplan (GeoSyntec, 2003a) and two addendum workplans (GeoSyntec, 2006a and 2006c). The following field activities were performed as part of 2003-2006 RI field work.

##### **4.4.1 Groundwater Level and NAPL Gauging**

Groundwater level and NAPL thickness monitoring was conducted in onsite and offsite wells (Figure 4-1). Gauging events were conducted in June 2003, October 2003, November 2003, December 2003, March 2004, June 2004, September 2004, December 2004, and December 2006. The monitoring network for the December 2006 event was reduced compared to 2003 and 2004 events because 15 monitoring locations had been

destroyed during the Emergency Action completed in 2006. Figure 4-2 shows the monitoring locations destroyed in 2005.

During each monitoring event conducted in 2003 through 2006, groundwater levels were measured using an interface probe. NAPL thickness was measured in monitoring wells during the October 2003 through December 2003, December 2004, and December 2006 events. Subsequent to December 2003, with the exception of the December 2004 and December 2006 events, product thickness and groundwater levels were not gauged in wells with detectable (i.e., measurable) amounts of NAPL. Field methodology for the gauging events have been summarized in Geosyntec letters and quarterly monitoring reports including GeoSyntec 2003b, GeoSyntec 2003c, GeoSyntec 2004a, GeoSyntec 2004b, GeoSyntec 2004c, GeoSyntec 2004d, GeoSyntec 2005a, and Geosyntec 2007.

#### **4.4.2 Geophysical Surveys**

A geophysical survey was conducted in an attempt to locate missing wells AW-1, AW-6, and AW-7. The geophysical survey was conducted in February 2004 by traversing areas where the monitoring wells were thought to be located with a portable proton precession magnetometer. The geophysical survey was conducted by Spectrum Geophysics of San Fernando, California. The field methodology for the geophysical survey is summarized in GeoSyntec's Well Installation and Geophysical Survey Report dated July 28, 2004 (GeoSyntec, 2004e), which is appended to this report in Appendix C.

A second geophysical survey was conducted in September 2005 in an attempt to locate two former oil exploration wells in the area of Lagoon 5. The geophysical survey was conducted using the Magnetic Method. Survey results indicate the existence of magnetic anomalies consistent with steel casing located in the southern portion of the Lagoon 5. A geophysical report dated February 15, 2006, along with the survey coordinates of the magnetic anomalies, is appended to this report in Appendix C. The geophysical report and survey data were originally reported in the Emergency Action Completion Report (PNL, 2006).

#### **4.4.3 Well Installation and Development**

Five monitoring wells (MW-19, MW-20, AW-1A, AW-4A, and B-4A) were installed at the Site in February 2004. The location of the new monitoring wells is presented in Figure 4-1. The wells were installed using hollow stem auger drilling methodology. MW-20 was installed to a depth of 74 feet to evaluate deeper groundwater quality and the potential vertical migration pathway in groundwater. MW-19 was installed offsite near the southeast boundary of the Site. B-4A and AW-4A were installed to replace wells with significantly submerged well screens (B-4 and AW-4). AW-1A was installed to replace AW-1 at a location further to the south to provide improved coverage.<sup>5</sup>

Subsequent to well installation, the wells were developed by surging and bailing and then pumping. The well installation procedures, boring logs, well construction diagrams, and development logs are presented in GeoSyntec's Well Installation and Geophysical Report dated July 28, 2004 (GeoSyntec, 2004e), which is appended to this report as Appendix C.

#### **4.4.4 Groundwater Sampling and Laboratory Analyses**

As part of the RI, five groundwater sampling events were completed. Four quarterly groundwater sampling events were conducted in selected onsite and offsite wells in 2004. The quarterly monitoring events were conducted in March-April 2004, June 2004, September 2004, and December 2004 in accordance with the GW RI/FS Workplan (GeoSyntec, 2003a). An additional groundwater sampling event was conducted in December 2006 in accordance with an addendum workplan (GeoSyntec, 2006c). Table 4-2 summarizes the monitoring locations sampled during the RI.

Field methodology for the quarterly sampling events was previously summarized in Geosyntec's quarterly monitoring reports (GeoSyntec 2004b, 2004c, 2004d and 2005a) and Geosyntec's December 2006 groundwater monitoring report (Geosyntec, 2007). The groundwater purging and sampling were performed using low flow sampling procedures in accordance with the approved purging and sampling methodology presented in the FSP of the GW RI/FS Workplan (GeoSyntec, 2003a). Low flow bladder pumps manufactured by QED (Model #s MPSP6C and SP3/4P) were used in

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<sup>5</sup> AW-1 was subsequently located during Well No. 80 site cleanup operations conducted in March 2004.



the field for purging and sampling. Dedicated bladders and purge/sample lines were used for each monitoring location to avoid cross-contamination. A total of 21 to 23 monitoring locations were sampled during each quarterly monitoring event completed in 2004 (Table 4-2). A total of 19 monitoring locations were sampled in the December 2006 monitoring event.

Groundwater sampling protocol included collection and analysis of QA/QC samples. The QA/QC samples included trip blanks prepared by the laboratory and equipment blanks, field blanks, and duplicate samples prepared or collected in the field. Field blanks were prepared by filling laboratory bottles with deionized water (DI) in the field during sampling operations, and equipment blanks were prepared by pumping DI water through the sampling pumps and then into the laboratory bottles. Trip blanks were prepared for each sample shipment to the laboratory. Two field blanks, two equipment blanks, and two duplicate samples were prepared or collected during each quarterly monitoring event.

Groundwater and groundwater QA/QC samples were transported to Del Mar Analytical of Irvine, California, for analysis. The samples were transported in ice chests cooled with wet ice under chain-of-custody (COC) procedure. COCs for groundwater samples are presented in Appendix D. Samples were analyzed for the selected analytes in accordance with the approved Workplans. Chemical compounds sampled and analyzed in the 2004 groundwater sampling events included:

- Volatile Organic Compounds (VOCs) (EPA Method 8260b);
- Semi-Volatile Organic Compounds (SVOCs) (EPA Method 8270c);
- Title 22 Metals (EPA 6020); and
- Mercury (EPA 7440).

In addition, selected samples were collected and analyzed for the following compounds:

- Hexavalent Chromium (EPA Method 7199);
- N-nitrosodimethylamine (NDMA- EPA Method 1625C-Modified);
- 1,4-Dioxane (EPA Method 8270C-Modified);
- Perchlorate (EPA Method 314.0); and
- Selected general minerals and Total Dissolved Solids (TDS).

Chemical compounds sampled and analyzed in the December 2006 groundwater sampling event included:

- VOCs (EPA Method 8260b); and
- SVOCs (EPA Method 8270c).<sup>6</sup>

Groundwater samples collected from three wells (AW-2, B-4A, and B-7) in December 2006 were also analyzed for Title 22 Metals (EPA 6020) and Mercury (EPA 7440).

It should be noted that as part of the December 2006 analytical program the laboratories low level 8270c methodology was used. Consequently, the reporting limits for SVOCs in the December 2006 monitoring program were lower than reporting limits in previous monitoring events.

#### **4.4.5 Channel Water Collection and Laboratory Analyses**

During the 4<sup>th</sup> quarter 2004 sampling event, a water sample was collected from the Huntington Beach Flood Control Channel (GeoSyntec, 2005a). The sample was collected from the location of the Magnolia Street bridge located approximately 1/3 of a mile from the Site using a bailer.<sup>7</sup> The purpose of collecting the sample was to evaluate potential impacts on shallow groundwater quality beneath the Site due to recharge from the flood control channel. The sample was analyzed for selected general minerals, TDS, and metals. Because of the constant inflow and outflow of water in the channel due to tides, water in the flood control channel is thought to be relatively well mixed, and therefore, water quality beneath the Magnolia Street Bridge is expected to be representative of general water quality in the Huntington Beach Flood Control Channel.

#### **4.4.6 NAPL Sampling and Laboratory Analyses**

NAPL was sampled in five monitoring locations during an investigation conducted between December 7 and December 9, 2004. The investigation was conducted as part of the December 2004 monitoring event and conducted in accordance with a Workplan addendum dated October 22, 2004. The Workplan addendum was conditionally

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<sup>6</sup> Monitoring Well AW-2 was not analyzed for VOCs or SVOCs.

<sup>7</sup> The sample collection was not described in the Groundwater RI/FS Workplan or requested by DTSC and is considered a discretionary sample.

approved by DTSC in their letter dated November 19, 2004. The investigation included gauging NAPL thickness at all Site monitoring locations.

NAPL samples were collected at monitoring well locations P-1, P-4, P-5, P-6, and P-8 using a 1-inch diameter stainless steel bailer. Upon retrieval of the sample, NAPL and any residual groundwater were manually separated and the NAPL was placed in glass bottles supplied by the laboratories. The NAPL samples collected during the NAPL investigation were analyzed for both physical and chemical characteristics. Samples collected from P-1, P-5, P-6, and P-8 were transported to Petroleum Testing Services (PTS) in Santa Fe Springs, California, and analyzed for:

- Density, specific gravity, viscosity, and interfacial tension; and
- Fuel fingerprinting (C<sub>4</sub> to C<sub>35</sub>) analyses.

NAPL samples collected from P-1, P-4, P-5, P-6, and P-8 were transported to Zymax Laboratories of San Luis Obispo, California, and analyzed for:

- VOCs (EPA Method 8260);
- SVOCs (EPA Method 8270);
- pH; and
- Title 22 Metals (EPA Method 6020).

Only NAPL samples collected from P-1 and P-6 were analyzed for SVOCs because the method detection limit obtained by the laboratory was deemed too high to yield significant information on SVOC content.

#### **4.4.7 Tidal Study**

In addition to the above groundwater RI field activities, DTSC requested that a tidal influence study and a groundwater gauging event be conducted as part of the Workplan preparation (DTSC letter dated April 28, 2003). Field methodology for the tidal influence study was summarized in Geosyntec's letter report dated July 7, 2003 (GeoSyntec, 2003d), and is appended to this report in Appendix E.

The tidal study was conducted between June 5, 2003, and June 13, 2003 (approximately 11,000 minutes). This period included intervals when the ocean tides (as predicted for Balboa Pier in Newport Beach) had a range of over 6 feet (spring tides). Two transducers were placed in standpipes installed within the Huntington Beach Flood

Control Channel to collect channel water elevation data at locations shown on Figure 5-10. Transducers were also placed in Site wells AW-4, AW-5, B-4, and MW-9 (Figure 5-10) to collect groundwater level data. One transducer was placed onsite to collect barometric pressure readings. A groundwater level and NAPL gauging event was also completed on June 26-27, 2003, as part of the tidal influence study. The study was performed in accordance with the Draft GW RI/FS Workplan (GeoSyntec 2003e), conditions specified in DTSC's letter dated April 28, 2003, and the Responsible Parties (RP's) response to comment letter dated May 9, 2003.

#### **4.4.8 Pit F Area Supplementary Groundwater Investigation**

DTSC requested additional groundwater characterization, including chemical delineation, gradient, and flow direction, in the southeast corner of the Site, near Pit F, in their letter dated January 12, 2006, and in a meeting on January 26, 2006. A supplemental groundwater investigation in the Pit F area, documented in the Supplementary Groundwater Investigation in the Pit F Area Report (Geosyntec, 2006b), was conducted using hydropunch push point grab sampling of groundwater in the Pit F area in accordance with a Workplan addendum dated April 20, 2006 (Geosyntec, 2006a). Also, the mapping of groundwater surface contours in that area was refined. Revisions to the previous contouring in that area are depicted in maps presented in Section 5.5.1.

The supplemental investigation was conducted on May 23 through May 25, 2006, and consisted of 12 hydropunch samples (HP-1 through HP-12) in the vicinity of Pit F. Groundwater was collected from the upper three feet of the Semi-Perched Aquifer, just beneath the fine-grained silty/clay unit, as identified using logging from an adjacent push point done prior to the sample collection. The samples were analyzed for VOCs and SVOCs using EPA Methods 8260B and 8270C, respectively. Because the high degree of sedimentation in the grab samples was causing frothing when reacting with the acid preservative in the sample bottles of some of the samples, the acid was removed, and the unpreserved samples were then appropriately analyzed.

The supplemental investigation concluded that groundwater impacts have not significantly migrated downgradient from the known soil impacts related to Pit F. Revision 1 of the initial report is attached as Appendix K. Revision 1 includes incorporated responses to DTSC comments regarding the first draft and also incorporates the groundwater data that resulted from a split sample taken by DTSC.

#### **4.5 Monitoring Location Surveying**

The vertical elevation and horizontal coordinates of all monitoring locations were surveyed by Nunez Engineering of Whittier, California. All survey reports including the description of the benchmarks are provided in Appendix F. To survey in the monitoring locations, Nunez Engineering used the NAVD88 datum at the benchmark located at the intersection of Hamilton Avenue and Magnolia Street. Based on the 1995 County of Orange P.F.R.D./Geomatics-Land Information Systems Vertical Control Data Sheet and Tidal Plans and Tidal Datum Relationships chart (NOS, 1989), the MSL system used for the datum elevation at the TIDAL-1NP benchmark located at the Newport Bay Entrance is 2.46 feet higher than the NAVD88 system used for the datum at the Magnolia Street-Hamilton Avenue benchmark. This relative difference causes MSL-benchmarked elevation data to appear to be 2.46 feet lower than NAVD88-benchmarked elevation data.

Nunez Engineering was subcontracted to perform well surveying at several different junctures during the investigative work over the last several years. The following is a summary of the surveying work.

- All existing onsite wells were surveyed on May 30 and May 31, 2002 (PNL, 2002a). This survey included wells that were installed previous to the PNL 2002 investigation with the exception of AW-6, AW-7, and AW-1, which could not be found. Newly installed offsite wells MW-16, MW-17, and MW-18 were surveyed on August 8, 2002 (PNL, 2002a).
- Geoprobe wells (GP-1 through GP-25) and piezometers (P-1 through P-10) were surveyed on September 16, 2002 (PNL, 2003).
- Monitoring locations GP-5, GP-16, GP-20, GP-21, GP-23, GP-24, P-9, and P-10 were resurveyed on February 3, 2004. The objective of resurveying GP-24 and P-9 was to check the vertical casing elevations. In the case of P-9, the elevation was suspect due to the anomalous contribution to potentiometric surface mapping observed. In the case of GP-24, the elevation was known to be incorrect because of a broken casing at the surface. The objective of resurveying the other monitoring locations was to verify the horizontal positions (northings and eastings) of the locations. Suspected locations of

AW-1, AW-6, and AW-7 were also surveyed and labeled (see description on survey sheet dated February 3, 2004).

- Monitoring wells AW-1A, AW-4A, B-4A, MW-19, and MW-20, and the location of old well AW-1 were surveyed by Nunez Engineering on April 26, 2004. In addition, anomalies A1 and A2 (suspected AW-6 and AW-7 locations) were surveyed.
- Monitoring wells GP-10, GP-12, GP-15, and GP-24 were resurveyed on September 17, 2004, after casing repair.

## 5. REGIONAL AND SITE HYDROGEOLOGY

### 5.1 Regional Hydrogeology

The Site is located within the Orange County Groundwater Basin near the basin's extreme southwestern boundary (the ocean). A map of the groundwater basin is shown in Figure 3-1 and a generalized cross-section through the groundwater basin is shown in Figure 5-1. The cross-section depicts how the thick alluvial sediments of the main portion of the groundwater basin thin substantially toward the ocean as a result of movement along the Newport-Inglewood fault zone. The basin is generally divided into the Forebay Area where recharge to the basin generally occurs and the Pressure Area where near surface clayey layers generally prevent surface water from recharging the deeper aquifers (Figure 3-1). The Site is located in the southwestern portion of the Pressure area within an area known as the Santa Ana Gap or the Talbert Gap (Figure 3 1). The Site is approximately 10 miles south of the estimated boundary of the Forebay Area.

The Talbert Gap area where the Site is located is shown in Figure 3-1. The Talbert Gap is located along the coastline between the Newport Mesa and the Huntington Beach Mesa areas. The Talbert Gap area has been the focus of several investigations due to the seawater intrusion problems in the area (see discussion below). Documents that present the regional hydrogeology of the area include *Hydrology of the Long Beach-Santa Ana Area, California* (United State Geological Survey [USGS], 1959) and *Progress Report on Groundwater Geology of the Coastal Plain of Orange County* (CDWR, 1967).

As discussed in Section 3.8, shallow groundwater beneath the Site occurs in both the Holocene age upper and lower alluvial units. The upper alluvial unit forms the SPA (Semi-Perched Aquifer) and the lower unit forms the Talbert Aquifer.

The SPA is considered to be made up of a number of individual bodies of water that are limited in extent and shallow in nature. The SPA is generally described as being comprised of layered silts, clays, and fine-grained sands. The SPA extends to an estimated depth of approximately 80 to 90 feet below ground surface (bgs) in the vicinity of the Site (USGS, 1959). The SPA is generally considered to be an unconfined aquifer, and the water bearing deposits in the SPA are generally fine-grained sand and silt materials (USGS, 1959).

The Talbert Aquifer occurs beneath the SPA and is comprised of sands and gravels. The Talbert Aquifer is considered a regional aquifer and extends continuously from Santa Ana Canyon in the Santa Ana Mountains to the Pacific Ocean. The aquifer underlies the Talbert Gap and the Bolsa Gap (NW of the Huntington Beach Mesa) areas and at its widest point is approximately six miles in width in the City of Anaheim area. The Talbert Aquifer is present from a depth of approximately 80 to 90 feet bgs to a depth of approximately 150 feet bgs in the Site vicinity (USGS, 1959). The top and the base of the Talbert Aquifer in the Santa Ana Gap are shown in the cross-section presented in Figure 5-2. The Talbert Aquifer is highly permeable, but its permeability diminishes substantially toward the coast (USGS, 1959). Confined conditions occur in the Talbert Aquifer (CDWR, 1967).

Beneath the Talbert Aquifer in the Talbert Gap area is the water bearing zones of the Pleistocene age San Pedro Formation (Figure 5-2). The water bearing zones of the San Pedro Formation are comprised of sands and gravels.

The SPA has never been considered an important source of groundwater in the Orange County Groundwater Basin. The Talbert Aquifer, though, was historically an important groundwater source in the Site vicinity. However, groundwater production wells in the Talbert Gap area have been abandoned due to seawater intrusion. Historically, under conditions of little inland groundwater production, the Talbert Aquifer had a seaward gradient (southern gradient) and probably discharged into the ocean. However, inland groundwater production in the Talbert Aquifer and in deeper aquifers caused groundwater potentiometric heads to drop below sea level. This resulted in a reversal in groundwater flow direction, and seawater intrusion occurred through much of the Talbert Gap area, including the Site vicinity (CDWR, 1967). Significant deterioration of water quality in the Talbert Gap, including the Site area, occurred from 1930 to 1945 (USGS, 1959).

As a result of the increasing inland spread of seawater intrusion, an injection barrier system was installed to control the degradation of drinking water in the basin. The Talbert Water Injection Barrier was installed in 1976 and consists of a line of water injection wells across the Talbert Gap. The barrier is located approximately 3 miles north of the Site along Ellis Avenue as shown on Figure 5-3. Recycled potable water mixed with deep well water is injected at up to 15 million gallons per day to form a seaward piezometric gradient that acts as a barrier to prevent further intrusion of seawater into the fresh water aquifers.



In addition to the line of injection wells, seven extraction wells were installed between 1963 and 1969 in the area between the Talbert Water Injection Barrier and the ocean in an initial attempt to control seawater intrusion into the Talbert Aquifer. Pumping of the wells was stopped in 1979 and the pumps were reportedly removed from the wells in 1981 (The Earth Technology Corporation, 1990). The barrier project does not appear to have affected the inland shallow groundwater gradient at the Site (see Section 5.5).

To ascertain regional gradients in the Site vicinity, groundwater data were obtained from the Orange County Water District (OCWD) regarding horizontal and vertical gradients in their observation wells located in the Site vicinity. OCWD maintains groundwater monitoring wells in the Talbert Gap area to monitor groundwater elevations and chemical concentrations for the purposes of evaluating the extent of seawater intrusion. Three of the monitoring wells (OCWD-M2, OCWD-M28, and OCWD-M1) are located within approximately 1 mile of the Ascon Landfill Site and are shown on Figure 5-3. The monitoring wells appear to be screened in the Talbert Aquifer. Well construction and water elevation data from March 5 and 6, 1997, are presented below.

<b>Well Number</b>	<b>Distance from Site</b>	<b>Date Drilled</b>	<b>Total Well Depth</b>	<b>Screened Interval</b>	<b>Depth to Water (ft)</b>	<b>Water Elevation (ft MSL)</b>
OCWD-M1	1 mi NE	11/1/67	115	75-110	4.75	-0.56
OCWD-M2	.5 mi NNW	9/1/67	155	85-150	9.86	0.65
OCWD-M28	.5 mi E	7/1/69	155	80-145	1.16	0.91

Using these water level data from the three monitoring wells collected by OCWD, the calculated groundwater flow direction in the Talbert Aquifer is to the northeast. This flow direction is consistent with the flow component in the SPA beneath the Site (See Section 5.5).

Four wells (OCWD-T2, T-3, T-5, and SA-10) with multi ports/screens were found to be located within approximately 1.2 to 1.6 miles (north) of the Site (Figure 5-3). Data from these wells were used to evaluate regional vertical gradients. Data from three of the wells showed downward gradients, and data from one well (OCWD-T5) showed an upward gradient. OCWD-T5 is located closest to the Site and has one screen interval at

a depth of 110 to 190 feet (Talbert Aquifer) and a second deeper screen interval from 285 to 295 feet (San Pedro Formation). OCWD-T2 has a screen in the SPA and second screen interval in the Talbert Aquifer. Data from this well indicate a downward gradient. As described in Section 5.5.3.2, data indicate an upward vertical gradient at the Site.

## **5.2 Water Well Locations**

Figure 5-3 shows the drinking water and agriculture/industrial wells in the Site vicinity. The nearest drinking water production well is the HB-Dyke Well, which is located approximately 3 miles north of the Site on the inland side of the Talbert Water Injection Barrier. Two agricultural wells located within three to four miles of the Site are GKAW-FV and CALL-FV. A1-HB is a domestic well used to water plants in a commercial nursery (OCWD, personal communication, 2004). According to OCWD (personal communication, 2003), there is no groundwater production of any kind (drinking water, agricultural, industrial) within three miles of the Site. This is due to the fact that groundwater in the vicinity of the Site is severely degraded by seawater intrusion and thus is not used.

## **5.3 Site Hydrostratigraphy**

### **5.3.1 Stratigraphy**

The location of three cross-sections for the Site are shown on Figure 5-4, and the cross-sections are shown on Figures 5-5, 5-6, and 5-7. The cross-sections are based on selected borehole data that have been collected during various Site investigations. The cross-sections illustrate the relationship of Site wastes and fill materials, the underlying fine-grained layer (clay and silt) present across most, if not all, of the Site, and the underlying sands of the SPA. Stratigraphic units include: (1) fill materials, (2) impacted fill and waste materials, (3) fine-grained native materials including clay and silt, and (4) coarser-grained native materials that generally consist of silty sands and fine-grained sand materials.

The cross-sections show that the surface of the Site is directly underlain by fill material, impacted fill material, and waste. Based on aerial photograph interpretation, the wastes and fill materials at the Ascon Landfill Site were generally placed directly upon the native sediment. Soil fill material was used for forming berms for the lagoons and pits located on the Site. In addition, soil and construction debris, consisting of wood, brick,

concrete, and asphalt, were placed over much of the waste material and can be seen around the edges and extending into several of the lagoons. The waste materials disposed at the Site were generally drilling muds and oil-saturated wastes, which are present throughout most of the Site, with the exception of the western margin and southeastern corner of the property. The thickness of the waste varies from a few feet to as much as 20 feet. It is estimated that the fill and waste materials combined range in thickness from about 5 to 30 ft across the Site.

A fine-grained (silt and clay) layer underlies the Site. The fine-grained unit is generally 3 to 10 feet thick and occurs from approximately -10 feet to 5 feet above the NAVD88 datum (-12.5 to 2.5 feet MSL). The fine-grained layer has been described as a peat layer or petroliferous in some borings. Based on its location and apparent extent across the Site, it is interpreted that the fine-grained unit may be part of a substantial peat deposit that CDWR (1967) reports underlies the Talbert Gap Area a few feet below ground surface. The fine-grained layer occurs across nearly all of the Site, however, it was not observed in the very western portion of the Site in the area of AW-5 and was not observed in some recent boreholes (GP-13 and P-6) completed directly east of Lagoons 1 and 2 (see Figure 5-6). Radian (1988) also showed the fine-grained layer generally occurring across the Site in six cross-sections completed as part of their investigation. The presence of the fine-grained layer at the Site appears to have significantly impeded the downward migration of waste materials.

Below the fine-grained layer are sandy materials (fine- to medium-grained sands and silty sands) that generally contain some shell materials. These sands are interpreted to be part of the SPA.

The remaining discussion regarding site hydrostratigraphy is organized in terms of groundwater occurrence. Shallow groundwater beneath the Site occurs in the

- Perched Zone;
- SPA; and
- Talbert Aquifer.

### **5.3.2 Perched Zone**

Recent investigations by PNL (2003) at the Site delineated several zones of perched liquid in the east and southwest portions of the Site. The perched liquid was encountered between approximately 5 to 14 feet above NAVD88 within the waste zone

and fill zones and above the native soils (Table 5-1). The liquid was interpreted to be a mixture of rainwater and old pit liquids that were ponded on top of fine-grained waste and fill materials. Observations made during recent trenching investigations conducted as part of the Second Feasibility Study investigations (Pilot Study No. 3) indicated that liquids above the water table occur in thin sandy layers and produced relatively little liquid in the open trenches that intersected known perched liquid areas and depths. The water bearing materials in the perched zone were demonstrated to be discontinuous and of limited extent.

### **5.3.3 Semi-Perched Aquifer**

Regionally, the SPA is reported to consist of thin layers of sand and silty sand with interbedded clays, silts, and peat beds (USGS, 1959, CDWR, 1967). Beneath the Site, the main water bearing deposits of the SPA are fine-grained sands that extend from approximately 10 to 30 feet bgs to approximately 80 to 90 feet bgs (USGS, 1959). Generally, the SPA materials are considered alluvial in origin; however, silty fine sands with shell fragments have been noted in several of the Site boring logs including a deep monitoring well (MW-20) located in the middle portion of the Site. The silty fine sands with shells are interpreted to be beach deposits that interfinger locally with alluvial materials.

Groundwater in the SPA is generally considered to occur under unconfined conditions (USGS, 1959). However, comparison of groundwater elevations observed during drilling with measured water level elevations in completed monitoring wells indicates that confined or semi-confined conditions occur locally in the SPA beneath the Site (Figures 5-4 through 5-6). The fine-grained clay/silt layer that has been interpreted to overlie permeable sands throughout all or most of the Site acts as a confining or semi-confining layer. Groundwater levels were generally first observed in or near the sand zone during drilling and then rose after wells were completed (Figures 5-5 through 5-7). The fine-grained clay/silt layer appears to be absent in the very western portions of the Site in the vicinity of AW-5. Thus, unconfined conditions likely occur in the SPA in the very western portion of the Site.

Over the past two years of monitoring, the groundwater potentiometric surface elevations in the SPA have ranged from approximately -3.4 feet NAVD88 in the northwest portion of the Site to 1.45 feet above NAVD88 in the southwest portion of

the Site (Table 5-2). Seasonal fluctuations have ranged from approximately  $\frac{3}{4}$  to  $1\frac{3}{4}$  foot over this same two-year monitoring period (see Section 5.5.2).

Based on the groundwater data, a portion of the waste material at the Site that occurs above the SPA appears to be present below the groundwater potentiometric surface in the southeastern portion of the Site and possibly in the northwest portion of the Site in the vicinity of GP-2 and GP-1 (Figures 5-5 through 5-7). However, the actual first occurrence of groundwater beneath the Site is below the potentiometric surface and generally occurs in the sands that occur below the fine-grained layer. Thus, it is interpreted that the wastes are present above the actual groundwater surface at the Site.

#### **5.3.4 Talbert Aquifer**

The Talbert Aquifer is a sequence of sandy water-bearing zones separated by clay layers. The Talbert Aquifer is present immediately beneath the SPA. Based on USGS regional cross-section (Figure 5-2), the top of the Talbert Aquifer occurs at approximately 80-90 feet below the Site surface. Based on this interpretation, Site borings have not intersected the Talbert Aquifer.

#### **5.4 Site Monitoring Well Network**

The groundwater monitoring network in 2004 consisted of the following number of wells:

- 21 onsite monitoring wells;
- 4 offsite monitoring wells;
- 10 onsite piezometers (1 installed to measure perched liquids); and
- 25 onsite geoprobe wells (15 installed to measure perched liquids).

The locations of the monitoring points are shown in Figure 4-1. Most of the monitoring wells assess conditions in the SPA, although 1 piezometer and 15 geoprobe wells were installed to monitor conditions in the perched zone. Table 4-1 and Appendix A contain construction details of the monitoring points and indicate which wells monitor the SPA and perched zone.

As part of the Emergency Action in 2005, a total of 15 monitoring locations were properly destroyed in accordance with California Well Standards (Figure 4-2). The monitoring locations destroyed included five onsite monitoring wells (B-2, MW-4,

MW-14, MW-20, and NMW-1), four onsite piezometers (P-1 through P-4), and six onsite Geoprobe wells (GP-1 through GP-4, GP-24, and GP-25). In summary, after completion of the 2005 Emergency Action, the groundwater monitoring network consisted of the following number of wells:

- 16 onsite monitoring wells;
- 4 offsite monitoring wells;
- 6 onsite piezometers; and
- 19 onsite geoprobe wells (15 installed to measure perched liquids).

## **5.5 Groundwater Gradient and Elevation**

### **5.5.1 Groundwater Contour Maps**

Groundwater level data have been collected intermittently at the Site since approximately 1988, including twelve groundwater level gauging events completed from June 2002 to December 2006. The groundwater level data were used to construct numerous groundwater gradient maps for the SPA at the Site. Groundwater gradient maps developed by Radian (1988) and ESE (1997) are presented in Appendix G (Figures G-1 through G-3). The Radian and ESE maps are for the following dates:

- September 22, 1988 (Radian, 1988)
- January 15, 1996 (ESE, 1997)
- March 12, 1997 (ESE, 1997)

These contour maps were previously presented in the Groundwater RI/FS Workplan-Revision 1.0 (GeoSyntec, 2003a). Groundwater gradient maps developed by Geosyntec as part of this RI investigation are presented in Figures 5-8A through 5-8L. The Geosyntec maps are for the following dates:

- June 7, 2002
- August 9, 2002
- October 7, 2002 (revised)
- June 26, 2003 (revised)
- October 14, 2003 (revised)
- November 12, 2003 (revised)
- December 29, 2003 (revised)

- March 15, 2004 (revised)
- June 7, 2004 (revised)
- September 7, 2004 (revised)
- December 7, 2004 (revised)
- December 4, 2006

The contour maps from June 7, 2002, to December 7, 2004, were previously presented in Geosyntec letters and letter reports (GeoSyntec 2003b, GeoSyntec 2003c, GeoSyntec 2004a, GeoSyntec 2004b, GeoSyntec 2004c, GeoSyntec 2004d, GeoSyntec, 2005a, and GeoSyntec, 2007).<sup>8</sup>

Groundwater elevations measured in 1988, 1996, and 1997 are based on Mean Sea Level (MSL). The groundwater elevations collected in 2002 through 2004 are based on the NAVD88 datum (see Section 4.5). The MSL elevation data are 2.46 feet lower than NAVD88 elevation data due to benchmark elevation differences of 2.46 feet. Groundwater level elevations above MSL and above NAVD88 for years 2002, 2003, and 2004 are summarized in Tables 5-1 and 5-2. A brief description of historical contour maps listed above is presented below.

The September 1988 contour map (Figure G-1) shows shallow groundwater beneath the Site (SPA) to flow generally to the northwest in the northwestern portion of the Site and east to northeast in the southern and eastern portions of the Site. Radian's (1988) interpretation indicates that lagoons located in the central portion of the Site are locally recharging the shallow groundwater zone beneath the Site and that a ridge of high water occurs directly beneath the lagoons. Additionally, the groundwater flow direction in the southwest portion of the Site adjacent to the Huntington Beach Flood Control Channel is toward the northeast. This indicates that the channel is acting as a losing stream (channel discharges to shallow groundwater).

ESE's January 1996 and March 1997 contour maps (Figures G-2 and G-3) are consistent with the Radian (1988) map. A generally northwest groundwater flow direction in the northwestern portion of the Site and an easterly flow direction in the

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<sup>8</sup> Groundwater level contour maps have been continuously revised based on new elevation data, including revisions discussed in Section 4.4.8 and Appendix K. Consequently, groundwater level contour maps presented in Figures 5-8C through 5-8K are slightly different than the original contour maps presented in these cited documents.

eastern portions of the Site are evident. ESE's contour maps also show a ridge of high water associated with the Site lagoons. The axis of the ridge appears to be located slightly eastward of the lagoons. ESE's January 1996 contour map shows that the groundwater flow direction parallels the Huntington Beach Flood Control Channel in the southwest portion of the Site. However, water levels in key monitoring locations, wells AW-5 and B-4, were apparently not available for this time period, which might have shown flow away from the channel as expected. ESE's March 1997 contour map shows a northwesterly groundwater flow direction in the southwest portion of the Site. Again, key water level measurement points (B-4) were apparently not available.

Two contour maps from water level measurements collected by PNL in June 2002 and August 2002 were prepared (Figures 5-8A and 5-8B). These maps include several additional monitoring locations including well NMW-2 located along the channel area in the southwestern portion of the Site and offsite wells MW-16, MW-17, and MW-18. The contour maps show a northwesterly groundwater flow direction in the northwestern portion of the Site and a north to northeasterly groundwater flow direction in the eastern portion of the Site. This is generally consistent with previous groundwater contour maps in these areas. The June 2002 and August 2002 contour maps show that the groundwater flow direction in the southwestern portion of the Site is toward the northeast. This indicates that groundwater flow is away from the channel, indicating losing stream conditions.

Geosyntec prepared five groundwater contour maps based on data collected from October 2002 through December 2003 (Figures 5-8C through 5-8G). The contour maps include water level information collected from wells and more recently constructed piezometers (P wells) and geoprobe monitoring wells (GP wells). The data include many monitoring locations in the central portion of the Site. The data continue to indicate a generally northerly flow across the Site with northwest flow in the northwest corner of the Site and northeast flow in the southwest portion of the Site indicating losing stream conditions in the areas adjacent to the Huntington Beach Flood Control Channel. Localized groundwater lows are observed in the southeastern quadrant of the Site in October 2002, October 2003, and November 2003 (Figures 5-8C, 5-8E, and 5-8F). As a result of these groundwater lows, a local component of westerly groundwater flow occurs in the southeastern area during these periods.

Geosyntec prepared groundwater contour maps for March 2004, June 2004, September 2004, and December 2004 as part of the 2004 quarterly monitoring program (Figures



5-8H through 5-8K), and in December 2006 (Figure 5-8L). These maps include data collected from four additional monitoring wells installed in February 2004 (AW-4A, B-4A, AW-1A, and MW-19). The groundwater flow direction is generally consistent with previous contours maps and again demonstrates that groundwater flow direction is generally to the north, although a more easterly groundwater flow direction appears to occur in the southeastern portion of the Site. Groundwater flow direction in the western portion of the Site continues to be away from the Huntington Beach Flood Control Channel, although in the area immediately adjacent to the channel a northerly flow occurs in December 2004 (flow parallel to the channel).

In summary, fifteen groundwater contour maps dating from September 1988 to December 2006 indicate that groundwater generally flows toward the northwest in the northwestern portion of the Site, toward the northeast in the southwest portion of the Site, and toward the northeast to northwest in the eastern portion of the Site. Early groundwater contour maps suggested that a low ridge or mound of groundwater may be associated with the lagoons located in the middle portion of the Site; however, the latest maps, containing far more data, suggest that this is not the case. In general, groundwater data, including the most recent with many additional monitoring points, indicate that groundwater flow is away from the Huntington Beach Flood Control Channel. Thus, surface water in the channel appears to discharge into the SPA adjacent to the Site. The March 1997 data, suggesting a component of flow toward the channel, are missing key monitoring points that might have shown flow oriented away from the channel as observed in other monitoring events. A recent tidal study conducted at the Site also determined that water in the Huntington Beach Flood Control Channel discharges into the SPA (see Section 5.6).

### **5.5.2 Groundwater Levels and Seasonal Fluctuation**

Hydrographs for potentiometric surface elevations (groundwater level elevation) in selected Site wells for monitoring events conducted in September 1988, January 1996, March 1997, and twelve events conducted between June 2002 and December 2006 are presented in Figures 5-9 and 5-10. Figure 5-9 presents data collected from 1988 through 2006, and Figure 5-10 presents the data collected from June 2002 to December 2004 when more intensive gauging was conducted. The groundwater level elevation data are also summarized in Table 5-3. The wells included in the hydrographs represent monitoring locations that are generally well distributed across the Site, that have relatively long historical records, and do not contain NAPL.

Generally, groundwater elevations beneath the Site have ranged from approximately - 3½ to 3½ feet NAVD88 (Figure 5-9). The highest groundwater levels were generally recorded in March 1997 or December 2004. The March 1997 and December 2004 monitoring events occurred in the wet season. The lowest groundwater levels were generally recorded in October 2003, although significant lows in MW-13 and MW-15 were recorded in January 1996. The October 2003 monitoring event occurred at the end of the 2003 dry season.

On average, the high groundwater elevations recorded in the wells are approximately 2 feet higher than the recorded lows. The greatest difference in water level elevations occurred in MW-9 (3.9 feet) located on the southern boundary of the Site. The smallest difference in water elevations occurred in AW-5 (1.5 feet) and AW-8 (1.4 feet) located in the western portions of the Site. Based on these results, it is reasonable to assume that water level fluctuations ranging from approximately 1 to 4 feet may be expected at the Site. Similar groundwater level fluctuations were observed in monitoring wells located in Edison Park located just north of the Site between 1990 and 1994 (Orange County Integrated Waste Management District, 2003). The 1990 through 1994 years included both drought and very wet years.

Review of data presented in Figure 5-10 and Table 5-3 indicates that seasonal fluctuations do occur in the groundwater elevations across the Site. Gauging data collected on a monthly or quarterly interval, from October 2003 to December 2004, show that groundwater level elevations across the Site gradually increased through the wet season from October 2003 to March 2004, gradually declined in June 2004 and September through the dry season (although water levels in AW-4 continued to increase through June 2004), and then increased from September 2004 to December 2004. Seasonal fluctuations of groundwater levels in 2003 and 2004 ranged from approximately ¾ foot to 1¾ foot in the wells analyzed. Groundwater levels collected in December 2006 were within the range of those previously collected (Figure 5-9).

### **5.5.3 Groundwater Gradient Estimates and Interstitial Velocity Calculations**

#### ***5.5.3.1 Lateral Gradient Estimates and Interstitial Velocity Calculations***

Average groundwater gradients were estimated for various areas of the Site by using three point methodology. A general Site gradient that represents broad gradients in the middle portion of the Site was estimated using data collected from MW-15, AW-4 or AW-4A, and MW-16. Gradients for the southwestern portion of the Site, located

adjacent to the flood control channel, were estimated using wells AW-4 or AW-4A, AW-5, and B-4 or B-4A. Gradients were also calculated for the very northwestern portion of the Site where the steepest gradients have been observed and for the northeastern quadrant of the Site where the gradient is relatively flat. Wells NMW-1, GP-1, and MW-17 were used for the calculation in the NW portion of the Site and wells MW-4, GP-24, and MW-13 were used for the NE quadrant. Wells GP-22, MW-13 and MW-15 were used for the Southeast quadrant of the Site. The gradients for the different areas represent the range of gradients at the Site.

Groundwater data from October 2003 and December 2004 were used for the gradient estimates. October 2003 data represent groundwater conditions at the end of a dry season with generally the lowest groundwater conditions observed between 2002 and 2006. December 2004 data represent groundwater in a wet season and generally the highest groundwater elevation conditions observed between 2002 and 2006. Gradient estimates in feet/feet are summarized below.

Site Area	Wells	General Flow Direction	Gradient (Oct. 2003)	Gradient (Dec. 2004)
Middle Portion	AW-4(A), and MW-15 MW-16	NE	0.00077	0.00079
SW Area	AW-4(A), AW-5 and B-4(A)	NE to NNW	0.0009	0.0013
NW Area	NMW-1, GP-1, and MW-17	NW	0.006	0.007
NE Area	MW-4, GP-24 and MW-13	NE	0.0003	0.0005
SE Area	GP-22, MW-13 and MW-15	NW-NE	0.0005	0.0004

Groundwater gradients in the middle portion of the Site were estimated at 0.00077 and 0.00079. Relatively low gradients (0.0003 to 0.0005) occur in the northeastern portion of the Site. The highest gradients beneath the Site (0.006 and 0.007) are observed in the northwestern corner of the Site. Gradients were slightly higher in December 2004 than they were for October 2003, possibly suggesting slight gradient increases as groundwater levels increase.

Average interstitial groundwater velocities were estimated using the above estimated groundwater gradients and a published hydraulic conductivity (K) and effective porosity (p) for fine sand materials. Average interstitial velocities were calculated using the following formula:

$$V_a = K (dh/dl)/p$$

where:  $V_a$  = average interstitial velocity  
K = hydraulic conductivity  
dh/dl = gradient  
p = effective porosity

Using a K value of 8.2 feet/day (ft/day) and a p value of 0.23, reported by Todd (1976), and a groundwater gradient of 0.00077 to 0.00079, the average interstitial velocity in the middle portion of the Site (northeast flow direction) is estimated to be 0.03 ft/day or 10 feet a year, a relatively low rate. For the estimated gradients of 0.006 to 0.007 in the northwest corner of the Site (highest gradient), the average interstitial velocity is approximately 0.21 feet/day to 0.24 feet/day (approximately 75 to 90 feet per year).

#### ***5.5.3.2 Vertical Gradient***

The vertical groundwater gradient in the middle portion of the Site was evaluated using data acquired from MW-20 and P-4 (Figure 4-1). MW-20 is completed in the lower portion of the SPA from a depth of approximately 64 to 74 feet bgs. Piezometer P-4, located adjacent to MW-20, is screened across the water table from a depth of approximately 19 to 34 feet bgs. Water level elevations in MW-20 were measured to be approximately 1.1 to 1.5 feet higher than water level elevations in P-4 in March 2004, June 2004, September 2004, and December 2004.<sup>9</sup> This indicates that an upward vertical gradient is present in the middle portion of the Site. A potential vertical gradient may be calculated by dividing the potentiometric surface difference between the two wells (1.1 to 1.5 feet) by the difference of the elevation difference of the top of

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<sup>9</sup> Although P-4 contained product, the thickness of the product was negligible and not judged to have a significant impact on the groundwater elevation. Well MW-20 groundwater elevation data are not used in the potentiometric surface contouring.

MW-20 screen interval and the bottom of the P-4 screen interval (31.37 feet). This calculation indicates that the upward potential gradient is approximately 0.04 to 0.05 foot/foot.

### ***5.5.3.3 Potential Lateral and Vertical Conduits***

Potential lateral and vertical conduits in the subsurface that could increase the migration of contaminants in the groundwater include trenches for underground utilities and old well casings. There are no known underground utilities located below the groundwater surface that could serve as lateral conduits. DOGGR data indicate that four former oil wells are located on the property (see Section 2.4) and three have been abandoned. DOGGR records do not indicate that an oil well drilled in the 1920s in the area of Lagoon 5 was abandoned, but state that the well was converted to a water well. It is unlikely that these old oil wells provide a significant conduit for vertical migration because of the low mobility of the Site wastes and the presence of an upward vertical groundwater gradient, at least in the upper portion of the SPA. Nevertheless, Section 9.0 contains a recommendation to assess the presence of this old well.

## **5.6 Groundwater/Surface Water Interaction**

The only body of surface water near the Site is the Huntington Beach Flood Control Channel. The channel is located adjacent to the southwestern portion of the Site (Figure 2-1). To evaluate groundwater/surface water interaction between the surface water in the channel and the shallow groundwater beneath the Site, a tidal influence study was conducted. The study was conducted in general accordance with the Draft Groundwater Workplan dated March 10, 2003, and conditions specified in DTSC's letter dated April 28, 2003, and the RP's response to comment letter dated May 9, 2003. Results of the tidal study were previously submitted to DTSC in a letter report dated July 7, 2003 (GeoSyntec, 2003d), and the Groundwater RI/FS Workplan-Revision 1.0. The tidal study letter report is presented in Appendix E.

The tidal study was conducted between June 5, 2003, and June 13, 2003, for approximately 11,000 minutes. This period included intervals when the ocean tides (as predicted for Balboa Pier in Newport Beach) had a range of over 6 feet (spring tides). Two transducers were placed in standpipes installed within the Huntington Beach Flood Control Channel to collect channel water elevation data at locations shown on Figure 5-11. The vertical elevations of the standpipe locations were surveyed by Nunez

Engineering on June 17, 2003 (Appendix E). Transducers were also placed in Site wells AW-4, AW-5, B-4, and MW-9 (Figure 5-11) to collect groundwater level data. One transducer was placed onsite to collect barometric pressure readings.

The results of the tidal influence study are summarized in Figure 5-12. The electronic data and the spread sheet calculations made to estimate the elevations of groundwater and channel water are presented in Appendix E on a CD. Water level elevations are reported in feet above mean sea level (MSL). The significant results of the tidal influence study are as follows.

- Both channel measuring points (“Channel Standpipe” and “Bridge Standpipe”) showed approximately the same amount of water level fluctuation. The fluctuation was clearly in response to tides. The greatest fluctuation (>4 feet) occurred on June 12<sup>th</sup> and June 13<sup>th</sup> (near the end of the test) during a period when ocean tides at Balboa Pier in Newport Beach showed an approximate 6 feet of difference from high to low tide. This indicates that water level fluctuation in the channel is muted somewhat compared to fluctuation in the ocean, as would be expected in a restricted channel inland of the beach. Nevertheless, water levels in the channel are clearly influenced by tides.
- As shown on Figure 5-12, groundwater levels fluctuated in the monitoring wells during the test. Groundwater levels in all four wells responded in a similar manner throughout the monitoring period. Close inspection of the data indicate both a general decline of water levels in all wells over the monitoring period, as well as short-term fluctuations on the order of ½ to 1 day in duration with a magnitude of less than 0.2 feet. The data do not indicate a clear relationship between the observed short-term groundwater fluctuations and the tidally influenced water levels in the channel. Instead, the groundwater fluctuations coincide more closely with changes in barometric pressure that occurred over the monitoring period. Even if some of this fluctuation was caused by tidal influence, the magnitude of that influence is minimal (< 0.2 feet) and less than the seasonal fluctuations discussed in 5.5.2.
- The water level fluctuations in the channel did not significantly affect the groundwater flow direction beneath the western portion of the Site that is adjacent to the channel. As shown on Figure 5-12, the groundwater levels in

all Site wells responded in a similar manner throughout the monitoring period. Although the absolute elevation of groundwater changed during the monitoring period, the relative elevation did not change significantly. The groundwater flow direction as measured in the 4 wells remained relatively constant (north to northeast).

- Data collected during the tidal study clearly indicate that site groundwater does not discharge into the channel. Groundwater elevations were approximately 1 to 2 feet lower than water levels in the channel throughout the monitoring period. This relationship indicates that “losing stream” conditions occur in the channel; that is, the channel discharges to shallow groundwater.

In summary, the recent tidal influence study indicates: (1) groundwater does not discharge to the channel; and, (2) the groundwater flow direction continues to be away from the channel.

## **6. NATURE AND EXTENT OF GROUNDWATER CONTAMINATION**

### **6.1 Historical Monitoring Well Data (Pre- Year 2002)**

Groundwater analytical data were collected previously at the Site by the following investigators:

- Ecology and Environment -1982;
- Woodward Clyde Consultants -1983;
- Radian - 1988;
- ISCO - 1991; and
- ESE - 1997.

The wells sampled during the above investigations are tabulated in Table 4-2. All data up to and including the 1997 ESE data are summarized in the RI prepared by ESE in 1997 (ESE, 1997) and are tabulated and presented in Appendix H (Tables H-1 through H-4). The 1997 ESE report indicates the Radian, ISCO/ITARA, and ESE data were collected under QA/QC procedures, and that the WCC/E&E 1982-1983 data were likely collected under a QA/QC plan. As described in ESE (1997), the data known to be collected under a QA/QC plan generally met the data quality objectives, and the data appeared adequate to characterize contamination in groundwater at the Site.

The historical analytical results include a round of groundwater sampling conducted in February 1997. ESE (1997) reported that cross-contamination problems occurred during this event. Due to the cross-contamination problems, a re-sampling event was conducted in March 1997. Consequently, February 1997 data as reported in Appendix H are not considered representative of Site conditions.

Based on review of the historical data and the fact that a large amount of data were recently collected between 2002 and 2006, use of the more recent groundwater data for the health risk assessment (Section 7.0) is appropriate. Rationale for this decision is as follows:

1. The 2002-2006 data are more representative of current baseline conditions.
2. The 2002-2006 data include a large network of wells with a broad areal distribution across the Site and, therefore, are more representative of Site conditions.



3. The recent results include five monitoring events that used low flow sampling techniques and more stringent field QA/QC procedures than are believed used for previous data.
4. Laboratory QA/QC procedures are likely better for the most recent sampling events.

Based on this rationale, historical groundwater results (pre-2002) will not be used quantitatively for the health risk assessment presented in Section 7.0. DTSC approved this approach in their letter dated November 12, 2004, addressed to PNL.

## **6.2 CPT Data**

Tables B-1 through B-4 in Appendix B present data collected from 26 CPT borings completed in 1997 and 2002 by ESE and PNL, respectively. The locations of the CPT borings are presented in Figure B-1 (Appendix B). Generally, data collected from “grab water samples” or hydropunches in CPT borings are considered preliminary and are used for screening and/or planning purposes. Consequently, the groundwater data collected from the CPT borings will also not be used quantitatively in the risk assessment. However, it should be noted that the CPT data were used to locate three offsite wells, MW-16, MW-17, and MW-18, during the 2002 PNL investigation.

## **6.3 Recent Analytical Results (Year 2002 through 2006) From Monitoring Wells and Piezometers**

Recent analytical results include the 2002 PNL data that were collected between June 2002 and August 2002, the 2004 Geosyntec data collected during four quarters of sampling between January 2004 and December 2004 and the Geosyntec data collected during December 2006. The 2002 PNL data were collected under a DTSC approved workplan (PNL, 2002b) and were previously presented in the GARFR (PNL, 2002a) and the Groundwater RI/FS Workplan-Revision 1.0. The 2004 and 2006 data were collected under procedures presented in the Groundwater RI/FS Workplan-Revision 1.0 and the Addendum Workplan for Additional Groundwater Monitoring dated November 14, 2006. The 2004 and 2006 data have been previously reported in five Geosyntec

quarterly monitoring reports (GeoSyntec 2004b, GeoSyntec 2004c, GeoSyntec 2004d, GeoSyntec, 2005a, and Geosyntec, 2007)<sup>10</sup>.

The following discussions of groundwater quality summarize data collected during sampling events conducted in 2002 through 2006.

### **6.3.1 TDS and Major Cations and Anions**

As previously noted in Section 5.1, groundwater beneath the Site is degraded as a result of seawater intrusion. General mineral results including TDS concentrations collected during the first quarter 2004 are summarized in Table 6-1. General mineral results show that the shallow groundwater beneath the Site contains very high TDS concentrations (up to approximately 80% of typical concentrations in seawater). Concentrations of chloride, sulfate, and TDS in the Site groundwater are generally well above their respective MCL for drinking water (Table 6-1). TDS concentrations ranged from 4,600 milligrams per liter (mg/l) to 26,000 mg/l, chloride concentrations ranged from 1,400 mg/l to 13,000 mg/l, and sulfate concentrations ranged from 46 mg/l to 1,900 mg/l. Figure 6-1 shows that the highest TDS concentrations (above 20,000 mg/l) were detected in the southwestern portion of the Site in wells AW-4A, NMW-2, and MW-9 (generally near the Huntington Beach Flood Control Channel). The lowest TDS concentrations (below 10,000 mg/l) were detected in wells located far from the Huntington Beach Flood Control Channel (MW-16, MW-17, MW-18, MW-20, and AW-1). The major cation and anion in the groundwater are sodium and chloride, respectively.

Recent TDS results are consistent with previous sampling by ESE (1997) that showed TDS concentrations measured in 9 onsite wells ranged from 5,100 mg/l to 23,000 mg/L (Appendix H, Table H-3). The average concentration was approximately 14,000 mg/l.

The high TDS concentrations observed across the Site are the result of regional seawater intrusion into groundwater at the Site. TDS, sodium, and chloride concentrations are relatively higher in the southwestern portion of the Site that is adjacent to the Huntington Beach Flood Control Channel (Figure 6-1). A water sample collected in the Huntington Beach Flood Control Channel in December 2004 indicated

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<sup>10</sup> The report limits for VOCs originally reported in GeoSyntec 2004b, GeoSyntec, 2004c and GeoSyntec 2004d were revised (see Section 6.3.6).

that the TDS concentration of water in the channel was 33,000 mg/l (Table 6-2). The sodium and chloride concentrations in the channel were measured at 9,600 mg/l and 19,000 mg/l, respectively (Table 6-2). The occurrence of relatively high TDS groundwater adjacent to the channel is consistent with the interpretation that the Huntington Beach Flood Control Channel discharges to the SPA in this area of the Site (Section 5.6).

The above results for the channel water are consistent with results from a previous investigation. Ecology and Environment (1983) collected two water samples from the Huntington Beach Flood Control Channel and analyzed the samples for sodium. Sodium concentrations in the two samples were detected at 12,100 mg/l and 15,700 mg/l indicating relatively high TDS concentrations in the channel water.

### **6.3.2 Metals**

Analytical results for metals are presented in Table 6-3. Each of the metals, except beryllium, cadmium, lead, mercury, and silver, was detected in at least one of the groundwater sampling locations. Generally, with the exception of barium and selenium, dissolved metal concentrations in the onsite shallow groundwater were not significantly elevated, although concentrations of antimony and arsenic were detected slightly above the MCL in several monitoring locations

Barium concentrations in MW-20 (deep well) and B-4/B-4A were higher than concentrations of other wells. Barium in B-4 was detected at 1,200 ug/l in 2002. Barium in B-4A was detected at much lower concentrations (170 ug/l to 340 ug/l) during four subsequent sampling events completed in 2004, but was detected at 1,200 ug/L in December 2006. Barium concentrations in the deep monitoring well MW-20 ranged from 1,700 ug/l to 2,000 ug/l during the four quarters of 2004, which is above the MCL of 1,000 ug/l (Table 6-3). Elevated barium concentrations were not detected in any other well located on the Site. The high barium concentrations in MW-20 are likely to be representative of deeper groundwater quality, given the lower concentrations present in the shallow groundwater.

Concentrations of selenium varied across the Site. Selenium concentrations were not detected during the 2002 sampling but were detected as high as 140 ug/l during the 2004 sampling events and above the selenium MCL of 50 ug/l in 17 of 23 of the wells sampled during at least one of the sampling rounds. The highest concentrations of

selenium were generally found in the monitoring locations in the western portion of the Site, including AW-4A, NMW-2, B-4A, GP-1, and MW-9 (Figure 6-2). Selenium concentrations in these monitoring locations ranged from 59 ug/l to 140 ug/l, with the highest concentration being detected in GP-1 in September 2004. Selenium concentrations above 100 ug/l were detected at least once in each of these five monitoring wells. The lowest concentrations of selenium (3.8 ug/l to 34 ug/l) occurred in the more downgradient wells, MW-16 through MW-19, and MW-4 (Figure 6-2). Relatively low selenium concentrations also occurred in monitoring well MW-20. Slightly elevated (51 ug/l to 75 ug/l) and moderately elevated selenium concentrations (76 ug/l to 99 ug/l) were detected during one or more monitoring events in the remainder of the monitoring locations (Figure 6-2). The more moderate elevated selenium concentrations generally occurred in the middle or eastern portions of the Site.

There is no significant evidence that the high selenium concentrations in the groundwater are associated with the waste material at the Site. Selenium is found in crude oil, with some crude oils containing more selenium than others. However, high selenium concentrations have not been detected in the Site waste materials. Selenium was generally not detected in pit wastes or lagoon waste materials during the Radian investigation (Radian, 1988). Results of the recent NAPL investigation indicate that selenium was not detected in five NAPL samples collected across the Site (see Section 6.4.2).

There are several possible explanations for the high selenium concentrations in the groundwater beneath the Site. The most likely explanation is that the source of the selenium is seawater recharge from the Huntington Beach Flood Control Channel. The Huntington Beach Flood Control Channel discharges into the shallow groundwater beneath the Site (see Section 5.6) and, based on a channel sample collected in December 2004, contains elevated selenium concentrations (89 ug/l, see Table 6-2). A seawater source of selenium also would explain why concentrations are generally higher in the western portion of the Site that is located directly adjacent to the channel (Figure 6-2).

A second explanation, or possible contributing factor, is that the selenium may be naturally occurring and associated with the clay layer that extends across the Site. Selenium can naturally occur in clay and peat deposits that were formed in oxygen deficient environments such as estuarine or marsh environments. If oxygenated groundwater comes into contact with the geologic materials that contain the selenium

(in this case the clay materials beneath the Site) then the selenium may oxidize into a more soluble state and remobilize to the groundwater (Hibbs, 1999-2000). This type of scenario may also explain why selenium concentrations are higher in the western portion of the Site because the SPA is being recharged from oxygenated surface water occurring in the Huntington Beach Flood Control Channel adjacent to this portion of the Site.

Antimony and arsenic have also been detected slightly above their respective MCLs (6 ug/L and 10 ug/L) in a few monitoring wells. The detections of concentrations above MCLs in these wells are inconsistent and appear to be relatively localized. As shown in Table 6-3, antimony was detected slightly above the MCL in three monitoring wells (AW-2, B-4, and MW-4) in the June 2002 monitoring event. Antimony was not detected above the MCL in these wells or any other well in the subsequent five monitoring events completed in 2004 and 2006.<sup>11</sup>

Arsenic was detected above the MCL in three monitoring well locations (Table 6-3). Arsenic was detected at a concentration of 16 ug/l and 11 ug/L in B-4A in June 2004 and December 2006, respectively, at a concentration of 26 ug/L in GP-24 in June 2004, and at a concentration of 11 ug/L in MW-13 in December 2004.

The above described detections of arsenic and antimony exceeding the MCLs are not considered to be related to Site waste. This conclusion is supported by:

- The detections are widely distributed and not consistently found related to other Site chemicals of potential concern. For example, if the source of the metals were Site wastes, one would also expect to see consistently elevated VOCs (more easily transported than metals) associated with the elevated detections at all locations, which is not observed (see Section 6.3.3).
- The elevated detections of arsenic and antimony are not consistent temporally.

It is likely that the elevated arsenic and antimony detections are related to localized (areally and temporally) groundwater conditions affected by the extremely high TDS groundwater present beneath the site.

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<sup>11</sup> Only B-4A, B-7, and AW-2 were sampled for metals in December 2006.

### 6.3.3 VOCs

Table 6-4 summarizes VOCs detected in onsite and offsite monitoring locations. Figures 6-3 through 6-8 summarize the aerial distribution of VOC detections in onsite and offsite wells. VOCs were detected in three wells in 2002, four wells in the 1<sup>st</sup> quarter of 2004, five wells in the 2<sup>nd</sup> quarter of 2004, 10 wells in the 3<sup>rd</sup> quarter of 2004, six wells in the 4<sup>th</sup> quarter of 2004, and two wells in December 2006.

VOCs were generally detected at low levels (i.e., below 10 ug/l) and in onsite wells. VOCs detected at concentrations above 10 ug/l included 1,2,4-trimethylbenzene, benzene, ethylbenzene, sec-butylbenzene, isopropylbenzene, naphthalene, m,p,o-xylene, and toluene. The higher VOC concentrations were measured in three onsite wells--AW-5, B-4/B-4A, and B-7 (Figures 6-3 through 6-8). AW-5 and B-4/B-4A are located in the southwest portion of the Site, and B-7 is located in the southeast portion of the Site adjacent to Pit F.

Only two VOCs were detected above MCLs (Table 6-4). The compound 1,4-dichlorobenzene was detected slightly above the MCL in monitoring well NMW-1 during the PNL 2002 sampling event. Benzene was detected above the MCL in well MW-9 during the 3<sup>rd</sup> quarter 2004 and in monitoring well B-4/B-4A during all six sampling events conducted from 2002 to the end of 2006.

Figures 6-9 through 6-11 show concentrations through time of the elevated VOCs discussed above in Wells AW-5, B-4/B-4A, and B-7<sup>12</sup>. The figures also show total VOC concentrations. The following general observations can be made:

- VOC concentrations have generally decreased in AW-5 from March 2004 through December 2006 (Figure 6-9); and
- Overall VOC concentrations in B-7 and B-4/B-4A were higher in 2002 than in 2004, but increased in 2006 (Figures 6-10 and 6-11).
- During the quarterly monitoring program conducted in 2004, VOC concentrations in B-7 and B-4A increased from March 2004 through

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<sup>12</sup> Data collected from monitoring locations AW-5, B-4/B-4A, and B-7 were selected for graphing because the highest VOC concentrations were detected at these locations.

September 2004 and then sharply decreased in December 2004 (Figures 6-10 and 6-11).

VOCs have not been detected in any offsite wells with one exception: Chloromethane was detected in offsite well MW-19 during the 3<sup>rd</sup> quarter of 2004 at the relatively low concentration of 2.5 ug/l (Figure 6-6). Chloromethane was not detected in MW-19 in subsequent groundwater sampling events completed in December 2004 and December 2006. Chloromethane is not a significant contaminant in onsite monitoring wells. Chloromethane was detected at 1.7 ug/l in only one onsite well, GP-12, during the 2<sup>nd</sup> quarter sampling event. Thus, at this time, the detection of chloromethane in MW-19 is assumed not to be related to the Site. Chloromethane will continue to be monitored in MW-19 during future sampling events.

#### **6.3.4 SVOCs**

Table 6-5 and Figure 6-12 summarizes SVOCs detected in onsite and offsite monitoring locations. SVOCs were detected at only two onsite monitoring well locations, B-4/B-4A and B-7. SVOCs 2,4-dimethylphenol and 2-methylphenol were detected in B-4/B-4A at concentrations ranging from 97 ug/l to 1500 ug/l and 37 ug/l to 2100 ug/l, respectively (Table 6-5). The highest SVOC concentrations in B-4A were detected in December 2006 (Table 6-5). Benzoic acid was detected only once in B-7 at a concentration of 20 ug/l during the second quarter 2004 sampling event. Naphthalene was detected at a concentration of 20 ug/L in B-7 and 30 ug/L in B-4/B-4A<sup>13</sup> in December 2006 (Table 6-5). The detected SVOCs do not have MCLs.

#### **6.3.5 Emergent Compounds**

Results for 1,4-dioxane, NDMA, perchlorate, and chromium VI are summarized in Table 6-6. The compound 1,4-dioxane was detected in five wells (AW-4A, B-4A, B-7, GP-1, and MW-13) located on the Site at low concentrations. The highest 1,4-dioxane concentration detected was 3.5 ug/l in a sample collected from well GP-1. Figure 6-13 summarizes the 1,4-dioxane concentrations detected at the Site.

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<sup>13</sup> Naphthalene was measured as a VOC in B-4/B-4A.

NDMA was detected at a very low concentration (0.0021 ug/l, just above the detection limit) in a sample collected from MW-17 in the first quarter of 2004. NDMA was not detected at any other location nor was it detected in MW-17 in the 2<sup>nd</sup> quarter of 2004 (Table 6-6).

Chromium VI and perchlorate were not detected in any groundwater samples collected at the Site. However, some of the chromium VI sample analyses were rejected due to matrix interference problems (Table 6-6).

### **6.3.6 TPH**

PNL collected samples from 16 wells for Total Petroleum Hydrocarbon (TPH) analyses in June through August 2002. A summary of the results is presented in Table 6-7. TPH was detected in only one well at a relatively low concentration: 0.65 mg/l in well B-6.

### **6.3.7 QA/QC Results for 2004 Quarterly and December 2006 Monitoring Events**

Field and laboratory QA/QC procedures were conducted in general accordance with the Groundwater RI/FS Workplan-Revision 1.0. Field QA/QC results, including results for duplicate samples, equipment blanks, field blank and trip blank samples, were summarized in the quarterly monitoring reports (GeoSyntec 2004b, GeoSyntec 2004c, GeoSyntec 2004d, GeoSyntec, 2005a) and Geosyntec, 2007.<sup>14</sup> During the 2004 and 2006 monitoring events, a total of 10 duplicate samples, 10 equipment blanks, 10 field blanks, and 39 trip blanks were collected. The QA/QC sampling results are summarized as follows:

- Comparison of the primary and duplicate sample results indicates that the reported concentrations in the two samples are reasonably similar.
- Equipment blanks were analyzed for VOCs and SVOCs. Laboratory results indicate that chloroform (1.2 ug/l) was detected in an equipment blank collected in the second quarter of 2004 and naphthalene (1.1 ug/l) was detected in one equipment blank collected in the third quarter of 2004. No

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<sup>14</sup> The report limits for VOCs originally reported in GeoSyntec 2004b, GeoSyntec 2004c, and GeoSyntec 2004d were revised (see Section 6.3.3). Consequently, some VOCs now shown to be detected in equipment blanks, field blanks, and trip blanks were not previously reported (see discussion below).



other VOCs were detected in the ten equipment blanks analyzed. No SVOCs were detected in the equipment blanks analyzed except for bis(2-ethylhexyl)phthalate (11 ug/L) and di-n-butylphthalate (2.9 ug/L) detected in the first equipment blank collected in the December 2006 monitoring event. Concentrations of these two SVOCs were also detected at the same levels in seven monitoring wells sampled within two days of the collection of the equipment blank. Consequently, concentrations of these SVOCs in these seven wells were considered to be the result of equipment contamination and are considered to be non-detect.

- Field blanks were analyzed for VOCs. Laboratory results indicate that chloroform (1.2 ug/l) was detected in a field blank collected in the second quarter 2004. No other VOCs were detected in the ten field blanks analyzed.
- Trip blanks were analyzed for VOCs. Laboratory results indicate that no VOCs were detected in any of the 39 trip blanks analyzed during 2004 with the exception of a detection of naphthalene (1.4 ug/l) in trip blank TB-04 analyzed in the 3rd quarter of 2004.

In general, the QA/QC results demonstrate that the data are acceptable. The results indicate that field and laboratory methodology produced reasonably reproducible results and that field and laboratory decontamination procedures were sufficient.

A review of Reporting Limits (RLs) during the quarterly monitoring program indicated that the laboratories target RLs used for the EPA Method 8260B for VOCs did not meet the RLs specified in the Groundwater Remedial Investigation/Feasibility Study Workplan-Revision 1.0 for the first three quarters of sampling in year 2004. The laboratory, Del Mar Analytical, indicated that the VOC data originally reported were done so using the laboratory's standard level RLs. After discussions with DTSC, Geosyntec requested that Del Mar Analytical review the previous laboratory reports and evaluate lowering RLs in accordance with EPA Method 8260B methodology. Subsequently, Del Mar Analytical reviewed the laboratory information and lowered the RLs by reviewing each calibration curve for the data. RLs in the workplan were met except in three cases: (1) sample collected from B-7 during Quarter 2; (2) sample collected from GP-12 in Quarter 3; and (3) sample collected from GP-24 in Quarter 3. In all three cases the high RLs were not the result of inadequate calibration standards, but due to the fact that the samples were diluted due to either high VOC concentrations

(case 1) or matrix interference problems (cases 2 and 3). The revised laboratory reports were submitted to DTSC with Geosyntec's letter dated December 14, 2004 (GeoSyntec, 2004f). Data in Table 6-4 reflect the revised RLs.

Laboratory QA/QC results were presented in each laboratory report prepared by Del Mar Analytical. Level II data validation was performed on all 2004 and 2006 laboratory reports following guidance in *USEPA National Functional Guidelines for Organic and Inorganic Data Review, EPA SW846 and Standard Methods*. Results of the Level II validation are presented in Appendix D for the four quarters of sampling conducted in 2004. Data qualifiers indicated in these reports are summarized in the data tables (Tables 6-1 through 6-6).

## **6.4 Non-Aqueous Phase Liquids (NAPL)**

### **6.4.1 NAPL Distribution**

NAPL thickness in Site monitoring locations was gauged periodically from 2002 to 2006, as summarized in Tables 5-1 and 5-2. The viscosity of the NAPL in the Site monitoring wells is generally high (see Section 6.4.3) and characterized by field staff as very "sticky." As a result, the NAPL coats the surface of the field interface probe used for NAPL measurements, which often precludes the detection of water beneath the NAPL. Consequently, the accurate measurement of NAPL thickness in many of the Site wells has been difficult, but the general observation of the absence or presence of NAPL in the wells was always possible. Figure 6-14 presents the distribution of monitoring locations where NAPL was detected or observed at the Site in December 2004 when the full monitoring network was in place (i.e., pre 2005 Emergency Action). In December 2004, NAPL was detected at 18 of 59 locations across the Site. Trace amounts of NAPL (where NAPL is observed on the field interface probe but not detected by the interface probe) were observed in an additional four locations (Figure 6-14). NAPL was not detected in any offsite locations (Table 5-2 and Figure 6-14).

NAPL thickness measurements at monitoring locations, where measurements were obtainable, are presented in Tables 5-1 and 5-2. Monitoring wells with the largest measured NAPL thickness in December 2004 were P-1 and P-8. P-1 contained 3.5 feet of NAPL and P-8 contained 3.17 feet of NAPL (Table 5-2). Other wells that have had more the one foot NAPL in the past include B-2 (2.81 feet in June 2003) and GP-2 (1.5 to 5.94 feet from August 2002 to October 2002).

Enhanced or anomalous NAPL thickness in wells relative to NAPL thickness in the adjacent formation is well documented. Consequently, the NAPL thicknesses measured in the Site monitoring wells, as cited above, is not considered representative of actual NAPL occurrence in the soil formations beneath the Site. It is very likely that to a large extent the NAPL beneath the Site subsurface occurs above the groundwater surface of the SPA and that the presence of the NAPL in most of the monitoring wells is likely an artifact of well construction. This premise is discussed below in more detail.

It is well documented that NAPL thickness in monitoring wells is a poor indicator of product thickness in the adjacent formation (CONCAWE, 1979, Hall et. al, 1984, Blake and Hall, 1984, and Abdul et. al., 1989). Generally, NAPL thickness in wells is significantly larger than the thickness of NAPL-impacted soils in the formation. In unconfined systems, the enhanced petroleum accumulation in wells is produced by NAPL accumulation on top of the capillary fringe above the free water table and the subsequent migration of NAPL into the wells which act as “holes” in the capillary fringe. In confined systems, NAPL can accumulate on top of confining beds and then accumulate in the well if the well seal does not extend down to the top of the confining bed. In such cases, the well can act as a “hole” in the confining bed or as a NAPL collection “sump.” This latter model (confined system) is likely a good depiction of what is occurring at the Ascon Site.

Figure 6-15 (a-e) presents a cross-section of wells considered to be completed in the SPA where NAPL has been observed or measured. The figure illustrates the relationship between lithology, monitoring well construction, NAPL occurrence, and groundwater. The figure shows that significant occurrences of waste material or impacted soils (i.e., visual evidence of impacts such as staining and observations of free-phase hydrocarbons) in the Site subsurface is generally above or in the top portions of the clay/silt layer that extends across the Site. As discussed in Section 5.3.3 and shown on Figures 5-5 through 5-7, the clay/silt layer acts as a confining layer, and first groundwater in the SPA appears to occur at or near the base of the clay/silt layer. Observations of hydrocarbon staining or NAPL (free product) were generally not observed in the SPA. The main exception to this observation is the Pit F area where relatively significant Pit F contamination appears to occur in the SPA (Figure 6-15d). NAPL from Pit F has either migrated through the clay layer or the bottom of Pit F is below the silt/clay layer. It should also be noted that in the case of P-6 and P-9 the clay/silt layer does not appear to be present (P-6) or is thin (P-9), and consequently, oil saturated waste appears to occur directly on top of the SPA (Figures 6-15c and 6-15d).

The occurrence of NAPL in well B-2 is anomalous. Based on logs, B-2 was completed in the SPA with the seal extending well below the clay/silt layer and well below any contaminated materials or waste (Figure 6-15a and boring log in Appendix A). It is likely that either NAPL flowed into the open borehole before the well was constructed or that the monitoring well was not constructed properly. Nearby well NMW-1, which was completed with a conductor casing adjacent to the zone of contamination does not have NAPL.

Observations of NAPL occurring on top of groundwater in numerous SPA monitoring wells may be artifacts of well construction, and it is likely that in almost all areas of the Site NAPL occurs above the confined groundwater. With the exceptions discussed above, Site monitoring wells completed in the SPA and containing NAPL are completed through the waste material and through the clay/silt layer. Most monitoring wells have been constructed in a way that the cement/bentonite seal does not extend below the top of the clay/silt layer (Figure 6-15a-e). As a consequence, the well acts as a “hole” in the fine-grained confining layer (i.e., clay/silt layer), which allows NAPL to migrate through the well annulus and then to the groundwater surface in the well. Figure 6-16 shows a schematic diagram depicting a model of how NAPL could migrate into a well that intersects the waste material and the fine-grained confining bed.

In summary, in December 2004, NAPL was measured or observed in 22 of 59 monitoring locations. Sixteen of these locations are wells considered to be completed in the SPA. NAPL was not detected in any offsite locations. With several exceptions (Pit F area, P-6, and P-9) the NAPL is inferred to be present above the clay layer at the site.

#### **6.4.2 NAPL Chemical Laboratory Analyses**

NAPL samples were collected during the December 2004 monitoring event from P-1, P-4, P-5, P-6, and P-8 and analyzed for metals, VOCs, and pH. NAPL samples collected from P-1 and P-6 were analyzed for SVOCs. Laboratory reports for the NAPL samples are presented in Appendix I. Table 6-8 summarizes detected metal concentrations in the NAPL samples. The metals arsenic, barium, chromium, lead, nickel, vanadium, and zinc were detected in one or more of the NAPL samples. The pH of the NAPL samples ranged from 5.1 to 7.0 (Table 6-8).

Table 6-9 summarizes VOCs detected in the NAPL samples. The VOCs detected are petroleum hydrocarbons and are commonly found in crude oils and other petroleum fractions.

SVOC data for the two samples analyzed are presented in Appendix I. SVOCs were not detected in any sample.

#### **6.4.3 NAPL Chromatograms and Physical Sample Analyses**

NAPL samples collected from P-1, P-5, P-6, and P-8 were fingerprinted, and the results were interpreted by Dr. L.W. Slentz of PTS Laboratories. Dr. Slentz concluded that the four samples analyzed were similar in overall composition and are mixtures of a least three or more oil field products—gasoline or gasoline-ranged hydrocarbon, diesel, native crude oil, and a kerosene-like fraction. This interpretation is consistent with the disposal history of the Site including the possible disposal of oil-based drilling muds. Results of the fuel fingerprinting analyses are presented in Appendix I.

Physical analyses including interfacial/surface tension, specific gravity, density, and viscosity were also conducted on the NAPL samples collected from P-1, P-5, P-6, and P-8 (Appendix I). Results indicate that the specific gravity of the samples ranged from 0.9434 to 0.9842 at 70° F and viscosity ranged from 426 to 12,241 centipoise at 70° F. The viscosity range of the samples is considered high which limits the overall mobility of the NAPL materials.

#### **6.5 Lateral and Vertical Extent of Dissolved and NAPL Contamination in Groundwater**

Available information indicates that the occurrence of VOC and SVOC contamination is limited to the Site area and does not extend past the Site boundaries. The lateral extent of dissolved phase contamination may be estimated by reviewing the areal distribution of VOCs and SVOCs (Figures 6-3 through 6-8 and Figure 6-12). The detection of relatively elevated VOC concentrations on the Site is generally limited to localized areas, specifically AW-5, B-4/B-4A, and B-7, and SVOCs have been detected in only two wells on the Site, B-4A and B-7 (Figure 6-12). Concentrations of dissolved phase VOC and SVOC contaminants in wells downgradient of these wells and wells located on the hydraulically downgradient boundaries of the Site (northern and eastern boundaries along Hamilton and Magnolia Avenues) including wells AW-8, MW-4, AW-3, MW-13, AW-1, AW-1A, and MW-15, have been relatively low or below

detection limits. In addition, dissolved phase VOC and SVOC contaminants have not been detected in any offsite wells (MW-16 through MW-19), with the exception of the detection of chloromethane at a low concentration (2.5 ug/l) in MW-19 (Figure 6-6) and a very low detection of NDMA in MW-17 (Table 6-6). Based on the available information, the lateral extent of the significant dissolved phase contamination is limited to localized areas of the Site and does not extend offsite.

As discussed in Section 2.2 waste materials have been present on the Site since approximately 1938, when the Site was first used as a landfill. The facts that wastes have been present on the Site for a long period of time and that significant groundwater contamination is localized with no evidence of offsite migration indicate that contaminant transport is being impeded. The relatively small amount of significant dissolved phase contamination is likely attributable to a combination of factors including: (1) the presence of the clay/silt layer that extends across the Site; (2) the confined or semi-confined nature of the groundwater occurring beneath the Site; and (3) the apparent occurrence of contaminant attenuation in the groundwater. As discussed in Section 5.3, a fine-grained clay/silt layer generally occurs across the entire Site with the possible exception of some localized areas, such as the area directly east of Lagoon 1 and 2 in the vicinity of GP-13 and P-6 (see Figures 5-5 and 5-6). The fine-grained unit appears to effectively impede the migration of the waste materials to the confined groundwater in the SPA in most areas of the Site. In some areas where contaminants have apparently migrated through the fine-grained unit, such as the locations of B-4A and B-7 (Pit F area), the concentrations of VOCs are laterally limited. This is likely due, in part, to the attenuation of these contaminants through adsorption of the contaminant on saturated soil materials and/or some component of biodegradation.

The vertical extent of dissolved phase contamination is also limited. No VOCs or SVOCs have been detected in the deep monitoring well MW-20. The upward vertical gradient in the SPA beneath the Site is likely the main contributing factor in limiting the vertical extent of dissolved phase contamination in the SPA (see Section 5.5.3.2).

As discussed in Section 6.4.1, the lateral and vertical extent of NAPL is limited to the Site area. No NAPL has been detected in the offsite wells (Figure 6-14). The lack of NAPL in offsite wells is likely attributable to a combination of factors including the presence of the fine-grained clay/silt layer discussed previously and the relatively low mobility of the NAPL. The clay/silt layer that occurs across the Site appears to effectively impede the migration of NAPL to the groundwater in the SPA. In addition,

the NAPL is relatively immobile in water saturated formations. The vertical extent of NAPL in groundwater is further limited by its lower specific gravity/density compared to the groundwater.

## 7. RISK ASSESSMENT

### 7.1 Introduction

The objective of the risk assessment is to evaluate potential baseline health risks associated with chemicals detected in groundwater at the Site. Baseline risks for the soil/waste operable unit have been evaluated previously in the soil/waste RI (ESE, 1997). The results of the risk assessment can be used to identify chemicals and exposure media that may pose an unacceptable risk to current and/or future receptors at the Site and to provide information for remedial planning. This risk assessment was prepared as part of the Groundwater RI to evaluate potential exposures and “define risks to public health and the environment” related to groundwater, as required by the Consent Order, and to subsequently provide information for the FS.

The overall approach used in the risk assessment is based on United States Environmental Protection Agency (USEPA, 1989; 1991a; 1991b; 1997a; 2000; 2002) and Cal-EPA guidance documents (1999; 2004a, 2004b). The risk assessment consists of five major components organized in the following manner:

- **Data Review and Evaluation:** A review of available data to characterize the Site and identify data gaps; to define the nature and extent of environmental contamination identified at the Site; and to identify Site-related chemicals of potential concern (COPCs) (defined as potentially hazardous chemicals associated with the Site that are present at concentrations higher than background levels).
- **Exposure Assessment:** An assessment of the magnitude, frequency, duration, and routes of potential human exposure to Site-related COPCs. The exposure assessment considers both current and likely future Site uses and is based on complete exposure pathways to actual or probable human receptors (i.e., general groups that could come in contact with Site-related COPCs). The exposure scenarios are summarized in the Conceptual Site Model (CSM), which includes the sources, affected media, release mechanisms, and exposure pathways for each identified receptor population.



- **Toxicity Assessment:** A presentation of available information to identify the nature and degree of toxicity and to characterize the dose-response relationship (the relationship between magnitude of exposure and magnitude of potential adverse health effects on each receptor) for each COPC.
- **Risk Characterization:** A synthesis of exposure and toxicity information to yield quantitative estimates of potential cancer risks and noncancer hazards to defined receptor populations.
- **Uncertainty Analysis:** A discussion of the uncertainties associated with each of the four previous steps to assist decision-makers in evaluating the risk assessment results in the context of the assumptions and variability in the data used.

Because the Site is currently undeveloped, this risk assessment quantitatively addresses potential groundwater chemical exposures to hypothetical onsite future residents and commercial workers if the Site is redeveloped for these purposes. Potential offsite exposures are addressed qualitatively based on the results of the onsite evaluation. This groundwater risk assessment focuses on the evaluation of the incremental baseline risks associated with dissolved phase chemical concentrations in groundwater. As mentioned above, the soil/waste media have been previously evaluated in the soil/waste RI.

## **7.2 Data Evaluation/Chemicals of Potential Concern**

Many groundwater investigations have been conducted at the Site over the last approximately 20 years. As presented in these previous Site investigation documents, onsite groundwater has been impacted by TPH, SVOCs, VOCs, and metals. As discussed in Section 6.0, one round of groundwater monitoring was conducted in 2002 and five rounds of sampling have been conducted in 2004 and 2006. The results of the recent groundwater monitoring confirmed historical groundwater monitoring results in that onsite groundwater contains TPH, SVOCs, VOCs, and metals. As discussed in Section 6.1, these more recent groundwater data collected in 2002, 2004, and 2006 better reflect the current groundwater condition and therefore have been used to evaluate potential health risks associated with chemicals in groundwater at the Site.

COPCs were identified using the above referenced dataset. COPCs are defined as chemicals clearly associated with the Site, which are present in concentrations higher

than background levels. For purposes of the risk assessment, all organic chemicals detected in at least one groundwater sample were considered in the COPC selection process. Elevated concentrations of metals were evaluated in Section 6.3.2.

As discussed below, the groundwater to indoor air pathway is considered the only complete pathway at the Site. Therefore, the final quantitative risk assessment COPC list focused on VOCs. While groundwater beneath the Site is not suitable for potable water use, chemical concentrations were also compared to MCLs.

### **7.3 Exposure Assessment**

The objectives of an exposure assessment are to identify receptors (populations) that may be exposed to chemicals in contaminated media, the exposure pathways, and the route of potential intake. In addition, for pathways considered complete, the chemical concentrations to which the receptors are potentially exposed (exposure point concentrations) and the frequency, magnitude, and duration of these potential exposures (exposure parameters) must be estimated. This exposure assessment focuses on the COPCs detected in groundwater at the Site. The following steps are considered in the exposure assessment:

- Identification of potentially exposed receptor populations;
- Identification of complete exposure pathways;
- Estimation of exposure point concentrations for specific pathways; and
- Estimation of chemical intakes for receptor populations associated with each complete exposure pathway.

The end product of the exposure assessment is a measure of chemical intake as an average daily dose (ADD) that integrates the exposure parameters for the receptors of concern (e.g., contact rates, exposure frequency, and duration) with the exposure point concentration for the media of concern. These ADDs are then used in conjunction with chemical-specific toxicity values (e.g., reference doses and cancer slope factors) to arrive at an estimate of potential health risks for the receptors.

### 7.3.1 Conceptual Site Model

The Conceptual Site Model (CSM) identifies potential chemical sources, release mechanisms, transport media, routes of chemical migration through the environment, exposure media, and potential receptors. A risk assessment considers the current and the anticipated future use of a Site when developing a CSM. Receptors that may currently or in the future be potentially exposed to Site-related chemicals are then also identified to help assess the likelihood and extent of their potential exposures.

The general CSM was constructed based on a review of the available Site information regarding the environmental setting and chemical distribution in environmental media. The general CSM, presented in Figure 7-1, represents the current understanding of the sources of COPCs, the means by which they are released and transported within and among media, and the exposure pathways and routes by which they may contact human receptors.

Currently, the Site is not used, and therefore no receptors are currently present on the Site. However, the potential exists for future residential and/or commercial/industrial development. Therefore, three future exposure pathways may be possible:

- Exposure to chemicals in groundwater through potable water use.
- Exposure to chemicals in groundwater that may migrate to the adjacent channel.
- Exposure to VOCs that may migrate from groundwater through the subsurface into indoor air.

These three exposure pathways are evaluated below to determine if they are complete and warrant further evaluation in the risk assessment.

#### 7.3.1.1 *Drinking Water Pathway*

As discussed in Section 5.1, groundwater quality beneath the Site is substantially degraded due to seawater intrusion. However, the Santa Ana Regional Water Quality Control Board (RWQCB) Basin Plan indicates that groundwater beneath the Site has beneficial uses including municipal uses. Consequently, from a regulatory perspective,

the groundwater beneath the Site must be considered a potential drinking water source and the drinking water pathway must be considered.

Review of analytical data indicates that TDS, chloride, and selenium concentrations in shallow groundwater exceed the MCLs across the Site (see Section 6.3.1 and 6.3.2). These exceedances are considered to be the result of sea water intrusion and/or recharge from the Huntington Beach Flood Control Channel. Antimony and arsenic have also been detected slightly above their respective MCLs (6 ug/L and 10 ug/L) in a few monitoring wells. The detections of concentrations above MCLs in these wells are inconsistent and appear to be relatively localized. Only two VOCs were detected above MCLs (Table 6-4). The compound 1,4-dichlorobenzene was detected slightly above the MCL in monitoring well NMW-1 during the PNL 2002 sampling event. Benzene was detected above the MCL solely in well MW-9 during the 3<sup>rd</sup> quarter 2004 and in monitoring well B-4/B-4A during all six sampling events conducted from 2002 to the end of 2006. Based on these results, and from a Basin Plan perspective, Site groundwater has been degraded by both inorganic and organic chemicals and would not be suitable for drinking. However, given a number of other factors, the drinking water pathway is not considered complete for the following reasons.

- The Site is located in the Talbert Gap area. Groundwater in the Talbert Gap has been severely degraded due to seawater intrusion (see Section 5.1). The Site is located 3 miles south (seaward) of the Talbert Water Injection Barrier (Figure 5-3). The Talbert Water Injection Barrier is operated to control seawater intrusion north of the barrier.
- Orange County Water District records indicate that there are no groundwater production wells of any kind, including wells used for drinking water, within 3 miles of the Site (Figure 5-3 and Section 5.2). This is due to the fact that groundwater in the vicinity of the Site is severely degraded by seawater intrusion and thus is not used.
- Groundwater chemical results indicate that the shallow groundwater quality beneath the Site is severely degraded. General mineral results show that shallow Site groundwater occurring in the SPA contains very high TDS concentrations (up to approximately 80% of typical concentrations in seawater). TDS concentrations in samples collected in 2004 ranged from 4,600 mg/l to 26,000 mg/l. The major anions in the groundwater were found

to be sodium and chloride. Sodium concentrations ranged from 760 mg/l to 7,400 mg/l and chloride concentrations ranged from 1,400 mg/l to 13,000 mg/l. Based on these results, groundwater quality in the SPA beneath the Site does not qualify as drinking water resources as defined by California State Water Resources Control Board (CSWRCB) Resolution No. 88-63 due to the elevated TDS and chloride concentrations (CSWRCB, 1988).

- The lateral and vertical extent of contamination at the Site is very limited even though waste has been at the Site since 1938 (approximately 69 years). Chemical data indicate that VOCs and SVOCs have not been detected in any offsite wells with the exception of a single detection of chloromethane at a low concentration. Chemical data also indicate that no VOCs or SVOCs have been detected in a deep monitoring well (MW-20) located in the middle of the Site. The limited extent of chemical impact is believed to be due to a clay/silt layer that occurs across the Site and impedes contaminant migration to the shallow Site groundwater and a vertical upward gradient beneath the Site. Given the limited lateral and vertical impacts to shallow groundwater beneath the Site and the extremely long distance to existing or potential drinking water wells (3 miles), groundwater contamination beneath the Site water will not affect drinking water sources.
- The aquifer located directly beneath the Site, the SPA, is not considered an important source of groundwater. The Talbert Aquifer, a historically important aquifer, although now degraded and not used in the region of the Site, is located beneath the Site and the SPA at a depth of approximately 80 to 90 feet. Current upward vertical gradients in the SPA limit the potential for downward migration of contaminants from the Site to the Talbert Aquifer.

In summary, while there are exceedances of MCLs at the Site, based on the above information, the drinking water pathway is considered to be incomplete and is not evaluated further in this risk assessment.

### ***7.3.1.2 Groundwater/Surface Water Interaction Pathway***

The major surface waters in the area of the Site are the Pacific Ocean (2/5 mile south of the Site), the Santa Ana River (1 mile east of the Site), and the Orange County Flood Control Channel System, Huntington Beach Flood Control Channel (adjacent and southwest). The relatively large distances between the Site and the Pacific Ocean and the Santa Ana River and the predominantly northward groundwater flow direction in the Site area preclude the discharge of Site groundwater into these surface water bodies. In addition, based on analysis and a Site-specific tidal study, it is concluded that Site groundwater does not discharge to the Huntington Beach Flood Control Channel. This conclusion is supported as follows:

- Analytical model calculations presented in the Groundwater RI/FS Workplan-Revision 1.0 predict that flow is away from the flood control channel.
- Historical groundwater flow data collected between September 22, 1988, and December 7, 2004, show that groundwater flow direction in the area of the Site adjacent to the flood control channel is predominantly toward the northeast (away from the channel). Discussions regarding historical groundwater flow direction is further outlined in Section 5.5.1.
- A week long Site-specific tidal study conducted in June 2003 showed that even during periods of very low tides, Site groundwater did not discharge to the channel (see Section 5.6). The tidal study indicates that groundwater elevations beneath the Site were 1½ to 2 feet lower than low tide water levels in the channel throughout the study period (Figure 5-11). The tidal study indicated that “losing stream” conditions occurred in the channel; that is, the channel discharges surface water to shallow groundwater.

Based on the above information, the groundwater/surface interaction pathway is considered incomplete.

### **7.3.1.3 Groundwater to Indoor Air Pathway**

VOCs are present in several of the wells at the Site. Because groundwater beneath the Site is relatively shallow (shallowest 5 to 7 feet) beneath the Site, the potential exists for VOCs in groundwater to migrate through the subsurface into indoor air. Therefore, this pathway is considered complete and is evaluated further in the risk assessment. There also exists the potential for VOCs in groundwater to migrate into outdoor air, however this pathway is considered negligible as when compared to the indoor air pathway and therefore was not evaluated quantitatively.

### **7.3.2 Exposure Pathways and Receptors**

Exposure pathways and receptors were selected based on current and future use of the Site. At present, the Site is not useable and is undeveloped. However, in the future the Site will be remediated to allow for a future land use consistent with all applicable laws and regulations. Future exposures could potentially include onsite commercial, residential and recreational exposures. Therefore, this risk assessment evaluates the incremental risk from dissolved phase chemical concentrations in groundwater to these potential future receptor groups..

The Consent Order (CO) states that Site cleanup shall be to levels appropriate for unrestricted use. As a result, a future onsite residential exposure scenario was evaluated in the risk assessment to assure evaluation of conditions for unrestricted land use of the Site. Specifically, exposure to future onsite residents (adult and child residents for a duration of 30 years) via inhalation of indoor air volatiles emanating from groundwater was evaluated. Because adjacent land use includes commercial businesses, onsite commercial worker exposures were also evaluated. A recreational receptor was not evaluated in this assessment as recreational exposures are typically substantially less than the more conservative residential and commercial exposures. This is due to the smaller amount of time spent at the Site for a recreational receptor and that recreational exposures are predominately to outdoor air. Groundwater typically does not contribute significantly to outdoor air VOC concentrations. Potential exposures to vapors emanating from chemicals detected in offsite groundwater were not evaluated quantitatively, as only one VOC, chloromethane, was detected in offsite groundwater at

a concentration of 2 ug/L and is believed to be unrelated to the Site. This is further discussed in the risk characterization.

The focus of this evaluation is on the contribution of VOCs in groundwater to Site risks. This evaluation will be used to provide information for the development of remedial objectives for the groundwater portion of the SFS.

Based on the above information, the following receptor groups and exposure pathways under current and future land use conditions were evaluated quantitatively in the risk assessment:

Potentially Exposed Receptor	Scenario	Exposure Pathway
Onsite Resident	Hypothetical Future	Inhalation of volatiles in indoor air from groundwater
Onsite Commercial Worker	Hypothetical Future	Inhalation of volatiles in indoor air from groundwater

Exposure parameters were selected based on values presented in the *Supplemental Guidance: Standard Default Exposure Factors* (USEPA, 1991a), and *Exposure Factors Handbook* (USEPA, 1997a). Exposure parameter values that were used in the risk assessment are presented in Table 7-1.

The exposure parameters for a residential receptor are considered more conservative (health-protective) due to inclusion of a sensitive child receptor, as well as to the higher magnitude, frequency, and duration of potential exposures, than for a commercial worker. Therefore, evaluating a hypothetical, residential exposure scenario will also be protective for other, short-time visitors (e.g., trespassers) to the Site.

### 7.3.3 Fate and Transport Evaluation

The potential exists for VOCs to volatilize from groundwater into indoor air. This pathway was evaluated using the Johnson and Ettinger (J&E, 1991 and USEPA, 2000) subsurface vapor intrusion model to estimate potential migration of subsurface vapors into indoor air. The J&E computer spreadsheet model is public domain software that is freely available at the USEPA and DTSC internet website. The spreadsheet, which also calculates exposure levels and risk estimates, was modified recently by DTSC to



incorporate suggested building parameters and the latest Cal-EPA Office of Environmental Health Hazard Assessment (OEHHA) toxicity values (2004b). These values were used in the vapor intrusion assessment conducted for the Site.

For evaluating future onsite residents and commercial workers potentially exposed to indoor air vapors emanating from groundwater, the maximum concentration detected in groundwater was used as the Exposure Point Concentration (EPC) for input into the model with the assumption that contamination is present below the bottom of a future building. The depth to groundwater of 5 feet bgs was assumed, as this was the approximate shallowest depth of groundwater that was observed during the RI sampling. Based on boring logs of soils at the Site and the cross-section presented in Section 5.3.1, soil types were assumed to be loam to represent the top 3 feet of fill and silty-clay to represent 2 feet of the clay layer that has been observed at the Site. The assumption of 2 feet of silty-clay was based on a conservative estimate of the average thicknesses of the clay layer observed in the field. Default soil properties from the Soil Screening Guidance for loam and the model spreadsheet values for silty-clay were used for each of the soil types.

For the residential scenario, a  $Q_{\text{soil}}$  (volumetric flow rate) value of 5 liters per minute (l/min) was used to represent the volumetric flow rate of chemical vapors from directly below the building into indoor air. Due to the uncertainty associated with vapor permeability rates directly beneath a building, the use of a  $Q_{\text{soil}}$  value in the range of 1 to 10 l/min has been recommended by USEPA and DTSC with a default assumption of 5 l/min recommended. For the commercial worker scenario, a  $Q_{\text{soil}}$  value of 11.6 l/min was estimated based on an adjustment for the proposed building dimensions. Note that with this assumption, the vapor intrusion calculations become insensitive to building size. The proposed length and width of a commercial building are estimated at 50-foot by 50-foot (1,525 cm x 1,525 cm) with a proposed ceiling height of 10 feet. The default building dimensions for the residential scenario were used (1,000 cm x 1,000 cm) with a proposed ceiling height of 8 feet.

The input parameters used in the J&E model to evaluate the indoor air pathway are presented in Table 7-2.

### 7.3.4 Exposure Point Concentrations

Maximum VOC concentrations detected in groundwater were used in the fate and transport evaluation. This approach is consistent with recommendations given by DTSC for evaluating the vapor intrusion pathway with respect to future buildings and is considered conservative in nature.

The predicted indoor air concentrations from the model were used as exposure point concentrations (EPCs) in the calculation of cumulative risk and hazard, as presented in Appendix J. The model-predicted indoor air EPCs from groundwater are also presented in Table 7-4 and 7-5. The J&E model spreadsheets, including the model inputs, intermediate calculations, and predicted indoor air concentrations are presented in Appendix J for the residential and commercial exposure scenarios. The J&E model spreadsheets are used only to calculate indoor air concentrations and not to calculate risk. The approach used to calculate risk for the vapor intrusion pathway is described below.

### 7.3.5 Estimating Chemical Intake

The exposure assessment quantifies the magnitude, frequency, and duration of chemical intake (daily intake) by receptor populations. ADD or “Lifetime Average Daily Dose” (LADD) of COPCs for each exposure pathway is estimated. ADDs and LADDs are calculated using guidelines in the Risk Assessment Guidance for Superfund (USEPA, 1989), Preliminary Environmental Assessment Guidance Manual [Cal-EPA, 1999], Site-specific information, and professional judgment, as appropriate.

The intake factor is a value that combines the Site-specific and receptor-specific assumptions for a given exposure pathway and is expressed as the amount of media (e.g., soil) taken into the body per unit concentration of chemical in the media. Multiplying the intake factor by the chemical concentration yields the ADD (mg/kg-day) for that receptor population and exposure pathway. The following is a generic equation used to calculate the daily dose:

$$\text{ADD/LADD(mg/kg - day)} = \text{Selected EPC} \times \text{Summary Intake Factor}$$

The values and assumptions used to calculate the intake factor are dependent on the exposure pathway and receptor population being evaluated. A more detailed

description of the inhalation intake calculations is presented below. The exposure assumptions used in this risk assessment for the future onsite commercial worker and resident are summarized in Tables 7-1 and 7-2.

For the indoor air pathway, the model-predicted indoor air concentrations (Ca) are used in the following intake equation:

$$ADD/LADD = \frac{C_a \times InhR \times EF \times ED}{BW \times AT}$$

Where:

- C<sub>a</sub> = predicted indoor air concentration from groundwater (mg/m<sup>3</sup>)
- InhR = inhalation rate (m<sup>3</sup>/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (days)
  - cancer effects: 70 years x 365 days;
  - noncancer effects: ED x 365 days

Under the residential exposure scenario, cancer risks are calculated using an age-adjusted factor, since inhalation rates and body weights are different for children and adults in their first 30 years of life. The age-adjusted factor approximates the integrated exposure for small children and adults by combining their intake rates, body weights, and exposure frequency and duration. The following is an equation used to estimate the age-adjusted inhalation factor:

$$InhF_{adj} = (ED_c \times InhR_c / BW_c) + (ED_a \times InhR_a / BW_a)$$

Where:

- InhF<sub>adj</sub> = age-adjusted inhalation factor (m<sup>3</sup>-year/kg-day)
- a = adult exposure parameter
- c = child exposure parameter

The  $\text{InhF}_{\text{adj}}$  is used in the following equation to calculate the LADDs and ADDs of COPCs via indoor inhalation of vapors for residential exposures:

$$\text{ADD}_{\text{adj}} \text{ or } \text{LADD}_{\text{adj}} = \frac{\text{Ca} \times \text{InhF}_{\text{adj}} \times \text{EF}}{\text{AT}}$$

The exposure parameters that were used to calculate intake of COPCs via inhalation of vapors are provided in Table 7-1.

## 7.4 Toxicity Assessment

The toxicity assessment characterizes the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from such exposure. For purposes of calculating exposure criteria to be used in risk assessments, adverse health effects are classified into two broad categories: noncarcinogens and carcinogens. Toxicity criteria are generally developed based on the threshold approach for noncancer effects and the non-threshold approach for cancer effects.

The key dose-response criteria are unit risk factors (URFs) for calculating cancer risks from exposure to carcinogens and reference concentrations (RfCs) for estimating hazard from exposure to noncarcinogens. In addition, Cal-EPA has developed chronic Reference Exposure Levels for noncancer effects, which were used in place of RfCs, if available. In this evaluation, chronic toxicity criteria were selected (in order of preference) from the following sources: 1) Cal-EPA OEHHA Toxicity Criteria Database, online [2007]; 2) USEPA's [2007] Integrated Risk Information System (IRIS) as referenced in USEPA Region IX Preliminary Remedial Goals (PRG) table [USEPA, 2004]; 3) USEPA [1997b] Health Effects Assessment Summary Tables (HEAST), as referenced in the Region IX PRG table [USEPA, 2004]; or 4) USEPA NCEA Superfund Health Risk Technical Support Center, as referenced in the USEPA PRG table [2004].

### 7.4.1 Toxicity Criteria for Potential Carcinogens

Potential cancer effects resulting from human exposure to chemicals are generally estimated quantitatively using oral cancer slope factors (CSFs) or inhalation unit risk factors (URFs). Oral CSFs are expressed in units of  $(\text{mg}/\text{kg}\cdot\text{day})^{-1}$ . To characterize

potential cancer risks from inhalation, URFs were converted when needed from units of  $(1.0 \text{ ug/m}^3)^{-1}$  to units of  $(\text{mg/kg-day})^{-1}$  by assuming that an individual inhales at a rate of 20 cubic meter per day, and has an average body weight of 70 kg and this absorption is equivalent by either route (USEPA, 1989).

Oral and inhalation CSFs are derived by Cal-EPA and USEPA from the results of chronic animal bioassays, human epidemiological studies, or both. Animal bioassays are usually conducted at dose levels that are much higher than those likely to be produced by human exposure to environmental media. These high dose levels are used to detect possible adverse effects in the relatively small test populations used in the studies.

Because humans are generally exposed at lower doses, the data are extrapolated using mathematical models. Most commonly, the linearized multistage model is used to estimate the largest possible linear slope (95UCL) at low extrapolated doses that is consistent with the data. The 95UCL slope of the dose-response curve is subjected to various adjustments, and an interspecies scaling factor is usually applied to derive a CSF for humans. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad hoc basis.

Conservative (i.e., health protective) assumptions are generally applied, and the models are believed to provide rough estimates of the upper limits on potential carcinogenic potency. The actual risks associated with exposure to a potential carcinogen and quantitatively evaluated on the basis of its CSF are not likely to exceed the risks estimated and may be much lower or even zero.

The inhalation CSFs and URFs used in this risk assessment are presented in Table 7-3.

#### **7.4.2 Toxicity Criteria for Potential Noncarcinogens**

Potential noncancer effects resulting from human exposure to chemicals are estimated quantitatively using chronic reference doses (RfDs) for ingested chemicals and reference concentrations (RfCs) for inhaled chemicals. As was the case for the CSFs, RfDs and RfCs are only available for oral and inhalation exposures. In the absence of criteria specific to the dermal exposure pathway, the oral RfDs were used to evaluate the dermal route of exposure.

These toxicity values are developed by the USEPA RfD/RfC workgroup on the basis of a wide array of noncancer health effects. The RfD, expressed in units of milligrams of chemical intake per kilogram of body weight per day (mg/kg-day), is an estimate of the maximum human exposure level that can be present without an appreciable risk of deleterious effects during a designated time. The RfC is expressed in units of milligrams of chemical per cubic meter of air (mg/m<sup>3</sup>) and is an estimate of the maximum air concentration that can be present without an appreciable risk of deleterious effects. RfCs assume a human body weight of 70 kilograms and an inhalation rate of 20 m<sup>3</sup>/day.

RfDs and RfCs are usually derived from either human studies involving workplace exposures or from animal studies, and are adjusted using generic uncertainty factors. The RfD and RfC provide benchmarks against which human intakes of chemicals resulting from exposure to impacted environmental media are compared. Chronic reference exposure levels (RELs) for inhalation exposure have been developed by Cal-EPA for the Air Toxics Hot Spots program. When available, these values were used in the risk assessment.

The chronic reference doses and reference exposure levels used in the risk assessment for the chemicals detected at the Site are presented in Table 7-3.

## **7.5 Risk Characterization**

### **7.5.1 General**

Risk characterization integrates the results of the toxicity assessment (Section 7.4) and the exposure assessment (Section 7.3) to estimate potential cancer risks and adverse noncancer health effects associated with exposure to chemicals detected at the Site. This integration provides quantitative estimates of risk and noncancer hazard that are then compared to acceptable standards.

The process of risk assessment is an iterative process where factual site, receptor, and chemical-specific data are used when available. When site-specific data are not available, conservative (i.e., health protective) assumptions are utilized. The use of repeated, conservative assumptions can lead to overly conservative estimations of risk but certainly provides an upper-bound estimate of the actual risk. Thus, for any site, the estimated risk level reflects an upper-bound estimate of the most probable risk. The

most probable risk is likely to be much less, perhaps as low as zero, and probably not measurable in the potentially exposed population.

USEPA guidance (1989) recommends that exposures to chemicals be estimated for both average and Reasonable Maximum Exposure (RME) conditions. Estimates of exposure under RME conditions are calculated by combining exposure factors so that the result is the maximum exposure that is reasonably expected to occur (USEPA, 1989). RMEs are intended to place conservative upper bounds on the potential risks, meaning that each risk estimate is unlikely to be underestimated, and it may very well be overestimated. The RMEs for a given pathway were derived by combining the upper-bound estimate of the concentration for each chemical (as represented by the maximum) with reasonable maximum values describing the extent, frequency, and duration of exposure, as discussed in Section 7.3. In this risk assessment, maximum concentrations of VOCs detected in groundwater were used to calculate exposures and risk for both residential and commercial exposure scenarios.

## **7.5.2 Risk Management Criteria**

Various demarcations of acceptable risk have been established by regulatory agencies. The USEPA has established acceptable levels of risk at Superfund sites. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and other relevant guidance (USEPA, 1991b) states that sites posing a cumulative cancer risk of less than  $10^{-4}$  and hazard indices less than unity (1.0) for noncancer endpoints are generally not considered to pose a significant risk warranting remediation. The California Hazardous Substances Account Act (HSAA) incorporates the NCP by reference, and thus also incorporates the acceptable risk range set forth in the NCP. The Resource Conservation and Recovery Act (RCRA) Corrective Action program incorporates this same range of potential health risks as the “acceptable risk range” for determining whether corrective action is warranted at RCRA facilities and for closure purposes. The Safe Drinking Water and Toxic Enforcement Act of 1986 (California Proposition 65) regulates chemical exposures to the general population and is based on an acceptable risk level of  $1 \times 10^{-5}$ .

Under most situations, cancer risks in the range of  $10^{-6}$  to  $10^{-4}$  may be considered to be acceptable with cancer risks less than  $10^{-6}$  considered insignificant. These risk estimates are incremental to the far greater background risk of Americans developing cancer. The background risk is one chance in three ( $0.3$  or  $3 \times 10^{-1}$ ) for every American

female, and one chance in two ( $0.5$  or  $5 \times 10^{-1}$ ) for every American male, of eventually developing cancer (ACS, 2002).

To understand the significance of the risk and hazard estimates presented in the risk characterization, it is critical to establish the risk management criteria that will be used for comparison. The risk management criteria presented in this risk assessment focus on numerical standards that were compared to the risk assessment results (cancer risk estimates and noncancer hazard indices). It is acknowledged that additional risk management considerations such as technical feasibility, economic, social, political, and legal factors may be part of the final risk management decision. The results of the risk characterization are really the starting point for risk management considerations for a site.

### 7.5.3 Risk Characterization Results

In the risk characterization step of the risk assessment, excess cancer risk is estimated by multiplying the LADD by the chemical-specific cancer slope factor (CSF). The following equation is used to estimate the excess cancer risk per each COPC:

$$\text{Excess Cancer Risk} = \text{LADD} \times \text{CSF}$$

The chemical-specific excess cancer risks are then summed to yield a cumulative cancer risk, which is typically compared to the USEPA acceptable risk range of  $10^{-6}$  to  $10^{-4}$  or to DTSC's acceptable target risk goal of  $1 \times 10^{-6}$ .

Chemical-specific hazard quotients are estimated by calculating the ratio of the ADD to the corresponding chronic reference dose (RfD) for noncancer effects. The following equation is used to estimate the hazard quotient:

$$\text{Hazard Quotient} = \frac{\text{ADD}}{\text{RfD}}$$

The chemical-specific hazard quotients are then summed to form a cumulative hazard index (HI), which is typically compared to an acceptable hazard level of 1. Hazard indices less than the benchmark level of 1 indicate that no adverse health effects are predicted from exposure to COPCs at the Site. If the HI is greater than 1, the COPCs



can also be grouped together according to target organ effects with the HIs recalculated as a more refined tier of analysis.

The chemical-specific cancer risk and hazard index estimates are presented in Tables 7-4 and 7-5 for each of the receptor groups and exposure pathways discussed in Section 7.3. The J&E vapor intrusion model spreadsheets and detailed risk calculations are presented in Appendix J. The following table summarizes the receptor groups, exposure medium and exposure pathways quantitatively evaluated in this risk assessment.

<b>Receptor Population</b>	<b>Exposure Medium</b>	<b>Potentially Complete Exposure Pathway</b>	<b>Cancer Risk</b>	<b>Noncancer Hazard</b>
On-Site Resident	Groundwater	• Vapor Inhalation in Indoor Air	4E-06	0.64
On-Site Commercial Worker	Groundwater	• Vapor Inhalation in Indoor Air	8E-07	0.08

Benzene was the primary contributor to the future onsite residential risk with a chemical specific risk estimate of  $3.8 \times 10^{-6}$ . This risk estimate is based on the maximum detected concentration of benzene solely in Well B-4 and accounts for 86 percent of the total residential incremental risk. Other benzene concentrations detected in onsite wells were an approximate order of magnitude lower than those detected in Well B-4. All other chemical-specific risk and noncancer hazards were below  $1 \times 10^{-6}$  and 1, respectively.

As discussed earlier, only one chemical, chloromethane, was detected in offsite groundwater at a concentration of 2.5 ug/L in a single well, MW-19, during the 3<sup>rd</sup> quarter of 2004. Chloromethane was not detected in MW-19 in subsequent groundwater sampling events completed in December 2004 and December 2006. A similar concentration was detected onsite (1.7 ug/L), however as discussed in Section 6.3.3, the offsite detection is not believed to be related to the Site. Nevertheless, the estimated noncancer hazard quotient for this onsite concentration assuming residential land use was 0.00001, well below a target hazard index of 1. Therefore, there is no significant health risk associated with chloromethane concentrations detected in offsite wells.

## 7.6 Uncertainty Analysis

The methodology used in this risk assessment is consistent with USEPA and Cal-EPA risk assessment guidance. However, the procedures used in any quantitative risk assessment are conditional estimates given the many assumptions that must be made about exposure and toxicity. Major sources of uncertainty in risk assessment include (1) natural variability (e.g., differences in body weight or sensitivity in a group of people); (2) incomplete knowledge of basic physical, chemical, and biological processes (e.g., the affinity of a chemical for soil, degradation rates); (3) model assumptions used to estimate key inputs (e.g., exposure, dose response models, fate and transport models); and (4) measurement error primarily with respect to sampling and laboratory analysis. While such uncertainty is inherent in all risk assessments, Geosyntec has no data or other information that suggest any of the above situations has impacted the validity of its analysis or conclusion of this risk assessment.

Site-specific factors, which this assessment incorporates, decrease uncertainty, although uncertainty may persist in even the most site-specific risk assessments due to the inherent uncertainty in the process. However, because the assumptions used tend to be health-protective and conservative in nature, the estimated risks are likely to exceed the most probable risk posed to potential receptors at the Site.

Some of the most significant elements affecting uncertainty for this risk assessment include:

- The maximum concentration detected in groundwater was used in the risk assessment. In addition, it was assumed that chemical concentrations remain constant over the duration of exposure. No abiotic or biotic degradation mechanisms, which reduce the concentrations of COPCs over time, are assumed to occur. This general assumption of steady-state conditions also applies to sources and chemical release mechanisms and may result in a conservative estimation of long-term exposure concentrations. This is considered conservative for petroleum related VOCs such as benzene which have been shown to degrade in shallow soils. As a result, actual soil gas concentrations that may enter a building may be lower than model predictions used in this risk assessment.

- Default soil physical properties were used for the soil type for the loam and silty clay. Lack of Site-specific values may introduce some uncertainty into the vapor modeling and may result in an over-prediction or under-prediction of vapor inhalation exposures from groundwater.

In summary, many aspects of the human health risk assessment contain sources of uncertainty. Conservative simplifying assumptions are made so that health risks can be estimated quantitatively. Because the exact amount of uncertainty cannot be quantified, this risk assessment is intended to overestimate rather than underestimate probable risk.

## 8. SUMMARY AND CONCLUSIONS

The Ascon Landfill Site is a 38 acre parcel located in Huntington Beach, California. The Site was operated as a waste disposal facility from approximately 1938 through 1984. The primary types of wastes disposed of at the Site were drilling muds and oilfield wastes (crude oil and tar). Other hydrocarbons are known to have been disposed at the Site include fuel oils, phenolic wastes, mercaptans, styrene, and synthetic rubber. Chromic and sulfuric acids, aluminum slag, and magnesium and potassium chloride were also reportedly deposited in the landfill. Wastes disposed at the Site were placed directly upon the native sediments or in surface impoundments such as lagoons and pits. Soil and imported fill materials were used to form containment berms and to cover the areas where wastes were disposed. An earthen berm, from approximately 10 to 20 feet high, was constructed around much of the Site perimeter to contain the surface impoundments located in the interior of the Site. Consequently, most of the Site is approximately 10 to 20 feet higher than the adjacent areas.

Drilling mud and oil-saturated wastes are present throughout most of the Site, with the exception of the western margin and southeastern corner of the property. Eight pits (Pits A through H) have been identified on the Site, all of which have been covered, with the exception of Pit F. There are currently five lagoons (Lagoons 1-5) on the Site (Figure 2-2). Pit F was used to dispose of styrene waste, and the uncovered lagoons contain mostly oil drilling wastes. The thickness of the waste varies from a few feet to as much as 20 feet. Soil and construction debris have been placed over much of the waste material and can be seen around the edges and extending into several of the lagoons.

The extent and distribution of Site wastes has been investigated since the early 1980s. More recently, work outlined in the Imminent and Substantial Endangerment Determination and Consent Order between the DTSC and the Settling Parties (effective January 8, 2003) was conducted, including the Groundwater RI. The Groundwater RI was conducted in accordance with the Groundwater RI/FS Workplan-Revision 1.0. The primary objectives of the Groundwater RI was to assess groundwater quality conditions beneath the Site and adjacent to the Site, and to determine the probability of risk to public health, safety, and welfare, and the environment posed by hazardous substances at or from the Site.

Information used to assess the Site groundwater conditions was collected during past investigations, conducted as early as the 1980s, up to recent investigations completed in 2003, 2004, and 2006. The recent investigations conducted as part of the Groundwater RI/FS included the completion of multiple rounds of groundwater level and NAPL gauging, a groundwater/surface water interaction study (tidal study), installation of five new monitoring wells, completion of six groundwater sampling events including a 2002 event, four quarterly groundwater monitoring events in 2004, and a groundwater monitoring event conducted in 2006. A NAPL sampling event was also completed in 2004 and a supplemental groundwater investigation was completed in the Pit F area in 2006. The salient findings of this Groundwater RI are presented below in six categories:

- Regional Hydrogeology;
- Site Hydrogeology;
- Groundwater/Surface Water Interaction;
- Dissolved Phase Groundwater Contaminants;
- NAPL Contaminants; and
- Risk Assessment Results and Conclusions.

## **8.1 Regional Hydrogeology**

The most relevant findings regarding regional hydrogeology are as follows:

- The Site is located in the southwest portion of the Orange County Groundwater Basin, approximately 2,000 feet from the Pacific Ocean. The area of the basin where the Site is located is known as the Talbert Gap. Shallow groundwater beneath the Site occurs in Holocene age upper and lower alluvial units. The upper alluvial unit forms the SPA (Semi-Perched Aquifer) and the lower unit forms the Talbert Aquifer. Water bearing zones of the Pleistocene age San Pedro Formation occurs below the Talbert Aquifer.
- The SPA is not considered an important source of groundwater in the basin. The Talbert Aquifer was historically an important groundwater source in the Talbert Gap area; however, groundwater production has been abandoned in the area due to significant deterioration of groundwater quality from seawater intrusion. Currently, the area of seawater intrusion extends three miles inland from the Site to the location of the Talbert Water Injection Barrier.

- There is no groundwater production of any kind (drinking water, agricultural, industrial) within three miles of the Site. This is due to the fact that groundwater in the vicinity of the Site is severely degraded by seawater intrusion and thus is not used.

## **8.2 Site Hydrogeology**

Both published regional information and data collected at the Site have been used to develop the Site hydrostratigraphy. Site hydrostratigraphy has been illustrated in cross-sections presented in Figures 5-5, 5-6, and 5-7. Site stratigraphy is important to understand in regard to the location of the waste material and the potential migration of contaminants and waste to the groundwater. Findings regarding Site hydrogeology are as follows:

- Stratigraphy at the Site generally consists of non-native fill and waste materials that occur above native Holocene-age alluvium.
- Shallow groundwater beneath the Site occurs in units defined as the Perched Zone, the SPA, and the Talbert Aquifer. The Perched Zone occurs above the SPA at elevations of approximately 5 to 14 feet NAVD88 and is used to define the occurrence of water above the groundwater piezometric surface. Liquids in the Perched Zone occur in thin and discontinuous layers of permeable fill and waste materials.
- The SPA occurs below the Perched Zone and consists mainly of fine-grained sands. The top of the SPA occurs at an elevation of approximately 0 to -10 feet NAVD88 and extends to a depth of approximately -80 to -90 feet NAVD88 (see regional cross-section in Figure 5-2). The top of the SPA occurs at the base of a fine-grained clay/silt unit that extends across the entire Site. Regionally, groundwater in the SPA is considered to be under unconfined conditions. However, Site observations generally indicate confined or semi-confined groundwater conditions occur locally beneath the Site with the fine-grained clay/silt layer, which underlies the waste materials, acting as a confining bed. The fine-grained clay/silt unit is thought to impede the downward movement of wastes and contaminants to the groundwater occurring in the SPA.

- Below the SPA is the Talbert Aquifer. The Talbert Aquifer is a sequence of sandy water-bearing zones separated by clay layers. As discussed above, the Talbert Aquifer was historically used for groundwater production purposes, but seawater intrusion has significantly deteriorated groundwater quality in the region of the Site. Thus, the aquifer is not being used as a groundwater source within a three mile radius.
- Groundwater levels in the SPA have been collected intermittently at the Site since approximately 1988, including eleven groundwater level gauging events completed from June 2002 to December 2004. Groundwater contour maps of SPA groundwater levels are presented in Appendix G and Figures 5-8A through 5-8L. Important information regarding groundwater levels and groundwater flow direction in the SPA is as follows:
  - Groundwater elevations beneath the Site have ranged from approximately  $-3\frac{1}{2}$  to  $3\frac{1}{2}$  feet NAVD88. Hydrographs (Figures 5-9 and 5-10) indicate that seasonal fluctuations do occur in the groundwater elevations across the Site and that higher groundwater levels can be expected during wet portions of the year. Based on onsite and offsite data, it is reasonable to assume that water level (potentiometric surface) fluctuations ranging from approximately 1 to 4 feet will occur across the Site.
  - The direction of shallow groundwater flow in the SPA has been generally consistent throughout time. Groundwater flow in the northwest portion of the Site is toward the northwest and groundwater flow direction in the central and eastern portions of the Site is generally toward the northwest to northeast. A component of easterly flow may exist in the southeastern quadrant of the Site. Groundwater flow direction in the southwest portion of the Site adjacent to the Huntington Beach Flood Control Channel is generally away from the channel toward the north to northeast.
  - Based on the estimated lateral groundwater gradients for the Site, and published K and p values for fine sand materials, the average interstitial velocity in the middle portion of the Site (northeast flow direction) is estimated to be 0.03 ft/day or 10 feet a year, a relatively

low rate. In the northwest corner of the Site where the highest groundwater gradients were observed, the average interstitial velocity is approximately 0.21 feet/day to 0.24 feet/day (approximately 75 to 90 feet per year).

- Vertical gradients were evaluated using groundwater levels collected from a monitoring well (MW-20) screened in the lower portion of the SPA and an adjacent piezometer, P-4, screened in the shallow portion of the SPA. The data indicate that vertical upward gradients exist in the SPA beneath the Site.

### **8.3 Groundwater/Surface Water Interaction**

Results of the investigation indicate that interaction of groundwater beneath the Site and surface water bodies is not significant. Findings include:

- The major surface waters in the area of the Site are the Pacific Ocean (2/5 mile south of the Site), the Santa Ana River (1 mile east of the Site) and the Orange County Flood Control Channel System, Huntington Beach Flood Control Channel (adjacent and southwest). The relatively large distances between the Site and the Pacific Ocean and the Santa Ana River, and the predominantly northward groundwater flow direction in the Site area preclude the discharge of Site groundwater into these surface water bodies.
- Based on groundwater flow directions and Site-specific tidal study, the shallow groundwater beneath the Site does not discharge to the Huntington Beach Flood Control Channel. Historical groundwater flow data collected between 1988 and 2006 show that groundwater flow direction in the area of the Site adjacent to the flood control channel is predominantly toward the northeast (away from the channel). In addition, a week-long Site-specific tidal study conducted in June 2003 showed that, even during periods of very low tides, Site groundwater did not discharge to the channel and that “losing stream” conditions occurred in the channel.

### **8.4 Dissolved Phase Groundwater Contaminants**

Recent groundwater quality data were collected during a sampling event completed by PNL in June-August 2002, four quarterly monitoring events completed in 2004, and one



monitoring event in 2006. Groundwater data collected during these 2002, 2004, and 2006 monitoring events were used in the risk assessment calculations (Section 7.0). Findings are summarized as follows:

- General mineral results show that the shallow groundwater beneath the Site contains very high TDS concentrations consisting mainly of dissolved sodium and chloride. TDS concentrations were measured up to 26,000 mg/l, which is approximately 80% of typical concentrations in seawater. The highest TDS concentrations were detected in the southwestern portion of the Site, in locations generally near the Huntington Beach Flood Control Channel. The high TDS concentrations confirm the occurrence of seawater intrusion beneath the Site and further indicate the occurrence of losing stream conditions in the Huntington Beach Flood Control Channel which is influenced by tidal activity and contains water with high TDS concentrations. Concentrations of chloride, sulfate and TDS in the Site groundwater are well above MCLs for drinking water.
- Generally, with the exception of barium and selenium, dissolved metal concentrations in the shallow groundwater were not significantly elevated. Barium concentrations were detected at elevated levels in the deep monitoring well MW-20 (concentrations ranged between 1,700 ug/l to 2000 ug/l during the four quarters of 2004, which is above the 1000 ug/l MCL for barium ). The high barium concentrations in MW-20 is likely unrelated to Site wastes and is thought to be representative of deeper groundwater quality given the lower concentrations present in the shallower monitoring locations. Elevated barium concentrations were not detected in any other well located on the Site except of B-4/B-4A where barium was detected at a concentration of 1,200 ug/L in 2002 and 2006. Elevated selenium concentrations (up to 140 ug/l) were detected across the Site and above the selenium MCL of 50 ug/l in 17 of 23 of the wells sampled during at least one of the sampling rounds. The highest selenium concentrations were detected in the western portion of the Site. The most likely explanation is that the source of the selenium in groundwater is seawater recharge from the Huntington Beach Flood Control Channel
- Antimony and arsenic have also been detected slightly above their respective MCLs in a few Site monitoring wells. The detection of concentrations above the MCLs in these wells are inconsistent (i.e., not reproducible) and appear to

be relatively localized. Antimony was detected at concentrations (11 ug/L or 12 ug/L) slightly above the MCL in three monitoring wells (AW-2, B-4, and MW-4) in the June 2002 monitoring event. Antimony was not detected above the MCL in these wells or any other well in the subsequent five monitoring events completed at the Site. Arsenic was detected above the MCL in three monitoring well locations. Arsenic was detected at a concentration of 16 ug/l and 11 ug/L in B-4A in June 2004 and December 2006, respectively, at a concentration of 26 ug/L in GP-24 in June 2004 and at a concentration of 11 ug/L in MW-13 in December 2004. These detections are not considered to be related to Site wastes.

- VOCs were generally detected at low levels (i.e., below 10 ug/l) and in onsite wells. The detection of VOC concentrations above 10 ug/l was localized and occurred in only three onsite wells AW-5, B-4/B-4A, and B-7 (Figures 6-3 through Figures 6-8). VOCs detected at higher concentrations included 1,2,4-trimethylbenzene, benzene, ethylbenzene, sec-butylbenzene, isopropylbenzene, naphthalene, m,p,o-xylene, and toluene. VOCs have not been detected in any offsite wells (MW-16 through MW-19), with the exception of chloromethane which was detected at a low concentration (2.5 ug/l) in MW-19, located southeast of the Site. VOCs were not detected in monitoring well MW-20, which is completed in the lower portion of the SPA.
- Comparison of MCLs with VOC concentrations detected in the shallow groundwater beneath the Site indicates that two VOCs were detected above MCLs--benzene and 1,4-dichlorobenzene (Table 6-4). Benzene was detected above its MCL of 1.0 ug/L in well MW-9 during the 3<sup>rd</sup> quarter 2004 and in monitoring well B-4/B-4A during all six sampling events conducted from 2002 to 2006. Benzene in MW-9 was detected at a concentration of 3.2 ug/L in the 3<sup>rd</sup> quarter 2004, and benzene concentrations in B-4/B-4A ranged between 1.8 and 70 ug/L during the six sampling events. The compound 1,4-dichlorobenzene was detected at a concentration of 5.6 ug/L in monitoring well NMW-1 during the 2002 sampling event. This is slightly above the MCL of 5 ug/L for this compound. 1,4-dichlorobenzene was not detected above the MCL in any other well during the six sampling events completed.
- SVOCs were detected at only two onsite monitoring well locations, B-4/B-4A and B-7. SVOCs 2,4-dimethylphenol and 2-methylphenol were detected in

B-4/B-4A at concentrations ranging from 97 ug/l to 1,500 ug/l and 37 ug/l to 2,100 ug/l, respectively (Table 6-5). Benzoic acid was detected only once in B-7 at a concentration of 20 ug/l during the second quarter 2004 sampling event. Naphthalene was detected in B-4/B-4A and B-7 at concentrations of 30 and 20 ug/L, respectively, in December 2006<sup>15</sup>.

- The emergent chemical compounds 1,4-dioxane, NDMA, perchlorate, and chromium VI were analyzed for in selected samples as summarized in Table 6-6. Results indicate 1,4-dioxane was detected in five wells (AW-4A, B-4A, B-7, GP-1, and MW-13) located on the Site at relatively low concentrations (0.61 ug/l to 3.5 ug/l). NDMA was detected at a very low concentration (0.0021 ug/l) in a sample collected from MW-17 in the first quarter of 2004 but was not detected at any other location nor was it detected in MW-17 in the 2<sup>nd</sup> quarter of 2004. Chromium VI and perchlorate were not detected in any groundwater samples collected at the Site.
- Total Petroleum Hydrocarbon (TPH) was detected in only one of sixteen wells tested for TPH during the 2002 sampling event. TPH was detected in B-6 at a relatively low concentration: 0.65 mg/l.

The results of the groundwater sampling, as summarized above, indicate that the lateral and vertical extent of dissolved phase contaminants in groundwater is limited. The detection of relatively elevated VOC concentrations on the Site is limited to localized areas, specifically AW-5, B-4/B-4A, and B-7, and SVOCs have been detected in only two wells on the Site, B-4A and B-7. In addition, no significant concentrations of VOCs were detected in offsite wells. The supplemental groundwater investigation in the Pit F area showed that groundwater impacts from Pit F have traveled less than 150 feet from the Pit F perimeter over the time Pit F materials have been in place, at least 50 years. The limited extent of the groundwater contamination together with the fact that wastes have been present on the Site for a long period (up to 65 years) indicates that contaminant transport is being significantly impeded. The relatively small amount of significant dissolved phase contamination is likely attributable to a combination of factors including: (1) the presence of the clay/silt layer that extends across the Site; (2) the confined or semi-confined nature of the groundwater occurring

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<sup>15</sup> Naphthalene was measured as a VOC in monitoring well B-4/B-4A.

beneath the Site; (3) the low groundwater velocity at the Site; and (4) the apparent occurrence of attenuation of waste constituents in groundwater. The limited vertical extent of dissolved phase contamination, as indicated by the lack of contamination in MW-20, is likely the result of the upward vertical gradient in the SPA beneath the Site.

## **8.5 NAPL Contaminants**

Findings regarding the NAPL at the Site include:

- NAPL occurs across the Site in monitoring wells completed in both the perched zone and the SPA. Based on a gauging event conducted in December 2004 as part of the NAPL investigation, measurable NAPL was detected in 18 of 59 locations across the Site, including six perched wells. Trace amounts of NAPL were observed in an additional four locations.
- Analyses indicate that the overall composition of the NAPL is an apparent mixture of several hydrocarbon fractions including gasoline or gasoline-range hydrocarbons, diesel, native crude oil, and a kerosene-like fraction. This interpretation is consistent with the disposal history of the Site including the possible disposal of oil-based drilling muds. Physical analyses of the NAPL indicate that the product mixture is relatively viscous and immobile, confirming field observations.
- Although, NAPL was detected or observed in 16 wells considered completed in the SPA, analysis of boring logs indicates that NAPL in the Site subsurface occurs above or in the top portions of the fine-grained clay/silt layer, and not in the SPA. Exceptions are the Pit F area, the area in the middle portion of the Site directly east of Lagoon 1 and Lagoon 2 where the clay/silt layer may have been removed or does not occur, and in the area of P-9 where the fine-grained layer appears to be very thin. The occurrence of NAPL in many of the monitoring wells completed in the SPA is likely the artifact of well construction and that NAPL has migrated through the well annulus and then to the groundwater surface in the Site monitoring wells.
- The lateral and vertical extent of NAPL is limited to the Site area. The lack of NAPL in offsite wells is likely attributable to a combination of factors

including the presence of the fine-grained clay/silt layer discussed previously and the relatively low mobility of the NAPL.

## **8.6 Risk Assessment Results and Conclusions**

A risk assessment was conducted using groundwater data collected between 2002 and 2006 and following EPA and Cal EPA guidance. Three exposure pathways for groundwater including the surface water/groundwater interaction pathway, the drinking water pathway, and the vapor intrusion pathway were evaluated in the groundwater risk assessment. Findings are as follows:

- Based on information collected during the tidal study and gauging events, and the evaluation of the Site groundwater with respect to potable water use, the only complete exposure pathway identified was the vapor intrusion pathway.
- Analyses of vapor intrusion pathway indicated that the estimated potential incremental cancer risk to future onsite residents was  $4 \times 10^{-6}$ . Benzene was the primary contributor to the future on-site residential risk with a chemical specific risk estimate of  $3.8 \times 10^{-6}$ . This risk estimate is based on the maximum detected concentration of benzene in Well B-4A. Other benzene concentrations detected in onsite wells were an approximate order of magnitude lower than those detected in Well B-4A. All other chemical-specific risk and noncancer hazards were below  $1 \times 10^{-6}$  and 1, respectively, for both future residential and commercial land use.
- Results of the risk assessment indicate that benzene in one onsite well at the Site poses a potentially unacceptable risk to future residents through the vapor intrusion pathway.

## 9. RECOMMENDATIONS

Based on the results of the GW RI, we have prepared the following recommendations.

1. The origin of anomalies A1 and A2 should be further investigated and identified during remedial activities at the Site. If A1 and A2 are identified as old monitoring wells (i.e., AW-6 and AW-7), the monitoring wells should be destroyed in accordance with applicable standards.
2. The Pacific Ranch #1 oil well, located in Lagoon 5, should be properly destroyed in accordance with applicable standards.
3. The Interim Groundwater Monitoring Workplan (Geosyntec, 2006c), which was approved by DTSC in their letter dated May 7, 2007, should be implemented. The program includes the installation of three new monitoring wells and gauging and sampling of selected monitoring locations.

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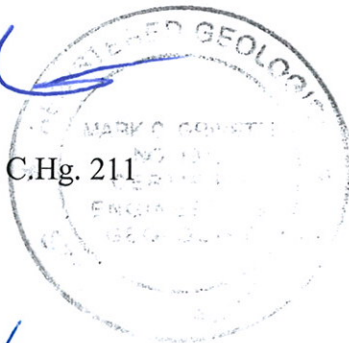
If you have any questions or require further information please call us.

Sincerely,

Geosyntec Consultants, Inc.



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DATED FEBRUARY 15, 2006



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DATED JUNE 14, 2007