ADDITIONAL SOIL VAPOR EVALUATION AND ENGINEERING FEASIBILITY STUDY
POWAY LANDFILL
POWAY, CALIFORNIA

PREPARED FOR

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EXECUTIVE SUMMARY

This Additional Soil Vapor Evaluation and Engineering Feasibility Study (EFS) was prepared to further assess potential soil vapor impacts potentially related to the Poway Landfill (the site) on the adjoining residential community south of the site, and evaluate corrective action alternatives. A Corrective Action Program (CAP) for the site is also provided in this report. This report was prepared by GeoSyntec Consultants (GeoSyntec) for the County of San Diego, Department of Public Works, Landfill Management (the County). The scope of services described herein were performed in accordance with the Corrective Action Program (CAP) and revised Downgradient Soil Vapor Work Plans submitted to and approved by the Regional Water Quality Control Board (RWQCB) and San Diego County Department of Environmental Health Local Enforcement Agency (LEA) (GeoSyntec, 2005a and 2006).

Site History

The Poway Landfill (the site) is located at 14900 Poway Road in Poway, California (Figure 1). Between 1949 and 1966 the site was operated as a burn dump, and from 1967 to 1975, the site was operated as a Class II (Class III under current regulations) solid waste disposal facility. The landfill was permitted to receive residential, commercial, and agricultural wastes. No known septic, industrial, chemical or liquid wastes were received at the site. In 1975 the landfill ceased collecting waste. Under current regulations the site is considered an inactive landfill. After wastes were no longer accepted, a cover consisting of a layer of clean soil was installed. Currently, the cover ranges in thickness from approximately 2 feet on the slopes to greater than 8 feet on the top deck. In addition, a landfill gas (LFG) extraction system was installed. The LFG system which is continually being modified consists of 24 LFG extraction wells and a flare to destroy the extracted landfill gas.

The site is monitored semi-annually in compliance with Order No. 94-165, which requires the County to submit semi-annual detection monitoring reports to the RWQCB on 30 April and 30 October of each year. In accordance with Waste Discharge Requirements (WDRs) established for the site by the RWQCB in Order No. 94-165 (RWQCB, 1994), the County maintains storm water BMPs during the rainy season (October through April).

Routine groundwater monitoring has been performed at the site since 1991 under the direction of the RWQCB. In addition, several investigations have been conducted at the site from the early 1990s to the present, demonstrating the County's proactive approach to maintaining regulatory compliance and protecting public safety. The investigations have included:

- A water-quality solid waste assessment test (SWAT) in 1993 to determine whether the site posed a threat to water quality.
- An evaluation monitoring program (EMP) in 1999 in response to the detection of potential landfill constituents in groundwater samples collected from site monitoring wells.
- A source characterization in 2003 and 2004 to further evaluate the source of volatile organic compounds (VOCs) detected in groundwater samples collected from monitor wells in the northwest portion of the site.
- A Phase II EMP in 2004 to further evaluate the nature and extent of potential landfill impacts. The Phase II EMP included a screening-level vapor risk assessment based on soil vapor samples collected along the southern site boundary. The results of the screening level vapor risk assessment using the County of San Diego, Department of Environmental Health (DEH) model indicated an acceptable risk to hypothetical residents to the south of the site The excess lifetime cancer risk (ELCR) estimated using the Johnson & Ettinger (J&E) model, modified by the California Department of Toxic Substances Control (DTSC) slightly exceeded the target risk goal of one additional theoretical case of cancer per million people (mathematically expressed as 1×10^{-6}) as established by the U.S. EPA, DTSC and DEH. However, the inputs used in the model were conservative and likely resulted in an overestimation of risk.
- An Updated Report of Waste Discharge (ROWD) and EFS in 2005 to further evaluate the nature and extent of potential landfill impacts. The ROWD/EFS included an update to the previous screening level vapor risk assessment. The cancer risk estimated using the DTSC J&E model and maximum exposure point concentrations (EPCs) in soil vapor samples slightly exceeded the target risk goal of 1×10^{-6}, but the inputs used in the model were conservative and likely resulted in an overestimation of potential risk. Using the J&E model and the 95% upper confidence limit (UCL95) concentrations, the potential cancer risk was approximately equivalent to the target risk goal of 1×10^{-6}.

Based on the results of the 2005 ROWD/EFS, the County voluntarily initiated an additional soil vapor evaluation and EFS. Field activities performed under the direction of the RWQCB and LEA during the period from January through June 2006 related to the Poway Landfill included the following:

Summary of Field Activities

- Installing 16 onsite soil vapor wells and 22 offsite soil vapor wells. These were sampled in April and May 2006;
- Installing and sampling two groundwater monitor wells near the southern property boundary;
- Performing a manometer pressure survey to assess the LFG extraction system performance near the toe of the landfill;
- Performing a historical land use and underground utility evaluation for the adjoining offsite area south of the site; and
- Performing an offsite source evaluation which included surface water sampling, stormwater-sediment sampling, and collecting vapor samples from utility vaults and the laboratory analyses of the collected samples. .

Summary of Results

The volatile constituents detected in soil vapor samples collected near the southern site boundary and/or offsite area south of the site include tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride, and benzene. The results of the investigation are summarized as follows:

Landfill Gas and Soil Vapor Sampling Results

Onsite and offsite soil vapor sampling was performed during multiple events between February and May 2006. VOC concentrations in soil vapor samples collected along the southern property boundary in February 2006 were generally higher than concentrations detected in samples collected in April and May 2006. Higher VOC concentrations detected in soil vapor samples collected during the February soil vapor sampling appear to be due to high-vacuum conditions encountered in some sampling locations. High vacuum conditions caused tracer gas breakthrough, which resulted in elevated laboratory reporting limits, laboratory method interference, and what are believed to be “false positive” results for some constituents of concern such as benzene. Subsequent to development of improved field sampling methods to monitor applied vacuum conditions during purging and sampling, and limit the amount of vacuum applied to the vapor wells, VOC concentrations detected in soil vapor sampling during the April and May 2006 sampling events were significantly lower than those detected during the

February 2006 sampling events. The improved vapor sampling procedures utilized in the April and May 2006 events appear to yield more consistent and repeatable sample data.

Landfill Gas Samples

Landfill gas samples collected from vapor wells installed within refuse near the toe of the landfill in April 2006 contained several VOCs including constituents of concern (COCs) such as dichlorodifluoromethane (DCDFM), PCE, TCE and benzene. Methane concentrations in the landfill gas samples ranged from 16 to 30 percent by volume.

Southern Site Boundary Vapor Samples

Soil vapor samples collected along the southern site boundary during the April and May 2006 sampling events contained significantly lower concentrations of DCDFM, PCE and benzene than landfill gas samples. In addition, none of the eleven soil vapor samples collected along the southern site boundary in April and May 2006 contained detectable concentrations of TCE or vinyl chloride. These data indicate significant attenuation of VOCs between the toe of the landfill and the southern site boundary, and that significant concentrations of landfill gas are not migrating offsite. In addition, nitrogen and methane concentrations detected along the southern site boundary and beneath the residential area south of the site appear consistent with native soil vapor concentrations and not landfill gas migration.

Offsite Vapor Samples

A lower percentage of offsite soil vapor samples contained detectable concentrations of DCDFM and benzene than soil vapor samples collected from the southern site boundary, and offsite concentrations of DCDFM and benzene were generally lower than soil vapor samples collected from the southern site boundary. Additional attenuation is apparent for DCDFM between the southern site boundary and the adjoining offsite area south of the site. Benzene was detected at relatively consistent concentrations in the offsite samples regardless of the distance the samples were collected from the landfill.

Concentrations of constituents of concern generally attenuate one to two orders of magnitude between the toe of the landfill and the southern site boundary. However, PCE was reported at a greater frequency and at higher concentrations in offsite samples than in soil vapor samples collected from the southern site boundary. In addition, PCE was detected in four offsite soil vapor samples at higher concentrations than reported for landfill gas samples. In addition, none of the soil vapor samples collected from the southern site boundary contained detectable concentrations of TCE, but approximately 30

percent of the offsite soil vapor samples contained TCE. Therefore, the landfill gas and soil vapor data collected between April and June 2006 suggest that concentrations of some constituents (primarily PCE and TCE) detected in offsite soil vapor samples appear to be attributable to offsite sources.

Groundwater Sampling Results

Historical groundwater monitoring demonstrates that VOCs in groundwater samples collected from monitor wells near the property boundary attenuate significantly with distance in the area south of the site.

Based on groundwater sampling performed between March and May 2006, trace concentrations of benzene were detected in groundwater samples collected from monitor wells POGW-16, and Vapor Well-1 near the southern site boundary, and in the groundwater sample collected from offsite well POGW-17B. Benzene concentrations detected in soil vapor samples collected from offsite soil vapor wells were greater than concentrations theoretically derived from volatilizing from groundwater. Therefore, benzene concentrations in offsite soil vapor do not appear to be attributable to groundwater, and may be due to offsite sources unrelated to the landfill.

PCE and TCE were detected in groundwater samples collected from groundwater monitor wells near the southern site boundary (POGW-15, -16, -20, and -21 and Vapor Wells-1 and -2), and from offsite monitor well POGW-17B. Detected concentrations of PCE and TCE in these groundwater samples could produce the theoretical concentrations of PCE and TCE in soil vapor similar to the concentrations observed in offsite soil vapor samples. Therefore, PCE and TCE concentrations in offsite soil vapor theoretically may be due to groundwater volatilization. However, sporadic PCE and TCE detections in offsite soil vapor samples, the absence of TCE in vapor samples collected near the southern site boundary, and presence of higher concentrations of PCE in offsite samples than at the southern site boundary or in landfill gas suggests offsite sources unrelated to the landfill may be contributing to concentrations of PCE and TCE detected in offsite soil vapor samples.

Manometer Testing Results

The results of the soil vapor well manometer testing suggest that each medium in which the soil vapor wells are screened is influenced by barometric changes; however, the extent by which each medium is influenced is varied. The results indicate that some soil vapor wells are influenced by the landfill gas extraction system. However, barometric pressure changes were significantly more influential on the measured pressure in each medium than the landfill gas extraction system.

Manometer readings for soil vapor wells installed within the refuse were relatively low as the barometric pressure fluctuated, suggesting moderate to significant pneumatic connectivity of the landfill waste with the atmosphere. This suggests that the landfill cap may be relatively permeable, which may be the cause of elevated oxygen concentrations observed in landfill gas at the Poway Landfill.

One of the two soil vapor wells installed below the refuse showed a response to the operation of the landfill gas extraction system, indicating that the influence of the landfill gas extraction wells extends to some degree to soil underlying the refuse. This suggests that vapor may be extracted from the soil below the waste while the landfill gas extraction system is on, which may somewhat reduce the horizontal influence of the extraction wells during the landfill gas extraction system "on" cycle, thereby reducing their effectiveness at extracting within the waste.

No responses to operation of the LFG extraction system were observed in the soil vapor wells outside the footprint of the landfill waste.

Alternate Source Evaluation

Relatively low soil vapor concentrations of BTEX constituents and chlorinated hydrocarbons including PCE and TCE in the residential area south of the site could be attributable to offsite sources unrelated to the Poway landfill including atmospheric fallout, infiltration of storm water, minor leaks from utilities, asphalt-paved surfaces, chemical usages south of the site, periodic application of hydrocarbon-based street sealants, or periodic street maintenance. Theoretically, volatilization of VOCs from groundwater may account for some of the VOC concentrations detected in offsite soil vapor samples. However, the concentrations and distribution of VOCs detected in offsite soil vapor samples suggests offsite source(s) are contributing to VOC concentrations in offsite soil vapor.

Updated Vapor Risk Assessment Results

The background risk of eventually developing cancer from all causes is approximately one in three (33 percent) for American women or one in two (50 percent) for American men (ACS, 2002). If one million people were exposed to contamination and only one of those people got cancer from that exposure, then according to the USEPA, DTSC, and DEH this risk is acceptable. This is commonly referred to as the excess incremental cancer risk of $1x10^{-6}$.

Using the DTSC (J&E) model and VOC concentrations for each vapor well, the ELCR was estimated to range from 2×10^{-8} to 9×10^{-7}, while the noncancer hazard was estimated to range from 0.001 to 0.05. These hypothetical risk values are acceptable

according to the USEPA, DTSC, and DEH even when conservative assumptions and input parameters are used.

Conclusions

Evaluation of laboratory analytical results for samples collected during this assessment indicates VOCs detected in soil vapor samples collected in the adjoining area south of the site may be attributable to the landfill and other offsite sources unrelated to the landfill. Based on the updated vapor risk assessment, the VOCs detected in offsite soil vapor samples do not appear to represent an adverse health threat to the residents located near the Poway Landfill. Therefore, additional subsurface investigation of onsite or offsite soil vapor impacts does not appear to be warranted.

The County will implement corrective action to address potential offsite impacts resulting from the Poway Landfill. Proposed corrective action includes ongoing onsite and offsite semi-annual groundwater monitoring, semi-annual onsite and offsite soil vapor monitoring, and enhancements to the landfill gas extraction system.

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY ES-1
1. INTRODUCTION 1
1.1 Terms of Reference 1
1.2 Objectives and Scope of Work 1
1.3 Regulatory Compliance 2
1.4 Report Organization 3
1.5 Limitations 3
2. BACKGROUND 5
2.1 Site Location 5
2.2 Site History 5
2.3 Site Setting 5
2.3.1 Topography and Geomorphology 5
2.3.2 Geology 6
2.3.3 Hydrogeology 6
2.3.4 Hydrology 7
2.4 Previous Investigations 7
2.4.1 Routine Semi-Annual Groundwater Monitoring 7
2.4.2 Water-Quality Solid Waste Assessment (SWAT) 7
2.4.3 Evaluation Monitoring Program (EMP) 8
2.4.4 Source Characterization 8
2.4.5 Phase II Evaluation Monitoring Program 8
2.4.6 Updated Report of Waste Discharge and Engineering Feasibility Study ... 9
3. SUMMARY OF FIELD ACTIVITIES 10
3.1 General 10
3.2 Soil Vapor Well Installation and Sampling Activities 10
3.2.1 Onsite Soil Vapor Well Installation 10
3.2.2 Offsite Soil Vapor Well Installation 11
3.2.3 Soil Vapor Well Sampling 11
3.3 Low Level Detection Groundwater Monitoring 12
3.4 Installation of Groundwater Monitor Wells 12
3.5 Offsite Source Investigation 13
3.6 Utility Investigation 14
3.7 Vapor Probe Manometer Testing 15
4. SUMMARY OF FIELD INVESTIGATIONS 16
4.1 General 16
4.1.1 Data Validation 16
4.2 Soil Vapor Analytical Results 16
4.2.1 Landfill Soil Vapor Wells 16
4.2.2 Southern Site Boundary Soil Vapor Wells 17
4.2.3 Offsite Soil Vapor Wells 20
4.3 Groundwater Monitoring Results 23
4.3.1 VOCs in Groundwater 23
4.3.2 VOCs Partitioning From Groundwater 25
4.4 Offsite Source Investigation Results 26

4.4.1 Historical Aerial Photographs ... 26
4.4.2 Surface Water Sample Results ... 27
4.4.3 Soil Sampling Results ... 27
4.5 Utility Investigation Results ... 28
4.6 Manometer Testing Results ... 29
4.6.1 Soil Vapor Wells Screened Within Landfill Waste ... 29
4.6.2 Soil Vapor Wells Screened in Soil Underlying Landfill Waste ... 29
4.6.3 Soil Vapor Wells Screened at the Southern Site Boundary ... 30
5. UPDATED HUMAN HEALTH RISK ASSESSMENT ... 31
5.1 Previous Human Health Risk Assessment ... 31
5.2 Updated Human Health Risk Assessment ... 32
6. SUMMARY AND CONCLUSIONS ... 33
6.1 Chemical Quality of Soil Vapor ... 33
6.2 Chemical Quality of Groundwater ... 34
6.3 Potential Sources of Soil Vapor Impacts ... 35
6.4 Manometer Testing ... 35
6.5 Updated Human Health Risk Assessment ... 36
6.6 Conclusions ... 36
7. ENGINEERING FEASIBILITY STUDY ... 37
7.1 General ... 37
7.2 Screening Analysis ... 37
7.3 Engineering Feasibility Analysis ... 37
7.3.1 No Further Action ... 37
7.3.2 Monitored Natural Attenuation ... 38
7.3.3 Source Control Alternatives ... 39
7.3.3.1 Vertical Vapor Barrier at Southern Property Boundary ... 39
7.3.3.2 Soil Vapor Extraction (SVE) at the Southern Site Boundary ... 40
7.3.3.3 Enhancement of the Current Landfill Gas Extraction System ... 41
7.3.4 Source Removal Alternatives ... 42
7.3.4.1 Excavation of Waste and Disposal Off-Site ... 42
7.4 Summary ... 42
8. CORRECTIVE ACTION PROGRAM ... 43
8.1 General ... 43
8.2 Source Control ... 43
8.2.1 Cover and Storm Water Maintenance ... 43
8.2.2 Enhancement of the LFG System ... 43
8.3 Soil Vapor Monitoring ... 44
8.4 Monitored Natural Attenuation ... 44
9. CORRECTIVE ACTION MONITORING AND REPORTING PROGRAM ... 46
9.1 General ... 46
9.2 Source Control ... 46
9.3 Corrective Action Groundwater Monitoring ... 46
9.4 Corrective Action Monitoring Parameters ... 47
9.5 Corrective Action Soil Vapor Monitoring ... 47
9.6 Corrective Action Soil Vapor Monitoring Parameters ... 48
9.7 Monitoring and Reporting Frequency ... 49
10. REFERENCES ... 50

TABLES

1 Historical Groundwater Elevations
2 Summary of Soil Vapor Analytical Results, February through June 2006
3 Summary of Groundwater Analytical Results, March, April and May 2006
4 Summary of Theoretical vs. Measured Soil Vapor Concentration
5 Summary of Surface Water Analytical Results
6 Summary of Sediment and Soil Sample Analytical Results
7 Summary of Utility Vapor Analytical Results
8 Assessment of Potential Corrective Measures

FIGURES

1 Site Location
2 Groundwater Monitoring Network and Landfill Gas Extraction System
3 Regional Geology
4 Groundwater Elevation Fluctuations
5 Groundwater Elevations and Flow Direction 1 June 2006
6 Hydrologic Features
7 Soil Vapor Wells and Utility Locations
8 Benzene Concentrations in Soil Vapor, April and May 2006
9 PCE Concentrations in Soil Vapor, April and May 2006
10 TCE Concentrations in Soil Vapor, April and May 2006
11 Estimated Risk Associated with COCs Detected in Individual Vapor Wells
12 Corrective Measures

APPENDICES

A Field Procedures
B Soil Vapor Well Installation Permits and Subsurface Surveys Geophysical Reports
C Boring Logs and Soil Vapor Well Construction Diagrams
D Soil Vapor Collection and Logs
E Laboratory Media Certification Reports
F Laboratory Analytical Certificates and Data Validation (electronic copy)
G Manometer Testing Procedures
H Historical Aerial Photographs
I Risk Assessment Procedures

1. INTRODUCTION

1.1 Terms of Reference

This Additional Soil Vapor Evaluation and Engineering Feasibility Study (EFS) was prepared to further assess potential soil vapor impacts potentially related to the Poway Landfill (the site) on the adjoining residential community south of the site, and evaluate corrective action alternatives. A Corrective Action Program (CAP) for the site is also provided in this report. This report was prepared by GeoSyntec Consultants (GeoSyntec) for the County of San Diego, Department of Public Works, Landfill Management (the County). The scope of services described herein were performed in accordance with the Corrective Action Program (CAP) and revised Downgradient Soil Vapor Work Plans submitted to and approved by the Regional Water Quality Control Board (RWQCB) and San Diego County Department of Environmental Health Local Enforcement Agency (LEA) (GeoSyntec, 2005a and 2006a). This report was prepared by Messrs. Sean McClain and Christopher Gale and was reviewed by Messrs. Veryl Wittig, P.G., C.Hg. and Sam Williams, P.G., C.Hg., in accordance with GeoSyntec's internal review policy. This report was also reviewed by Mr. Barry Pulver, P.G., C.E.G., C.Hg., of the County.

1.2 Objectives and Scope of Work

The objectives of the soil vapor evaluation and EFS were to: further assess the nature and extent of potential subsurface soil vapor impacts at the site, assess the chemical quality of soil vapor in the adjoining residential area south of the site; update the human health risk assessment previously prepared; evaluate potential corrective action alternatives; and establish a CAP to address offsite soil vapor impacts believed to be attributable to the site. This report presents a plan for the implementation of corrective action in accordance with the provisions of Title 27 § 20425. To achieve these objectives, GeoSyntec provided the following services:

- Performed an offsite source evaluation to assess historical land use and other potential sources which may be contributing constituents in soil vapor samples;
- Installed four soil vapor wells within the refuse and two soil vapor wells beneath the refuse to evaluate the chemical composition of LFG and the radius of influence from existing LFG extraction wells near the toe of the landfill;
- Installed eight soil vapor wells near the southern site boundary and two background soil vapor wells to further evaluate onsite and background soil vapor quality;

- Installed eight soil vapor well clusters and six single soil vapor wells within Sunset View Road; Dehia, Mirando and Silla Streets; Los Olivos, El Mar and Acton Avenues to further evaluate soil vapor quality in the adjoining residential area south of the site;
- Performed manometer testing on soil vapor wells within waste and near the southern site boundary to assess LFG extraction system performance near the toe of the landfill;
- Installed two groundwater monitor wells to further evaluate downgradient groundwater quality near the southern property boundary;
- Performed surface water sampling in the residential area downgradient of the site within Sunset View Road, Dehia and Mirando Streets, and Los Olivos Avenue to further assess storm water quality draining from streets;
- Performed surface water sampling on storm water discharging onto the site from Poway Road and sampled soil from the desiltation basin;
- Assessed subsurface utilities within Dehia Street and El Mar Avenue as potential pathways for offsite vapor transport through trench backfill material surrounding the underground utilities located near the southern property boundary;
- Performed vapor sampling from subsurface sewer utilities and storm water drop-inlets within and along Dehia and Mirando Streets and Los Olivos and Sunset View Avenues;
- Performed an updated vapor phase human health risk assessment for the adjoining residential area south of the landfill;
- Performed an EFS of viable remedial technologies that could be used in the CAP; and
- Developed a Soil Vapor CAP and Monitoring and Reporting Program.

1.3 Regulatory Compliance

On 10 March 2006, the RWQCB issued Notice of Violation (NOV) No. R9-2006-0035 for violations related to Order No. 94-165 for the Poway Landfill (RWQCB, 2006b). According to the NOV, the asserted violations include illegal discharges of waste to land and "waters of the State," and offsite migration of waste constituents. Before the NOV was issued, the County was working diligently and proactively to characterize and mitigate potential impacts from the site (GeoSyntec, 2004b and 2005b).

On 20 March 2006, the LEA issued Official Notice SWIS #37-AA-0018 for the Poway Landfill (LEA, 2006). According to the Official Notice, the County was required to determine whether the Poway Landfill is causing a hazard or nuisance by migration of landfill gas offsite. On 24 April 2006, the County submitted to the LEA a "Response to the Official Notice: Poway Landfill SWIS # 37-AA-0018" (County, 2006). The County's response addressed each action item outlined in the LEA's Official Notice.

1.4 Report Organization

The remainder of this report is organized into the following sections:

- Section 2, "Background" presents the site description, location, history, geology, hydrogeology and hydrology, and previous investigations performed at the site;
- Section 3, "Summary of Field Activities," describes the scope of services, investigation methods; soil vapor, surface water and groundwater sampling procedures, analytical parameters, and sample handling procedures;
- Section 4, "Summary of Field Investigations," presents and interprets field data and observations and analytical results for groundwater, surface water, soil, and soil vapor samples collected during field activities;
- Section 5, "Updated Human Health Risk Assessment" presents the results of the updated human health risk assessment;
- Section 6, "Summary and Conclusions" presents a summary of the results of the field activities, risk assessment and conclusions derived from those results;
- Section 7, "Engineering Feasibility Study" presents an evaluation of viable remedial technologies for apparent impacts associated with the site;
- Section 8, "Corrective Action Program" presents the remedial alternatives which include source control and soil vapor monitoring;
- Section 9, "Corrective Action Monitoring and Reporting Program" outlines proposed corrective action measures to be conducted to demonstrate the effectiveness of the selected corrective action alternatives; and
- Section 10, "References," presents a list of documents referenced in this report.

1.5 Limitations

The scope of services provided herein were performed in accordance with current state and local guidance, and the standard of care exercised by scientists and engineers

performing similar services in this area. The conclusions contained in this report are based solely on the analysis of the conditions observed by GeoSyntec personnel and as reported by regulatory agencies and other named sources. We cannot make any assurances concerning the completeness of the data presented to us.

No warranty, expressed or implied, is made regarding the professional opinions expressed in this report. If actual conditions are found to differ from those described in this report, or if new information regarding the site is obtained, GeoSyntec should be notified and additional recommendations, if required, will be provided. GeoSyntec is not liable for any use of the information contained in this report by persons other than the County of San Diego, or use of information in this report for any purposes other than referenced in this report without the expressed, written consent of GeoSyntec.

2. BACKGROUND

2.1 Site Location

The site is located on the south side of Poway Road at 14900 Poway Road in Poway, California (Figure 1). The San Diego County Tax Assessor's parcel number for the site is 321-200-38. This site is located in Township 14 South, Range 1 West, Section 7 of the San Bernardino Baseline and Meridian (USGS, 1975).

2.2 Site History

The site was operated as a burn dump from 1949 to 1966. From 1967 to 1975, the site was operated as a Class II (Class III under current regulations) solid waste disposal facility, and contains an estimated 165,000 tons of refuse with an average waste fill thickness of 30 feet (IT, 1993). The landfill was permitted to receive residential, commercial, and agricultural wastes. No known septic, industrial, chemical or liquid wastes were received at the site.

The landfill was constructed without a liner, and does not have a leachate collection or removal system. The landfill cover ranges in thickness from approximately 2 feet on the slopes to greater than 8 feet on the top deck. Other than the existing groundwater monitoring network and LFG migration probes, no leak detection system has been installed at the landfill. A LFG extraction system consisting of 24 LFG extraction wells and a flare have been in operation at the site since July 1996. A map showing the current groundwater monitoring network and LFG extraction system is included as Figure 2.

The site is monitored semi-annually in compliance with Order No. 94-165, which requires the County to submit semi-annual detection monitoring reports to the RWQCB on 30 April and 30 October of each year. The groundwater monitoring network consists of three background monitor wells (POGW-6, -9 and -10) and six compliance monitor wells (POGW-11, -12, -13, -14, -15, and -16). In June 2005, two nested monitor well pairs (POGW-17A/17B and POGW-18A/18B) were installed within the public right-of-way of Los Olivos and Dehia Street downgradient of the site to enhance the monitoring network.

2.3 Site Setting

2.3.1 Topography and Geomorphology

The site is located in a generally mountainous region on the western slope of the Peninsular Range province in San Diego County. Steep slopes bound the site to the east

and west. Elevations at the landfill range from approximately 735 feet above mean sea level (MSL) at the northeastern property boundary to approximately 610 feet above MSL along the southern property boundary.

2.3.2 Geology

The site is predominantly underlain by Cretaceous-age granitic rock of the Southern California Batholith (Figure 3). The crystalline rock is gray to reddish brown and ranges from extremely weathered to hard and fresh. Extremely-to moderately-weathered granitic rock is generally present at the surface as scattered outcrops, primarily at higher elevations around the landfill. Discontinuous outcrops of the Lusardi Formation, a poorly sorted conglomerate, rest unconformably on granitic bedrock in the northeast portion of the site (Kennedy and Peterson, 1975). The waste fill is underlain by Quaternary-age alluvium primarily composed of weathered granite along its eastern perimeter. No major faulting has been identified within one mile of the site; however, jointing is present in the granitic rock. Predominant surface joint attitudes and geologic contacts at the site and in the site vicinity strike approximately N35°W, N32°E, and N70°E (IT, 1999).

2.3.3 Hydrogeology

The site is located in the Poway Hydrologic Area (6.20) of the Penasquitos Hydrologic Unit (RWQCB, 2006a). Groundwater within the Poway Hydrologic Area has been designated as having existing beneficial use for municipal and agricultural uses and potential beneficial use for industrial supply uses (RWQCB, 2006a). Groundwater beneath the site is considered unconfined and flows within the fractured granitic bedrock. Historically, groundwater elevations have ranged from approximately 696 feet MSL to approximately 576 feet MSL (Table 1). Between August 1998 and late 2004, groundwater elevations at the site exhibited a general declining trend (Figure 4).

Due to significant rainfall that occurred between January and March 2005 (National Weather Service, 2005), groundwater elevations increased in all monitor wells and piezometers between the first and third quarter 2005 monitoring events (except for monitor well POGW-12). The most significant increase in groundwater elevations were observed in background monitor wells, ranging from 6.99 feet in POGW-6 to 23.98 feet in POGW-9. Groundwater elevations in offsite shallow monitor wells remained within historical ranges. Consistent with previous data, the direction of groundwater flow is generally southerly at an average hydraulic gradient ranging from 0.06 to 0.21 feet per foot (ft/ft) (Figure 5).

2.3.4 Hydrology

The site is located at the head of a small canyon that widens to the south and drains toward Poway Creek, a west-trending drainage approximately 3,500 feet south of the site (Figure 6). Drainage in Poway Creek flows west toward Rattlesnake Creek. Surface water for the Los Penasquitos Creek Watershed has been designated as having existing beneficial use for agricultural purposes, contact and non-contact water recreation, warm freshwater habitat and wildlife habitat and potential industrial uses (RWQCB, 2006a). With the exception of Rattlesnake Creek located approximately 5,000 feet upgradient of the site, no perennial surface water occurs within 1-mile of the site. Surface water runoff in the site vicinity occurs during and shortly after periods of precipitation and is directed away from the site by storm drains, drain pipes and a concrete-lined channel.

2.4 Previous Investigations

Several subsurface investigations have been conducted at the site since 1991. The findings of these investigations are summarized below.

2.4.1 Routine Semi-Annual Groundwater Monitoring

Routine groundwater monitoring has been performed at the site since 1991. Groundwater samples analyzed for general chemistry parameters and volatile organic compounds (VOCs) indicate that groundwater quality beneath the landfill is relatively stable with the exception of slightly increasing concentrations of trichloroethene (TCE) and cis-1,2,-dichloroethene (cis-1,2-DCE) in groundwater samples collected from monitor well POGW-14. The highest concentrations of VOCs have historically been observed in groundwater samples collected from former compliance monitor well POGW-7, and compliance monitor wells POGW-14 and POGW-16.

2.4.2 Water-Quality Solid Waste Assessment (SWAT)

A water-quality solid waste assessment test (SWAT) conducted for the Poway Landfill was performed in response to the provisions of the California Water Code, Section 13273, as amended (IT, 1993). The purpose of the SWAT was to determine whether the site poses a threat to water quality. The results of the SWAT indicated that in 1993 trichloroethene (TCE) and vinyl chloride were detected at concentrations above the drinking water standard in groundwater samples collected from monitor wells POGW-7 and POGW-8.

2.4.3 Evaluation Monitoring Program (EMP)

IT Corporation (IT) prepared an evaluation monitoring program (EMP) report on the Poway Landfill on behalf of the County for submittal to the RWQCB (IT, 1999). The EMP was implemented in response to the detection of potential landfill constituents in groundwater samples collected from site monitoring wells, according to the requirements of RWQCB Order No. 94-165. Groundwater samples were collected from existing monitor wells and four monitor wells (POGW-9, -10, -11, -12 and -13) installed between January and February 1996. The results of the EMP indicated that in 1999 VOCs (cis-1,2-DCE, methylene chloride, TCE, and vinyl chloride) were detected at concentrations exceeding maximum contaminant levels (MCLs) for drinking water in groundwater samples collected from monitor well POGW-7 located in the western portion of the site.

Due to a large screen interval, monitor well POGW-7 was destroyed in December 1999 because it was thought to be a pathway for constituent migration (GeoSyntec, 2000a). Monitor well POGW-14 was installed in January 2000 to replace POGW-7. Additional work was recommended to confirm the lateral and vertical extent of VOC impacts to groundwater in the vicinity of former monitor well POGW-7.

2.4.4 Source Characterization

To further evaluate the source of VOCs, primarily TCE, in the northwest portion of the site, GeoSyntec performed a source characterization in the vicinity of monitor well POGW-14 in April 2003. Groundwater samples were collected from five piezometers (POPW-1, POPW-2A, POPW-2B, POPW-3, and POPW-4) installed to delineate the extent of impacts in the "source area" (GeoSyntec, 2004a). The results of the source characterization indicated an apparent source of TCE in the northwest portion of the landfill. The presence of the TCE degradation product cis-1,2-DCE detected in groundwater samples collected from the POPW-series piezometers suggests that natural attenuation of TCE is occurring in site groundwater. Based on results of the source characterization and evaluation of historical groundwater sampling data, the source area appeared to be confined to the northwest portion of the landfill.

2.4.5 Phase II Evaluation Monitoring Program

To further evaluate the nature and extent of potential landfill impacts and assess potential risks to the residential community located south of the site near the toe of the landfill a Phase II EMP was performed (GeoSyntec, 2004b). Monitor well POGW-16 was installed near the southwest corner of the landfill property to provide additional downgradient groundwater monitoring data west of monitor well POGW-15 and downgradient of the localized "source area" in the northwest portion of the landfill. TCE, 1,1-dichloroethane (1,1-DCA), cis-1,2-DCE, and vinyl chloride were detected in

groundwater samples collected from monitor well POGW-16 at concentrations exceeding MCLs for drinking water.

Because VOCs detected in soil vapor and groundwater have the potential to migrate through the subsurface into indoor air, a screening-level vapor phase risk assessment was conducted to evaluate potential risk to the adjoining residential area south of the site. VOCs were detected in the soil vapor samples collected from nine soil vapor sampling locations near the southern property boundary. The most prevalent constituents detected in the soil vapor samples were dichlorodifluoromethane (DCDFM), acetone, 2-butanone, benzene, toluene, ethylbenzene, total xylenes, and tetrachloroethene (PCE). The screening-level vapor risk assessment was performed using the Department of Environmental Health (DEH) Vapor Risk model and the California Department of Toxic Substances Control (DTSC) modified Johnson and Ettinger (J&E) vapor intrusion model (DTSC J&E model). Estimated cancer risks and noncancer hazards using the DEH model were less than the DEH target health goals of 1×10^{-6} and 1.0, respectively. The cancer risk estimated using the DTSC J&E model slightly exceeded the DEH target risk goal of 1×10^{-6}; however, the inputs used in the model were conservative and likely resulted in an overestimation of risk.

2.4.6 Updated Report of Waste Discharge and Engineering Feasibility Study

To further evaluate the nature and extent of potential landfill impacts and assess potential risks to the residential community located south of the site, an Updated Report of Waste Discharge (ROWD) and EFS was performed (GeoSyntec, 2005b).

A screening-level offsite soil vapor survey was performed within Dehia Street and El Mar Avenue to obtain the necessary soil vapor data to update the vapor phase human health risk assessment for the adjoining residential area south of the landfill. VOCs (primarily benzene) were detected in soil vapor samples collected from two depths at ten soil vapor sampling locations within Dehia Street and El Mar Avenue.

The updated screening-level risk assessment using maximum exposure point concentrations (EPCs) did not change significantly when compared to the results from the vapor phase human health risk assessment conducted during the Phase II EMP. Although the cancer risk estimated using the DTSC J&E model and maximum EPCs still slightly exceeded the DEH target risk goal of 1×10^{-6}, the inputs used in the model were conservative and likely resulted in an overestimation of potential risk. Based on a distributional assumption using the DTSC J&E model and 95% upper confidence limit (UCL95) concentrations, the potential cancer risk was approximately equivalent to the DEH target risk goal of 1×10^{-6}.

3. SUMMARY OF FIELD ACTIVITIES

3.1 General

This section presents a summary of field activities performed during the period from January through June 2006 related to the Poway Landfill. These investigations were conducted in accordance with the Corrective Action Program and Revised Downgradient Soil Vapor Sampling Work Plans (GeoSyntec, 2005a and 2006a). A detailed description of field activities performed during the period from January through June 2006 at the Poway Landfill is provided in Appendix A.

3.2 Soil Vapor Well Installation and Sampling Activities

Prior to commencing field activities, City of Poway right of way encroachment permits and County of San Diego Department of Environmental Health (DEH), monitoring well permits were obtained, proposed boring locations were delineated, and Underground Service Alert (USA, Digalert) was notified for underground utility clearance. Prior to commencing installation of soil vapor wells, Subsurface Surveys and Associates, Inc. (Subsurface Surveys) of Solana Beach, California conducted subsurface utility clearances in the vicinities of the boring locations. Copies of Subsurface Surveys utility clearance reports, City of Poway encroachment permits, and DEH well permits (LMON 103707, LMON 103853, and LMON 103910) are provided in Appendix B. Soil boring logs and soil vapor well construction diagrams are provided in Appendix C. Soil vapor sample collection logs are provided in Appendix D. Soil vapor sampling media used during the April, May, and June 2006 sampling events were individually certified clean by the laboratory prior to sample collection (Appendix E).

3.2.1 Onsite Soil Vapor Well Installation

Soil vapor monitor wells were constructed in accordance with County of San Diego DEH guidance for small diameter monitor wells on 30 January 2006 and 20 March 2006. On 30 January 2006, Vironex Environmental Services (Vironex) of Santa Ana, California (under contract to GeoSyntec) constructed three pairs of nested soil vapor wells (PVP-1,-2, and -3) along the southern property boundary of the site. Nested soil vapor wells (PVP-2A/-2B and PVP-3A/-3B) were installed to depths approximately five and ten feet below the estimated slab elevations of the adjoining residences south of the site. Because bedrock was encountered before the target depth was achieved, PVP-1 consists of a single soil vapor well constructed at an elevation of approximately five feet below the estimated slab elevation of the adjoining residence to the south.

Based on concentrations of VOCs detected during the February 2006 sampling events (summarized in Table 2 and discussed in section 4.2.1) and previous sampling events (discussed in section 2.4) additional onsite soil vapor wells appeared warranted.

On 20 March 2006, Cascade Drilling, Inc. (Cascade) of Norwalk, California (under contract to GeoSyntec) constructed three additional soil vapor wells (PVP-1A, -4A, and -4B) along the southern property boundary, two background soil vapor wells along the northern and eastern property boundaries (PVP-5 and -6, respectively), and six soil vapor wells near the toe of the landfill (PVP-7A through -10B). The six soil vapor wells installed near the toe of the landfill were installed to evaluate the performance of the landfill gas extraction system to control vapor migration. Four soil vapor wells (PVP-7A, -8, -9, and -10A) were installed within the refuse and two soil vapor wells (PVP-7B and -10B) were installed in soil underlying the refuse (Figure 7).

3.2.2 Offsite Soil Vapor Well Installation

Based on VOCs detected in soil vapor samples collected along the southern site boundary and previously collected beneath Dehia Street and El Mar Avenue south of the site, soil vapor wells appeared warranted in the residential area downgradient of the site. In April 2006, Vironex (under contract to GeoSyntec) constructed 22 offsite soil vapor wells to further evaluate subsurface soil vapor quality in the residential area south of the site. Eight soil vapor well clusters and six single soil vapor wells were installed within Sunset View Road; Dehia, Mirando and Silla Streets; and Los Olivos, El Mar and Acton Avenues (Figure 7). The offsite soil vapor wells were constructed in accordance with DEH guidance.

3.2.3 Soil Vapor Well Sampling

GeoSyntec personnel sampled soil vapor wells PVP-1, -2A, -2B, -3A, and -3B on 2 February 2006 as detailed in Appendix A. Laboratory analytical results from the 2 February 2006 sampling event indicated tracer gas (2-propanol) breakthrough in two of the five primary soil vapor samples (PVP-2A and -2B) along with the duplicate soil vapor sample (PVP-1D, Table 2). Therefore, GeoSyntec personnel resampled soil vapor wells PVP-1, -2A, -2B, -3A, and -3B on 14 February 2006. During the 14 February 2006 sampling event, full (1 liter) soil vapor samples could not be collected from soil vapor wells PVP-1 and PVP-2B due to high vacuum conditions. Smaller sample volumes (less than 1-liter) were collected from PVP-1 and -2B, and analytical results indicated tracer gas breakthrough in both samples. High vacuum conditions, which prevented full soil vapor samples from being collected during the 14 February sampling event, appear to be attributable to a higher percentage of moisture in soil at the sample intervals in PVP-1 and -2B.

Soil vapor wells installed near the toe of the landfill were sampled by GeoSyntec personnel on 6 April 2006 when the landfill gas extraction system had been off for over 24 hours.

On 19 April 2006 GeoSyntec personnel began sampling onsite and offsite soil vapor wells with the exception of onsite soil vapor wells located along the toe of the landfill (PVP-7 through-10). Prior to sampling, pneumatic testing was conducted on the soil vapor wells to estimate relative soil permeability at the target depths. Following the pneumatic tests, soil vapor wells were purged of approximately three liters and subsequently sampled as detailed in Appendix A. Soil vapor samples were collected into laboratory supplied and certified clean one liter summa canisters.

On 8 May 2006 GeoSyntec personnel began the second of the proposed bi-weekly soil vapor sampling events. The relatively large volumes (approximately three liters) purged from the soil vapor wells during the April 2006 sampling event may have led to tracer gas breakthrough in some instances. Therefore, during the May 2006 sampling event, soil vapor wells were purged of approximately three borehole volumes of air rather than three liters. Following purging, soil vapor samples were collected into laboratory supplied and certified clean one liter summa canisters as detailed in Appendix A.

One duplicate soil vapor sample, an ambient air blank, and one trip blank were submitted along with the soil vapor samples to Air Toxics, LTD. (Air Toxics) in Folsom, California, for analysis for VOCs by EPA Method TO-15 and fixed gases by ASTM D-1945 for each day of sampling under chain of custody procedures.

3.3 Low Level Detection Groundwater Monitoring

Based on the relatively low concentrations of VOCs in soil vapor collected near the southern site boundary and in the residential area south of the site, low-level VOC analyses were recommended for groundwater samples collected from downgradient monitor wells to evaluate whether VOC concentrations in soil vapor are potentially attributable to groundwater as an alternate source. On 31 March and 3 and 4 April 2006 GeoSyntec personnel collected groundwater samples from downgradient groundwater monitor well POGW-16, abandoned Vapor Well 1 and Vapor Well 2; and downgradient offsite groundwater monitor wells POGW-15, -17A, -18A, and -18B (Figures 2 and 4). The lower level detection method was used to evaluate the potential presence of VOCs at concentrations below standard laboratory method detection limits. Groundwater samples were collected and analyzed for VOCs by EPA Method 8260B as detailed in Appendix A.

3.4 Installation of Groundwater Monitor Wells

Based on historical analytical results from groundwater samples collected from monitor wells POGW-16, POGW-15 and destroyed monitor well POGW-8, two additional groundwater monitor wells were installed to further evaluate potential groundwater impacts at the southern property boundary. Monitor well POGW-20 was

installed near the location of destroyed monitor POGW-8 and monitor well POGW-21 was installed between monitor wells POGW-15 and POGW-16 (Figure 2).

On 10 and 11 April 2006, Tri-County Drilling of San Diego, California (under contract to GeoSyntec) constructed groundwater monitor wells POGW-20 and -21 along the southern property boundary. Pilot borings were advanced using an all-terrain CME-75 hollow stem auger drill rig capable of converting to rock coring drilling methods. Boring POGW-20 was advanced using an eight-inch diameter auger through the residuum to the top of competent granitic bedrock to prevent caving of non-cohesive soils and to improve circulation and cuttings return. After encountering competent bedrock at 25 feet bgs, the boring was advanced to a depth of 44 feet below ground surface (bgs) using a 3.9-inch diameter rock core bit. Boring POGW-21 was advanced using eight-inch diameter augers through residuum and extremely weathered granitic bedrock to a total depth of 33.5 feet bgs. Subsurface conditions encountered during drilling were described in the field by a GeoSyntec geologist working under the direction of a California Professional Geologist. Groundwater wells were constructed in accordance with County of San Diego DEH monitor well permit number LMON 103898 (Appendix B).

GeoSyntec personnel developed and sampled monitor wells POGW-20 and POGW-21 on 12 May 2006 as detailed in Appendix A. Groundwater samples, a field blank, and a trip blank were submitted to Calscience Laboratories (Calscience) in Garden Grove, California for VOC analysis by EPA Method 8260B.

3.5 Offsite Source Investigation

The purpose of the offsite source investigation was to evaluate historical downgradient offsite property uses and potential offsite sources of VOCs previously detected in offsite soil vapor samples. Historic aerial photographs from 1928, 1958, and 1973 were reviewed at the County of San Diego Department of Public Works to document previous land use south of the site. GeoSyntec also evaluated storm water infiltration, underground utility alignments, historical agricultural activity, and historical construction activities in the adjoining area south of the site. Storm water runoff from Poway Road flows into a concrete channel located in the eastern portion of the landfill property where it discharges and infiltrates into a desiltation basin near the southern property boundary. To assess the presence of VOCs in storm water two surface water samples were collected following rain events on 31 March and 6 April 2006 in the concrete channel where storm water from Poway Road flows onto the site (Figure 7). In addition, sediment samples were collected from three locations at depths of approximately 2.5 and 5 feet bgs where the storm water discharges to the desiltation basin.

To assess the presence of VOCs in soil beneath the streets south of the site, soil samples were collected on 11, 12, 13 and 17 April 2006 beneath Dehia and Mirando Streets and Sunset View Road from just beneath the asphalt, 2.5 and 5 feet bgs from borings VW-2A, -4, -5, -12 and -13.

To assess the presence of VOCs in surface water runoff in the residential area south of the site following a rain event, surface water samples were collected on 22 May 2006 from the gutters along Dehia and Mirando Streets and Sunset View Road, downgradient of the site. The surface water and soil samples were analyzed for VOCs by EPA Method 8260B as detailed in Appendix A.

3.6 Utility Investigation

The purpose of the utility investigation was to asses the potential of underground utilities as a source of VOCs previously detected in offsite soil vapor samples. GeoSyntec obtained storm drain and sanitary sewer as-built construction drawings and engineering specifications for City of Poway right-of-ways of Dehia Street and El Mar Avenue to determine the location and construction specifications of underground utilities near the southern property boundary. The as-built drawings were used to select four soil vapor sampling locations adjacent to underground storm drain alignments and sanitary sewer alignments (Figure 7).

On 16 May 2006 GeoSyntec personnel advanced four hand auger borings to construct temporary soil vapor probes (Sewer Line #1 through #4) in the vicinities of subsurface utilities near the southern site boundary (Figure 7). The temporary soil vapor probes were allowed to equilibrate for at least four hours after installation prior to purging and sampling. The temporary soil vapor wells were purged, sampled and destroyed following sampling as described in Appendix A.

Because the soil vapor samples collected from temporary soil vapor probes contained VOCs, on 1 June 2006 additional vapor samples were collected from the interiors of sewer and storm drain vaults to further evaluate the potential of underground utilities as an alternative source of VOCs observed the residential neighborhood south of the site. Vapor samples were collected at four locations through manholes along sanitary sewer alignments and three storm drain alignments within the residential area south of the site. Underground utility vapor samples were collected from sanitary sewer and storm drain manholes beneath and along Dehia and Mirando Streets, Los Olivos Avenue, and Sunset View Road (Figure 7).

3.7 Vapor Probe Manometer Testing

A study was performed at the Poway Landfill between 10 April 2006 and 12 May 2006 to evaluate the vacuum response of soil vapor wells to the LFG extraction system and barometric pressure changes. A detailed discussion of the manometer testing methods and results is presented in Appendix G. Vapor wells that were evaluated were located within different media at various locations including:

- Within the waste near the toe of the landfill (PVP-7A, PVP-8, PVP-9, and PVP-10A);
- In native soil underlying the waste (PVP-7B and PVP-10B); and
- In native soil outside of the landfill waste footprint (PVP-1, PVP-1A, PVP-2A, PVP-2B, PVP-3A, PVP-3B, PVP-4A, PVP-4B, and PVP-5).

Results of the study were analyzed to qualitatively evaluate: 1) the influence of the LFG extraction system within the waste; 2) the permeability of the landfill cap; and 3) the pneumatic connectivity between the soil vapor wells and the atmosphere. Appendix G also includes a graphical presentation of the manometer readings. A brief summary of the testing methods is presented in Appendix A.

4. SUMMARY OF FIELD INVESTIGATIONS

4.1 General

The following sections summarize the results of the field activities performed at the Poway Landfill and adjoining residential area south of the site from January through June 2006. Laboratory analytical certificates for samples collected from January through June 2006 are included in Appendix F.

4.1.1 Data Validation

Laboratory data was validated by Julia Klens Caprio of GeoSyntec Consultants. A summary of the data validation is included with the laboratory analytical certificates in Appendix F. Based on the data validation, the data were determined to be usable as qualified.

4.2 Soil Vapor Analytical Results

The following sub-sections summarize the results of onsite and offsite soil vapor sampling performed at the site from January to June 2006. Analytical results for soil vapor samples collected between February and May 2006 are summarized in Table 2.

4.2.1 Landfill Soil Vapor Wells

A summary of the analytical results for landfill gas samples collected from vapor wells installed within the landfill (PVP-7A, -8, -9, -10A) and soil vapor samples collected from soil vapor wells installed below the refuse in the landfill is provided in Table 2. 20 VOCs were detected in the six soil vapor samples collected from the soil vapor wells installed in the toe of the landfill. The discussion presented herein focuses on indicators of LFG migration, such as DCDFM and vinyl chloride, and constituents which account for the greatest portion of the estimated risk, including PCE, TCE, and BTEX constituents. Samples collected from vapor wells installed within the waste (PVP-7A, -8, -9, -10A) contained the following:

- DCDFM at concentrations ranging from 210 to 910 ppbv (4 of 4 samples);
- PCE at concentrations ranging from 18 to 27 ppbv (2 of 4 samples-not detected in samples collected from PVP-7A and -10A);
- TCE at concentrations ranging from 19 to 37 ppbv (4 of 4 samples);
- Vinyl chloride at concentrations ranging from 82 to 250 ppbv (4 of 4 samples);
- Benzene at concentrations ranging from 87 to 180 ppbv (4 of 4 samples);
- Toluene at concentrations ranging from 74 to 700 ppbv (4 of 4 samples);

- Ethylbenzene at concentrations ranging from 360 to 2900 ppbv (4 of 4 samples); and
- Total xylenes at concentrations ranging from 56 to 920 ppbv (4 of 4 samples).

Landfill gas samples collected from the soil vapor wells installed in the toe of the landfill contained 38% to 58% nitrogen by volume; 16% to 30% methane by volume; 1.1% to 8.2% oxygen by volume.

Soil vapor samples collected from vapor wells (PVP-7B and -10B) installed in the native soil below the waste contained the following:

- DCDFM at concentrations of 73 and 260 ppbv, respectively;
- PCE at concentrations of 3.3 and 5 ppbv, respectively;
- TCE at concentrations of 10 and 23 ppbv, respectively;
- Vinyl chloride at concentrations of 31 and 280 ppbv, respectively;
- Benzene at concentrations of 87 and 120 ppbv, respectively;
- Toluene at concentrations of 160 and 36 ppbv, respectively;
- Ethylbenzene at concentrations of 700 and 210 ppbv, respectively; and
- Total xylenes at concentrations of 440 and 38 ppbv, respectively.

4.2.2 Southern Site Boundary Soil Vapor Wells

Soil vapor samples were collected on 2 February, 14 February, 19 April, 20 April and 8 May 2006 from soil vapor wells installed along the southern site boundary. Based on the results of previous soil vapor investigations conducted at the site, the primary constituent of concern (COC) in soil vapor along the southern site boundary was benzene.

Soil vapor samples collected from soil vapor wells PVP-1, -2A/2B, and -3A/3B during the 2 February and 14 February 2006 sampling events contained the following:

- DCDFM at concentrations ranging from 3.2 to 210 ppbv (11 of 12 samples);
- PCE at a concentration of 3.9 ppbv (1 of 12 samples);
- TCE at a concentration of 5.2 ppbv (1 of 12 samples);
- Vinyl chloride was not detected at a concentration greater than the detection limit;
- Benzene at concentrations ranging from 8.6 to 120 ppbv (10 of 12 samples);
- Toluene at concentrations ranging from 8.6 to 220 ppbv (11 of 12 samples);
- Ethylbenzene at concentrations ranging from 5.0 to 28 ppbv (9 of 12 samples); and
- Xylenes at concentrations ranging from 2.3 to 91 ppbv (11 of 12 samples).

Consistent with previous soil vapor investigations, the highest benzene concentrations were observed in the western portions of the site along the southern property boundary during the 2 February and 14 February 2006 sampling events. However, during the February 2006 sampling events, tracer gas breakthrough was detected in 7 of the 12 (58%) soil vapor samples collected from onsite soil vapor wells. Methane was detected in five of the seven soil vapor samples that did not contain indications of tracer gas breakthrough at concentrations ranging from 0.00049% to 0.031%. Nitrogen concentrations in these samples ranged from 79% to 96%.

During the 14 February 2006 sampling event, high vacuum conditions were encountered in soil vapor wells PVP-1 and PVP-2B. The highest benzene concentrations observed in soil vapor samples collected during the 2 February and 14 February sampling events was in the soil vapor sample collected from PVP-1 on 14 February 2006. The high vacuum conditions observed in PVP-1 may have resulted in stripping of VOCs from soil moisture at the target depth. Therefore, the VOC concentrations in detected in soil vapor samples collected from soil vapor wells exhibiting high vacuum conditions may not be representative of actual soil vapor conditions. In addition, the high vacuum conditions may have led to tracer gas breakthrough in some of the soil vapor samples collected during the February 2006 sampling events. Impurities in the tracer gas may also account for elevated benzene concentrations in soil vapor samples collected from soil vapor wells along the southern property boundary during the February 2006 sampling events. However, impurities in the tracer gas cannot be quantified using gas chromatography techniques as the 2-propanol peak on the chromatograph will overshadow other constituents which may be present. To account for the high vacuum conditions observed in PVP-1, an additional soil vapor well (PVP-1A) was installed adjacent to PVP-1 at a depth above where moisture was observed in subsurface soils. To account for potential impurities in the tracer gas, field sampling methods were modified prior to the April 2006 sampling event, as detailed in Appendix A.

During the April 2006 sampling event, soil vapor samples were not collected from soil vapor wells that exhibited high vacuum conditions, as detailed in Appendix A. Soil vapor samples collected from soil vapor wells along the southern property boundary during the April 2006 soil vapor sampling event contained the following:

- DCDFM at concentrations ranging from 1.6 to 68 ppbv (4 of 4 samples);
- PCE at concentrations ranging from 1.8 to 5.6 ppbv (3 of 4 samples);
- TCE was not detected at a concentration greater than the detection limit;
- Vinyl chloride was not detected at a concentration greater than the detection limit;
- Benzene at concentrations ranging from 1.4 to 6.2 ppbv (2 of 4 samples);
- Toluene at concentrations ranging from 3.3 to 14 ppbv (4 of 4 samples);

- Ethylbenzene at concentrations ranging from 3.3 to 5.6 ppbv (2 of 4 samples); and
- Xylenes at concentrations ranging from 1.6 to 2.3 ppbv (4 of 4 samples).

The concentrations of PCE in soil vapor samples were below the California Environmental Protection Agency's (Cal-EPA) California Human Health Screening Levels (CHHSLs) for PCE in shallow soil gas in residential land use areas of 26.54 ppbv (Cal-EPA, 2005). CHHSLs are intended to provide a screening level to indicate when further evaluation of potential risk may be warranted (Cal-EPA, 2005). Soil vapor samples collected from the southern site boundary during the April 2006 sampling events did not contain detectable concentrations of methane. Consistent with native soil vapor concentrations, nitrogen concentrations were 78% in soil vapor samples collected from soil vapor wells along the southern site boundary.

As detailed in Appendix A, during the May 2006 sampling event, field methods were modified to account for tracer gas breakthrough encountered during the April 2006 sampling event and to attempt to collect soil vapor samples from soil vapor wells that exhibit high vacuum conditions. Seven soil vapor samples were collected during the May 2006 sampling event from along the southern property boundary. However, samples collected from soil vapor wells PVP-2B and -4B contained tracer gas and are therefore considered invalid samples.

Soil vapor samples collected during the May 2006 sampling event contained the following:

- DCDFM at concentrations ranging from 1.6 to 93 ppbv (6 of 7 samples);
- PCE at concentrations ranging from 2.1 to 5.6 ppbv (5 of 7 samples);
- TCE was not detected at a concentration greater than the detection limit;
- Vinyl Chloride was not detected at a concentration greater than the detection limit;
- Benzene at concentrations ranging from 1.5 to 7.0 ppbv (3 of 7 samples);
- Toluene at concentrations ranging from 2.1 to 7.5 ppbv (6 of 7 samples);
- Ethylbenzene at concentrations ranging from 1.1 to 5.1 ppbv (4 of 7 samples); and
- Total xylenes at concentrations ranging from 2.3 to 20.3 ppbv (6 of 7 samples).

Similar to the April 2006 sampling event, PCE concentrations detected in soil vapor samples collected along the southern property boundary during the May 2006 sampling event were below the CHHSLs for PCE in shallow soil gas in residential land use areas. Consistent with the April 2006 results, methane was not detected at concentrations greater than the detection limit and nitrogen concentrations ranged from

78% to 80% in soil vapor samples collected from the southern property boundary during the May 2006 sampling event. Similar to the April 2006 sampling event, nitrogen concentrations were consistent with native soil vapor nitrogen concentrations.

The concentrations of VOCs detected in soil vapor samples collected from soil vapor wells along the southern property boundary are significantly lower than those detected in landfill gas samples collected from the toe of the landfill or soil vapor samples collected from soil vapor wells installed underlying the refuse in the toe of the landfill. In evaluating the potential of the migration of landfill gas as the source of offsite VOC concentrations in shallow soil vapors beneath the residential area south of the site, VOC concentrations at the property boundary can be reasonably expected to be greater than VOC concentrations detected in soil vapor samples collected beneath the residential area south of the site. However, benzene concentrations in PVP-2A and -4 are lower than detected downgradient in offsite soil vapor well VW-4B. The highest benzene concentrations detected at each soil vapor well location from the April and May 2006 sampling events are shown on Figure 8. Slightly higher benzene concentrations have been detected in some of the soil vapor wells within the public right-of-ways downgradient of the site than observed at the site boundary. Similarly, PCE concentrations at the south property boundary are significantly lower than detected in offsite soil vapor wells VW-4A, -4B, and -5A. In addition the nitrogen and methane concentrations detected in soil vapor samples collected from soil vapor wells at the southern property boundary are consistent with native soil vapor conditions and do not exhibit indications of landfill gas impacts. The methane and nitrogen concentrations detected in soil vapor samples collected from soil vapor wells along the southern site boundary suggest VOCs may not have been transported through advection of landfill gas.

4.2.3 Offsite Soil Vapor Wells

Offsite soil vapor wells were sampled from 19 April to 25 April 2006 and again from 8 May to 11 May 2006. Offsite soil vapor wells VW-12, -13, and -14 were also sampled on 1 June 2006. A summary of analytical results for soil vapor samples collected from offsite soil vapor wells during the April and May 2006 sampling events is provided in Table 2.

Soil vapor samples collected from offsite soil vapor wells during the April 2006 sampling event contained the following:

- DCDFM at concentrations ranging from 1.3 to 2.6 ppbv (2 of 11 samples);
- PCE at concentrations ranging from 1.7 to 52 ppbv (7 of 11 samples);
- TCE at concentrations ranging from 3.7 to 19 ppbv (2 of 11 samples);
- Vinyl chloride was not detected above the detection limit in offsite soil vapor samples;

- Benzene at concentrations ranging from 1.5 to 6 ppbv (5 of 11 samples);
- Toluene at concentrations ranging from 1.3 to 1000 ppbv (6 of 11 samples);
- Ethylbenzene at concentrations ranging from 1.6 to 67 ppbv (6 of 11 samples); and
- Total xylenes at concentrations ranging from 1.1 to 234 ppbv (9 of 11 samples).

Benzene in offsite soil vapor wells is below the residential land use CHHSL for benzene of 11.33 ppbv (Cal-EPA, 2005). TCE was detected in 2 of the 11 soil vapor samples collected from offsite soil vapor wells and concentrations of TCE are below the TCE residential land use CHHSL of 98.25 ppbv (Cal-EPA, 2005). PCE concentrations exceeded the residential land use CHHSL of 26.54 ppbv. CHHSLs are intended to provide a screening level to indicate when further evaluation of potential risk may be warranted (Cal-EPA, 2005). The results of the vapor risk assessment are presented in Section 5. Nitrogen concentrations in offsite soil vapor samples collected during the April 2006 sampling event ranged from 78% to 82%, which is consistent with native soil vapor concentrations. In addition, methane was not detected at concentrations greater than the detection limit in offsite soil vapor samples during the April 2006 sampling event.

Soil vapor samples collected from offsite soil vapor wells (including samples collected from soil vapor wells with tracer breakthrough, which were considered invalid samples) during the May 2006 sampling event contained the following:

- DCDFM at concentrations ranging from 1.3 to 17 ppbv (10 of 21 samples);
- PCE at concentrations ranging from 1.4 to 88 ppbv (14 of 21 samples);
- TCE at concentrations ranging from 1.5 to 5.6 ppbv (6 of 21 samples);
- Vinyl chloride was not detected above the detection limit in any offsite samples;
- Benzene at concentrations ranging from 1.2 to 5 ppbv (8 of 21 samples);
- Toluene at concentrations ranging from 1.3 to 17 ppbv (13 of 21 samples);
- Ethylbenzene at concentrations ranging from 1.6 to 18 ppbv (5 of 21 samples); and
- Total xylenes at concentrations ranging from 1.2 to 17.7 ppbv (11 of 21 samples).

Consistent with the April 2006 sampling event, benzene concentrations were below the residential land use CHHSL (Cal-EPA, 2005). Concentrations of TCE appear to have decreased slightly between the April 2006 and May 2006 sampling events. PCE was again detected at concentrations greater than the CHHSL for residential land use. Samples collected from soil vapor wells near the southern property boundary indicate concentrations of DCDFM appear to attenuate from the landfill to the southern property

boundary. Nitrogen concentrations in soil vapor samples collected from beneath the residential area south of the site during the May 2006 sampling event ranged from 79% to 88%, again consistent with native soil vapor nitrogen concentrations. Consistent with the April 2006 sampling event, methane was not detected at concentrations greater than the detection limit in soil vapor samples collected from beneath the residential community south of the site during the May 2006 sampling event.

Soil vapor samples collected from offsite soil vapor wells VW-13 and -14 during the May 2006 sampling event contained detectable concentrations of 1,3-butadiene. 1,3-butadiene is a constituent found in combustion exhausts, and therefore may be attributable to the tubing used to construct the soil vapor wells being stored in the back of the direct push rig prior to vapor well installation. Offsite soil vapor wells VW-12 through -14 were installed after the other offsite soil vapor wells. Soil vapor wells VW-13 and -14 were installed prior to VW-12, using tubing that may have been more exposed to exhaust fumes. To assess the significance of the 1,3-butadiene detections, soil vapor wells VW-12 through -14 were re-sampled on 1 June 2006. 1,3-butadiene was not detected in the soil vapor samples collected on 1 June 2006, indicating that the previous detections may have been an artifact of soil vapor well installation. In addition, PCE was detected in the soil vapor samples collected from VW-12, -13, and -14 and TCE was detected in soil vapor samples collected from VW-13 and -14 during the May 2006 sampling event. During the 1 June 2006 sampling event, PCE and TCE were detected at concentrations generally consistent with the May 2006 sampling event.

If VOC impacts detected in soil vapor samples collected from soil vapor wells within the residential area south of the site were attributable to migration of landfill gas, the concentrations of VOCs in soil vapor samples collected beneath the residential area south of the site should be less than the concentrations detected in landfill gas samples. Similarly, VOC concentrations in soil vapor samples collected beneath the residential area south of the site would also be expected to be less than concentrations collected from soil vapor wells installed along the southern property boundary. However, PCE concentrations in soil vapor samples collected from offsite soil vapor wells VW-4A, -4B, and -5A were greater than concentrations detected in soil vapor samples collected from the south property boundary and landfill gas samples collected from the toe of the landfill (Figure 9). Additionally, TCE concentrations detected in offsite soil vapor wells VW-4A, -5A, -7A, -8A, -13, and -14 are greater than the concentrations detected in soil vapor wells installed at the southern property boundary (Figure 10). Similarly, TCE was detected at a greater concentration (19 ppbv) in the soil vapor sample collected from offsite soil vapor well VW-7A than in the soil vapor sample collected immediately upgradient (VW-6A, no detection reported). Greater concentrations of VOCs further downgradient from the landfill are inconsistent with landfill gas migration as the source of VOC concentrations in soil vapor beneath the residential area south of the site. In addition, nitrogen and methane concentrations in soil vapor samples collected from

beneath the residential area south of the site during the April and May 2006 sampling events are inconsistent with landfill gas migration as the source of VOC concentrations in soil vapor beneath the residential area south of the site.

4.3 Groundwater Monitoring Results

4.3.1 VOCs in Groundwater

To further assess low concentrations of VOCs detected in groundwater, low level detection groundwater monitoring was conducted on groundwater samples collected from monitor wells POGW-15, -16, -17A, -17B, -18A, and -18B and abandoned Vapor Well-1 and -2 as described in Appendix A. To further evaluate potential groundwater impacts at the southern site boundary, monitor well POGW-20 was installed near the location of destroyed monitor POGW-8, and monitor well POGW-21 was installed between monitor wells POGW-15 and POGW-16 (Figure 2). Analytical results for groundwater samples collected from groundwater monitor wells POGW-20 and POGW-21 and the low level detection groundwater monitoring conducted in March, April, and May 2006 are summarized in Table 3. Groundwater samples collected in March, April, and May 2006 contained the following VOCs:

Parameter	Concentration (µg/L)									
	POGW-15*	POGW-16	POGW-20	POGW-21	VAPOR WELL -1	VAPOR WELL -2	POGW-17A	POGW-17B	POGW-18A	POGW-18B
Acetone	4.4JB	0.93JB	-	-	-	5.7	6.3B	2.2JB	2.6JB	2.4JB
Benzene	-	0.37J	-	-	0.08J	-	-	-	-	-
Bromodichloromethane	-	-	-	-	-	-	-	-	-	0.15J
2-Butanone	-	-	-	-	-	-	-	2.8J	-	-
Chlorobenzene	-	1.4	-	-	0.11J	-	-	0.34J	-	-
Chloroethane	-	-	-	-	-	0.47J	-	0.39J	-	-
Chloroform	-	-	-	-	-	-	-	0.38J	0.16J	1.2
Chloromethane	-	0.047J	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	-	0.28J	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	9.2B	-	-	0.53B	-	-	0.72	-	-
Dichlorodifluoromethane	0.29J	1.3	2.0	1.3	0.60	3.1	-	1.3	-	-
1,1-Dichloroethane	0.95	0.27J	-	-	0.082J	0.13J	-	0.28J	-	-
1,2-Dichloroethane	-	0.30J	-	-	-		-	-	-	-
1,1-Dichloroethene	0.23J	0.12J	-	-	0.31J		-	-	-	-
cis-1,2-Dichloroethene	0.32J	24	-	5.9	5.5	0.39J	-	1.1	-	-
1,2-Dicholoropropane	-	0.59	-	-	-	0.9JB	-	0.045J	-	-
2,2-Dichloropropane	-	-	-	-	-	-	-	0.66	-	-

Parameter	Concentration (µg/L)									
	POGW-15*	POGW-16	POGW-20	POGW-21	VAPOR WELL -1	VAPOR WELL -2	POGW-17A	POGW-17B	POGW-18A	POGW-18B
Isopropylbenzene	-	0.14J	-	-	-	-	-	-	-	-
Methylene Chloride	1.5JB	26B	-	-	29B	-	1.6JB	1.5JB	1.3JB	1.3JB
Tetrachloroethene (PCE)	1.3	1.8	0.42J	1.0	0.49J	0.8	-	0.46J	-	-
Toluene	-	0.018J	-	-	-	0.038B	0.022J	-	-	-
Trichloroethene (TCE)	0.31J	6.8	-	6.4	7.5	0.87	-	1.0	-	-
1,2,3-Trichloropropane	0.086J	-	-	-	-	-	-	-	-	-
Vinyl Chloride	-	0.48J	-	-	0.25J	-	-	0.097J	-	-
Methyl-t-Butyl-Ether	-	0.11J	-	-	-	-	-	-	-	-

– Not detected at concentration greater than the method detection limit (MDL)
J – Estimated concentrations between the MDL and the reporting limit (RL)
B – Reported in the associated Method Blank
*** – Offsite, but within 10 feet of southern property boundary**

DCDFM and PCE were detected in groundwater samples collected from monitor wells POGW-20 and POGW-21 at concentrations ranging from 2.0 to 1.3 µg/l and from trace to 1.0 µg/l, respectively. TCE was detected in the groundwater samples collected from monitor well POGW-21 at concentration of 6.4 µg/l. TCE concentrations in groundwater samples collected from monitor well POGW-21 are similar to TCE concentrations observed in groundwater samples collected from monitor well POGW-16. BTEX constituents were not detected in groundwater samples collected from POGW-20 and -21.

Acetone and methylene chloride were detected in groundwater samples collected from monitor wells POGW-15, -16, -17A, -17B, -18A and -18B. However, acetone and methylene chloride were also detected in the associated method blank and can be attributed to laboratory contamination.

Potential sources of VOCs in groundwater beneath the site and downgradient of the site include landfill gas, leachate, or groundwater in contact with waste. Based on previous studies conducted at the site, there is no evidence that the landfill is producing leachate. The presence of DCDFM in groundwater at relatively low concentrations along with relatively stable chloride concentrations associated with increasing VOC concentrations in downgradient monitor wells is consistent with landfill gas impacts. The presence of 1,4-dichlorobenzene (1,4-DCB) is consistent with impacts resulting from groundwater in contact with waste. Therefore historical groundwater monitoring conducted south of the site suggests VOCs in groundwater are primarily attributable to landfill gas impacts.

The primary VOCs detected in soil vapor samples collected from soil vapor wells installed along the southern property boundary and beneath the residential area south of the site are benzene, toluene, PCE, and TCE. Trace concentrations of benzene and toluene were detected in groundwater samples collected from monitor wells POGW-16 and -17B. PCE and TCE were also detected in groundwater samples collected from groundwater monitor wells near the southern site boundary and/or within the residential area south of the site. Vinyl chloride and cis-1,2-dichloroethene (cis-1,2-DCE) were also detected in groundwater samples collected from monitor wells near the southern property boundary and within monitor well POGW-17B in the residential area south of the site. However, neither vinyl chloride or cis-1,2-DCE were detected in soil vapor samples collected from soil vapor wells along the southern property boundary or within the residential area south of the site. VOCs in groundwater samples collected from monitor wells near the property boundary attenuate significantly with distance in the area south of the site.

4.3.2 VOCs Partitioning From Groundwater

Because VOCs have different aqueous solubilities, they can be present in different proportions detected in groundwater affected by the landfill than in soil vapor. The tendency for VOCs to partition from groundwater to soil vapor is described by constituent-specific Henry's Law constants [H]. Constituent-specific Henry's Law constants can be used to calculate a constituent specific theoretical gas-phase concentration [C_g] immediately above the groundwater surface, which would be at equilibrium with the concentration of the constituent in groundwater [C_w], using the following equation $C_g = HC_w$ (Pankow and Cherry, 1996). The calculated "relative" theoretical gas-phase concentrations would represent the maximum concentration of VOCs in soil vapor immediately above the groundwater surface due to partitioning from groundwater. Concentrations of VOCs partitioning from groundwater would be expected to decrease via volatilization, dispersion, and or diffusion with increasing vertical distance from the groundwater surface. Because soil vapor wells are generally screened in the unsaturated zone with some distance above the water table, for VOCs partitioning from groundwater to be the source of VOC concentrations in soil vapor, the calculated "relative" theoretical gas-phase concentration should be greater than the concentration detected in soil vapor samples.

Using concentrations of VOCs detected in groundwater samples collected from monitor wells near the southern site boundary, and offsite monitor wells south of the site, and the Henry's Law constants for each constituent, a "relative" theoretical concentration in soil vapor immediately above the groundwater surface was calculated using the groundwater data collected in April and May 2006. Although some VOCs were not detected in groundwater samples at concentrations greater than the laboratory method detection limit, they could potentially be present at concentrations less than the method

detection limit. Therefore, for constituents detected in soil vapor samples but not detected in groundwater samples the method detection limits were used to calculate conservative estimates of the maximum "relative" theoretical gas-phase concentration that could potentially result from VOCs partitioning from groundwater. The calculated "relative" theoretical gas-phase concentrations were compared to VOC concentrations detected in soil vapor samples collected from adjacent soil vapor wells as summarized in Table 4. If the calculated "relative" theoretical gas-phase concentration is greater than the measured soil vapor concentration, partitioning from groundwater could potentially account for the measured soil vapor concentration. Conversely, if the calculated "relative" theoretical gas-phase concentration is less than the measured soil vapor concentration, partitioning from groundwater alone cannot account for the measured soil vapor concentration.

Although VOCs partitioning from groundwater could theoretically account for concentrations of some VOCs in offsite soil vapor near the southern site boundary, partitioning from groundwater is generally inconsistent with VOC concentrations detected in offsite soil vapor samples (Table 4). Therefore, it appears that at least some of the VOC concentrations observed in offsite soil vapor samples may be attributable to a source other than VOCs partitioning from groundwater. Future sampling of the groundwater monitor wells and soil vapor wells will be used to further investigate the potential sources of VOCs detected in soil vapor samples collected from the adjoining area south of the site.

4.4 Offsite Source Investigation Results

4.4.1 Historical Aerial Photographs

Historical aerial photographs from 1928, 1958, and 1973 were reviewed at the County of San Diego Department of Public Works (Appendix H). The following presents a summary of the aerial photographs:

1928 Aerial: The site appeared to be undeveloped rural land. The adjoining area south of the site was primarily used as agricultural land containing citrus groves.

1958 Aerial: The site appeared to be operated as a burn dump and what appeared to be two parallel trenches were observed in the northern portion of the site. The adjoining area south of the site was primarily used as agricultural land containing citrus groves. Two small structures (what appears to be a home) were located approximately 400 feet southeast of the site and four large structures (what appears to be a farm) were located approximately 1000 feet south of the site.

1973 Aerial: The site appears to be an operating landfill. The area south of the site was developed with residential housing.

4.4.2 Surface Water Sample Results

To assess the presence of VOCs in storm water in the vicinity of the site, surface water samples were collected on 31 March and 6 April 2006 in the concrete channel where storm water enters the site (Figure 7). A summary of analytical results for surface water collected from storm water runoff is provided in Table 5. Samples collected from storm water flowing onto the site from Poway Road did not contain detectable concentrations of VOCs. Acetone was detected at concentrations ranging from 7.5 to 36 µg/l in the four surface water samples collected from gutters in the public right-of-ways south of the site. However, acetone was also detected in the trip blank and field blank and therefore is not believed to be attributable to surface water. Isopropyltoluene was detected in one surface water sample collected from the gutter along Mirando Street at a concentration of 1.2 µg/l. Trace concentrations of benzene were detected in surface water samples collected from gutters located along Dehia Street and Sunset View Road, and toluene was detected in samples collected from gutters along Dehia and Mirando Streets and Los Olivos and Sunset View Road. VOCs in storm water are likely from atmospheric fallout and residues on streets/gutters from traffic near the site.

Storm water studies conducted throughout the United States by the United States Geological Survey (USGS) indicate that the 10 most frequently detected volatile organic compounds in urban storm water are gasoline-related compounds such as benzene, toluene, ethylbenzene, and xylenes (BTEX compounds) with PCE ranking as the fourth most common constituent detected (USGS, 1996). In a similar report, non-point sources of VOCs were assessed in storm water from a parking lot. Once again, most of the detected VOCs were gasoline-related BTEX compounds (Lopez et. al, 2000). These sources of VOCs were attributed to air quality and leaking automobiles. The constituents and range of concentrations observed in the public right-of-ways downgradient of the site are consistent with the findings in surface water samples collected near the site and within these reports.

4.4.3 Soil Sampling Results

To assess the presence of VOCs from storm water discharging into the desiltation basin and soil beneath the public right-of-ways in the residential area south of the site, soil samples were collected from the desiltation basin and from borings advanced within Dehia and Mirando Streets and Sunset View Road in April 2006 (Table 6). Trace detections of acetone, chloromethane, naphthalene, toluene, 1,2,4-trimethylbenzene and xylene were detected in soil samples near the surface (DB-1-0.5) where storm water

discharges into the desiltation basin. Concentrations appear to decrease from trace to non-detect with depth in DB-1 and to non-detect with distance (DB-2 and DB-3) from the storm water discharge pipe.

Trace detections of toluene, 1,2,4-trimethylbenzene and xylene were detected in soil samples collected from vapor well VW-2. Soil samples collected from other vapor well locations did not contain detectable concentrations of VOCs. These data indicate that sediment in the desiltation basin resulting from storm water runoff from Poway Road and within the public right-of-ways contains relatively low concentrations of VOCs likely from atmospheric fallout and residues on streets/gutters from traffic at and around the site. Soil samples collected beneath the streets south of the site contained relatively low concentrations of gasoline constituents indicating that these constituents are unrelated to the landfill and may have been introduced during construction, paving, infiltration of hydrocarbon residues through the asphalt-paved surfaces, usage of standard household chemicals and solvents by individual residents south of the site, periodic application of hydrocarbon-based sealants, or periodic street maintenance.

4.5 Utility Investigation Results

A summary of analytical results for soil vapor samples collected from temporary soil vapor probes installed overlying underground utility alignments on 16 May 2006 is provided in Table 7. Benzene, DCDFM, and PCE were detected in the two soil vapor samples collected directly above sanitary sewer alignments in the residential neighborhood south of the site. Benzene concentrations ranged from 1.8 to 7.1 ppbv in soil vapor samples Sewer Line #1 and Sewer Line #2, respectively (Figure 7). PCE concentrations ranged from 33 to 38 ppbv in soil vapor samples Sewer Line #2 and Sewer Line #4, respectively. DCDFM was detected at concentrations ranging from 2.5 to 3.2 ppbv in soil vapor samples Sewer Line #1 and Sewer Line #3, respectively.

The benzene and PCE concentrations detected in soil vapor samples collected from temporary soil vapor probes overlying the sanitary sewer alignments were similar to concentrations detected in offsite soil vapor samples collected from nearby soil vapor wells VW-4A/-4B during the April and May 2006 sampling events. The concentrations of PCE detected in soil vapor samples collected in the vicinity of VW-4A/-4B suggest a localized area of elevated PCE concentrations that appear unrelated to the landfill. The concentrations of PCE detected in the soil vapor samples collected from VW-4A, -4B, Sewer Line #2, and #4 were greater than concentrations of PCE detected in soil vapor samples collected from along the southern property boundary and in landfill gas samples collected from the toe of the landfill. These data suggest the underground sewer alignments in the area south of the site may be an alternate source of VOCs detected in soil vapor samples collected south of the site.

Vapor samples were also collected from the interiors of sanitary sewer vaults and storm drain inlets in the residential area south of the site to further assess the potential of underground utilities as an alternative source of VOCs in offsite soil vapor. The vapor samples were collected in response to the concentrations of VOCs detected in soil vapor samples collected from temporary soil vapor probes Sewer Line #2 and #4. A summary of analytical results for vapor samples collected from within the sanitary sewers and storm drains within the residential community south of the site is provided in Table 7. Benzene was detected in the vapor sample collected from the sanitary sewer within Sunset View Road (PU-7) at a concentration of 2.4 ppbv. Toluene was detected in four of the seven vapor samples collected from underground utilities within the residential community south of the site. Therefore, underground utilities appear to be a potential contributing source of VOCs detected in shallow soil vapor samples collected from the residential area south of the site.

4.6 Manometer Testing Results

The results of the soil vapor wells analyses suggest that each medium in which the soil vapor wells are screened is influenced by barometric changes; however, the extent by which each medium is influenced is varied. The results also show that some soil vapor wells are influenced by the LFG extraction system. However, barometric pressure changes were more influential on the measured pressure in each medium than the LFG extraction system. The results and conclusions of the tests are summarized below for each type of medium in which the soil vapor wells are screened. A discussion of the test results, graphical presentation of the data, and conclusions are presented in Appendix G.

4.6.1 Soil Vapor Wells Screened Within Landfill Waste

Manometer readings for soil vapor wells PVP-7A, PVP-8, PVP-9, and PVP-10A were relatively low as the barometric pressure fluctuated, suggesting moderate to significant pneumatic connectivity of the landfill waste with the atmosphere. This suggests that the landfill cap may be relatively permeable, or that air is being drawn into the landfill through the seals of the LFG extraction wells, which may be the cause of elevated oxygen concentrations measured in LFG. These soil vapor wells also showed response to the operation of the LFG extraction system. Variations in the responses from these four soil vapor wells may be due to heterogeneities in the waste in which each well is screened.

4.6.2 Soil Vapor Wells Screened in Soil Underlying Landfill Waste

For soil vapor wells screened below the landfill waste (PVP-7B and PVP-10B), the response to barometric changes appears to occur with a lag time. As the barometric pressure makes significant diurnal increases and decreases, the pressure in the soil underlying landfill waste typically takes one to several hours to respond to the change.

Relatively moderate manometer readings suggest that the soil below the waste is pneumatically connected to the atmosphere, but to a lesser extent than the probes screened in the waste. While PVP-10B showed some response to the operation of the LFG extraction system, influence of the system on PVP-7B was not conclusive. These results suggest that the influence of the LFG extraction wells near PVP-10B extend downward to some degree. The influence appears to be sustained for a longer period of time than observed for probes screened within the waste, but the influence does appear to decay after several hours. Although the LFG extraction system appears to be affecting soils underlying the waste, extraction of vapors from the soil below the waste has the benefit of reducing the potential for LFG to migrate downward through this medium.

4.6.3 Soil Vapor Wells Screened at the Southern Site Boundary

No responses to operation of the LFG extraction system were observed in the soil vapor wells outside the footprint of the landfill waste.

5. UPDATED HUMAN HEALTH RISK ASSESSMENT

Conducting a risk assessment involves identifying Chemicals of Potential Concern (COPCs), evaluating exposure pathways, assessing chemical toxicity, and subsequently, characterizing risks. Estimated human health risks are based on a calculated dose (i.e., amount of chemical intake), which integrates exposure parameters for the receptors of concern (e.g., contact rates, exposure frequency and duration) with chemical-specific toxicity criteria (e.g., reference doses and cancer slope factors) and chemical concentrations.

Risk assessments are not intended to estimate the actual cancer risk to an individual but rather are intended to estimate excess lifetime cancer risks (ELCRs) due to the exposure of the COPCs. The ELCRs are then compared to levels considered acceptable for residential scenarios by the San Diego County Department of Environmental Health (DEH), as well as by Cal-EPA's Department of Toxic Substances Control (DTSC) and the United States Environmental Protection Agency (USEPA). According to DTSC and the DEH, the acceptable ELCR for residential scenarios is one additional case of cancer per 1,000,000 people. Typically this level is called 1 in a million, or mathematically expressed as 1×10^{-6}. This value is then compared to the DEH and the DTSC target risk goal of one theoretical excess cancer in a human population of one million (1×10^{-6}). USEPA (1989) states that cancer risks estimated using this approach are upper-bound estimates, which means, that the actual risk is likely to be less than the predicted risk. Moreover, any potential increase in cancer risk from exposure to COPCs detected in the soil vapor samples used for this assessment is in addition to a background risk of Americans developing cancer. The background risk is one chance in three (0.3 or 3×10^{-1}) for every American female, and one chance in two (0.5 or 5×10^{-1}) for every American male, of eventually developing cancer (ACS, 2002).

5.1 Previous Human Health Risk Assessment

Previous screening-level human health risk assessments were performed to evaluate potential vapor risk for the adjoining residential area south of the landfill (GeoSyntec, 2004b and 2005b). Using the DTSC J&E model and the 95% upper confidence limit (UCL95) exposure point concentrations (EPCs), the potential cancer risk was estimated at 1.4×10^{-6} for an adult resident and 1.8×10^{-6} for a resident with integrated child and adult exposures. The estimated noncancer hazard index (HI) for a child resident, the most conservative receptor, was less than the benchmark level of 1, which is acceptable according to the USEPA.

5.2 Updated Human Health Risk Assessment

Chemical-specific, cumulative ELCRs and noncancer hazard indices were estimated for current offsite residents potentially exposed to chemicals detected in soil vapor samples and volatilizing from the subsurface into a residence. An estimated potential ELCR less than 1 x 10^{-6} and an estimated noncancer HI less than 1 are below levels which would generally cause concern according to DEH, DTSC, and USEPA guidance. Results of the risk characterization are discussed below. When discussed herein, the estimated potential ELCRs and estimated noncancer hazard are based on offsite residents being potentially exposed to COPCs detected in soil vapor samples collected from offsite vapor wells (VW-1A/1B, -2A, -3A, -4A/4B, -5A, -6A, -7A, -8A/8B, -9, -10,-11, -12, -13, -14); property boundary vapor wells (PVP-1A, -2A, -3A/3B, -4A); and background vapor wells (PVP-5 and -6).

The potential risk and hazard estimates assume a resident is exposed 350 days per year for 30 years to indoor air contaminants volatilizing into a residential structure. The conservative nature of the default values (e.g., open crack space, building air exchange rate, and the assumption of no biodegradation or other loss mechanism for the COPCs) likely biases the modeled indoor air concentrations upward. A range of potential risk estimates was developed using the maximum concentrations of COPCs detected in samples collected from individual vapor wells in the DTSC J&E vapor intrusion model (Figure 11). The indoor air modeling results using the DTSC J&E model spreadsheets are presented in Attachment A of Appendix I.

Using the DTSC J&E model and COPC concentrations for each vapor well, the potential ELCRs was estimated to range from 2 x 10^{-8} to 9 x 10^{-7}, while the noncancer hazard was estimated to range from 0.001 to 0.05 for a child resident (Figure 11 and Tables I-5a through I-5d). The primary constituent contributing to the potential ELCR estimate is PCE, with a chemical-specific risk of 7 x 10^{-7}. The maximum concentration of PCE (88 ppbv) was detected in a sample collected at a depth of 10 feet bgs from offsite vapor well VW-4B. The estimated potential ELCR and noncancer hazard for each vapor well were below the target risk of 10^{-6} and the benchmark level of 1, respectively. These data indicate that the hypothetical risk to residents downgradient of the Poway Landfill is acceptable according to the USEPA, DTSC and DEH even when conservative assumptions and input parameters are used.

For comparison, potential risk for the residential area south of the site was estimated using 95% upper confidence limit (UCL95) concentrations as the EPCs. Using the DTSC J&E vapor intrusion model and UCL95 EPCs, the potential ELCR was estimated at 1 x 10^{-6}, which does not exceed the target risk goal of 10^{-6}. The estimated noncancer hazard of 0.04 for a child resident was less than the benchmark level of 1 (Table I-6).

6. SUMMARY AND CONCLUSIONS

This investigation involved collection of soil vapor, landfill gas, soil, groundwater and surface water samples and a vapor-phase human health risk assessment to further assess the potential for adverse risk to residents in the adjoining neighborhood south of the site due to the landfill. A summary of the results and conclusions are presented in this section.

6.1 Chemical Quality of Soil Vapor

VOCs were detected at higher concentrations in soil vapor samples collected along the southern property boundary in February 2006 than in April and May 2006. Elevated VOC concentrations detected during the February soil vapor sampling appears to be due to high-vacuum conditions encountered in some sampling locations and field sampling methods. VOC concentrations detected in soil vapor sampling during the April and May 2006 sampling events were significantly lower than those detected during the February 2006 sampling events. This is attributed to improved vapor sampling methods utilized in the April and May 2006 events, which appear to yield more consistent and repeatable sample data.

Landfill

LFG samples collected from vapor wells installed within refuse near the toe of the landfill in April 2006 contained several VOCs including constituents of concern (COCs) such as DCDFM, PCE, TCE, and benzene (Section 4.2.1). Methane concentrations in the LFG samples ranged from 16 to 30 percent by volume.

Southern Site Boundary

Soil vapor samples collected along the southern site boundary during the April and May 2006 sampling events contained significantly lower concentrations of DCDFM, PCE and benzene than LFG samples. In addition, none of the eleven soil vapor samples collected along the southern site boundary in April and May 2006 contained detectable concentrations of vinyl chloride. These data indicate significant attenuation of VOCs in soil vapor between the toe of the landfill and the southern site boundary, and that significant concentrations of LFG are not migrating offsite. In addition, nitrogen and methane concentrations detected in soil vapor samples collected along the southern site boundary and beneath the residential area south of the site appear consistent with native soil vapor concentrations and not landfill gas migration.

Offsite Area South of the Site

Several offsite soil vapor samples contain higher concentrations of the primary VOCs (such as benzene, PCE, and TCE) than soil vapor samples collected along the southern property boundary (Figures 8 through 10). Attenuation is apparent for DCDFM between the southern property boundary and the adjoining offsite area south of the site. Benzene was detected at relatively consistent concentrations in the offsite samples regardless of the distance the samples were collected from the landfill. However, PCE was reported at a greater frequency and at higher concentrations in offsite samples than in soil vapor samples collected from the southern property boundary. In addition, PCE was detected in four offsite soil vapor samples at higher concentrations than reported for landfill gas samples. Similarly, TCE was not detected in soil vapor samples collected near the southern property boundary, but approximately 30 percent of the offsite soil vapor samples contained TCE, some at concentrations consistent with TCE concentrations in landfill gas. Therefore, the landfill gas and soil vapor data collected between April and June 2006 suggest that concentrations of some constituents (primarily PCE and TCE) detected in offsite soil vapor samples appear to be attributable to offsite sources. Therefore, the greater concentration of PCE in soil vapor samples collected from VW-4A, -4B, and -5A may be the result of VOC partitioning from groundwater to the subsurface, leaking utilities, chemical usage by individual residents south of the site or periodic street maintenance.

6.2 Chemical Quality of Groundwater

VOC concentrations in groundwater samples collected from offsite monitor wells (POGW-17A/17B and POGW-18A/18B) downgradient of the site decrease significantly to non-detect or below the method detection limit (Table 3). As demonstrated by routine groundwater monitoring, sample analytical results collected from monitor wells near the southern site boundary (POGW-15, -16, -20, and -21) indicate concentrations of VOCs are below MCLs for drinking water or below the laboratory's method detection limit (MDL). Groundwater samples collected from offsite monitor wells (POGW-11, POGW-12, POGW-13, POGW-17A/17B and POGW-18A/18B) indicate concentrations continue to attenuate with distance from the site and none of the VOCs detected were reported at concentrations exceeding MCLs (GeoSyntec, 2006b).

Since August 2004, supplemental water quality analyses have been performed on groundwater samples collected from site monitor wells and piezometers during semi-annual monitoring events to evaluate the inherent capabilities of the native microorganisms to degrade and naturally attenuate the VOCs in site groundwater. Because sufficient data has been collected to demonstrate that natural attenuation is occurring in groundwater at the site, the County continues to monitor for a subset of natural attenuation parameters during semi-annual groundwater monitoring events.

6.3 Potential Sources of Soil Vapor Impacts

Southern Site Boundary

Two apparent sources of VOC impacts are evident near the southern property boundary: (1) where VOCs have partitioned from groundwater into the gas-phase and (2) vapor migration through the subsurface.

Offsite Area South of the Site

Relatively low soil vapor concentrations of BTEX constituents and VOCs including PCE and TCE in the residential area south of the site appear to be attributable to offsite sources unrelated to the landfill including atmospheric fallout, infiltration of storm water, minor leaks from utilities, asphalt-paved surfaces, chemical usages by individual residents south of the site, periodic application of hydrocarbon-based sealants, or periodic street maintenance. VOCs in groundwater may account for some of the VOC concentrations detected in offsite soil vapors (VW-4A/4B and VW-5A). However, VOCs partitioning from groundwater does not account for the concentrations of BTEX constituents or some chlorinated hydrocarbons such as PCE and TCE detected in offsite soil vapor samples. These data indicate an offsite source contributing to VOC concentrations in offsite soil vapor unrelated to the landfill is likely.

If the landfill was the source of VOCs detected in offsite soil vapor samples, concentrations would be expected to continue to attenuate with distance from the southern site boundary. However, some vapor samples collected at distances of approximately 1,000 feet south of the southern property boundary contain VOCs at higher concentrations than samples collected near the southern property boundary. These data indicate alternate or contributing offsite sources of VOCs within the residential area south of the site.

6.4 Manometer Testing

Results of manometer testing showed that the waste, soil underlying waste, and native soil near the southern site boundary each respond to barometric pressure changes to varying degrees. For the soil vapor wells screened in and below the waste, barometric pressure changes were more influential on the absolute pressure in each media than the LFG extraction system. The response of these soil vapor wells to barometric pressure changes suggest that the landfill cap is relatively permeable and enhancements to the LFG system appear warranted.

6.5 Updated Human Health Risk Assessment

Using the DTSC J&E model and VOC concentrations for each vapor well, the ELCRs were estimated to range from 2×10^{-8} to 9×10^{-7}, while the noncancer hazard was estimated to range from 0.001 to 0.05. These hypothetical estimated risk values are acceptable according to the USEPA, DTSC, and DEH even when conservative assumptions and input parameters are used.

6.6 Conclusions

Evaluation of laboratory analytical results for samples collected during this assessment indicates VOCs detected in soil vapor samples collected in the adjoining area south of the site may be attributable to the landfill, and other offsite sources unrelated to the landfill. As demonstrated by the updated vapor phase human health risk assessment, the estimated risk to offsite residents resulting from VOCs detected in offsite soil vapor samples does not exceed the target risk goal of 1 x 10-6. Therefore, additional subsurface investigation of onsite or offsite soil vapor impacts does not appear to be warranted.

The Downgradient Soil Vapor Sampling Work Plan included preparation of a work plan to perform additional vapor sampling and indoor air sampling on individual residential properties (GeoSyntec, 2006a). Based on the results of soil vapor sampling described herein, soil vapor sampling on individual residential properties near the site does not appear warranted at this time. Pending future soil vapor sampling results and human health risk screening, the need for evaluation of soil vapor impacts on selected properties will be evaluated.

7. ENGINEERING FEASIBILITY STUDY

7.1 General

According to the updated human health risk assessment, the ELCRs associated with potential exposure to COPCs in soil vapor samples collected at the southern property boundary and the adjoining area south of the site does not exceed the target risk threshold considered acceptable by the USEPA, DTSC and DEH (Section 5). However, according to the NOV, illegal discharges of waste and offsite migration of waste constituents have occurred. Therefore, to address issues identified in the NOV, this engineering feasibility study was prepared to conceptually evaluate potential remedial alternatives to mitigate discharges of waste and offsite migration of landfill-related constituents in the subsurface. The engineering feasibility study incorporated data collected during the current investigation and previous studies performed at the site.

7.2 Screening Analysis

Several potential remediation alternatives were evaluated in the screening analysis to address VOCs in the subsurface. The alternatives included:

1) No Further Action
2) Monitored Natural Attenuation (MNA)
3) Source Control
   - Vertical Vapor Barrier
   - Soil Vapor Extraction (SVE)
   - LFG Extraction System Enhancements
4) Source Removal
   - Waste Excavation and Removal

7.3 Engineering Feasibility Analysis

The conceptual scope of each technology is described in the following sections. A summary of the conceptual assessment of corrective measures, in terms of potential effectiveness, capital and operation and maintenance (O&M) costs, and implementability, is presented in Table 8. Each technology is assessed according to the given criteria in terms of relative magnitude (low, medium, or high). The advantages and disadvantages of each technology are also summarized in Table 8. A selected remedy may consist of a combination of multiple technologies.

7.3.1 No Further Action

Implementation of the “no further action” alternative would consist of no work now or in the future to mitigate discharges of waste and migration of LFG across the

southern property boundary. Implementation of the "no further action" alternative would not actively change present conditions. It is possible that natural subsurface attenuating processes, or the complete degradation of the waste materials that create the COCs, may over time cause offsite LFG migration to halt or diminish. However, this alternative does not include long-term monitoring, so impacts to offsite migration by changed conditions may not be discernable in the near future. The relative ability of this alternative to be implemented at the site is low, due to low expected acceptability of this alternative by regulatory agencies and the nearby residents. The relative magnitude of cost to implement this alternative is low with respect to both capital and O&M costs. No additional costs would be expected by implementation of this alternative.

7.3.2 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) refers to reliance on physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in media of concern. These processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction. To be considered an acceptable alternative, MNA would be expected to achieve site remedial objectives within a time frame that is reasonable compared to that offered by other more active methods.

MNA of LFG would be assessed through routine soil-vapor sample collection and analyses to demonstrate that COCs in soil vapor are attenuating. Samples would be collected from soil vapor wells. Soil-vapor quality would be monitored in samples collected on site (within and outside the limits of waste), near the property boundary, and off site. The data would be analyzed to evaluate fate and transport mechanisms, including dispersion, dilution, and possible volatilization processes.

MNA of groundwater would be assessed through routine sample collection and analyses to demonstrate that COCs in groundwater are attenuating. Samples would be collected from downgradient groundwater monitor wells on and adjacent to the site. Parameters to be analyzed would include VOCs, chloride, total dissolved solids, dissolved oxygen, oxidation-reduction potential (ORP), and pH. The data would be analyzed to further evaluate fate and transport mechanisms, including dispersion and dilution.

The relative ability of this alternative to achieve the stated remedial objective may be considered low. However, previous assessments at the site demonstrate that natural attenuation is occurring. Furthermore, active remediation may not be warranted for the relatively low concentrations of COCs observed in soil vapor and groundwater samples collected at the site boundary. MNA is generally a remedy that takes significant

time to achieve remedial objectives. Monitored parameters would be tracked to watch for improvement or other changes over time. If subsurface conditions change in such a way as to hamper the natural processes that tend to inhibit offsite migration, effectiveness of MNA could diminish.

The relative ability of this alternative to be implemented at the site is high. The relative magnitude of cost to implement this alternative at the site is low with respect to capital costs and O&M costs. O&M costs would primarily be associated with sample collection and analysis, and data tracking and reporting.

7.3.3 Source Control Alternatives

7.3.3.1 Vertical Vapor Barrier at Southern Property Boundary

Vertical vapor barriers can consist of an air curtain, soil bentonite slurry wall, gravel filled vapor collection trench, geomembrane cut-off walls, or other technologies. Slurry walls can desiccate and become ineffective for containment of soil gas in some subsurface conditions, while gravel filled trenches and geomembrane cut-off walls can be cost prohibitive. One of the most common vertical vapor barriers for use in controlling subsurface soil vapor migration is an air curtain. A typical air curtain consists of several air injection wells that are placed in a line to provide a positive air pressure within the vadose zone. The air injection wells provide a means to introduce air into the vadose zone where the pressurized air moves away from the air injection well. When several air injection wells are installed in a line, the pressurized air moves away from the line of injection wells, generally perpendicular to the line of wells. The pressurized air works to push the impacted soil vapor back towards the landfill, but also pushes soil vapor already beyond the air injection well line away from the air curtain. For this project, this type of air curtain would potentially force air (oxygen) into the landfill, thereby creating a potential for subsurface fires within the landfill, and potentially push soil vapor already beyond the air curtain away from the landfill.

To mitigate this potential problem with air curtains, a modification can be made to the operation of the air curtain that minimizes the potential for air intrusion into the landfill and the pushing of soil gas away from the air curtain. This modified air curtain is created by a series of wells that alternate in function as ambient-air inlets and soil gas extraction. The well series is typically installed around the perimeter of the zone to be isolated. The air inlet wells are equilibrated to atmospheric pressure while a blower attached to the gas extraction wells induces a vacuum. This will create a pressure gradient between the wells that causes air to enter the air-inlet wells and travel horizontally through the subsurface, in a direction parallel to the zone perimeter, toward the extraction well. This will flush the soil along the perimeter of the zone, and create a "curtain" of air to intercept and mitigate potential horizontal LFG migration to beyond

the zone perimeter. Extracted vapor may require treatment prior to discharge to the atmosphere, depending on local regulations and extracted-air quality.

For implementation at the site, an air curtain would be constructed along the southern property boundary to mitigate migration of LFG across the property boundary. The air curtain would be installed so that migrating soil gas would be intercepted and removed from the subsurface prior to migration across the southern property boundary. The downgradient offsite soil vapor wells would be monitored to evaluate effectiveness of the air curtain at interception of migrating landfill-related soil gas, and thus mitigation of off-site migration. Extensive monitoring may be required to assess whether subsurface channeling or changes occur over time.

The use of an air curtain was evaluated to potentially be a moderately effective alternative with a medium to high degree of difficulty to implement. The ability to implement this corrective measure to mitigate migration of LFG-related constituents is feasible, but the technology would only be effective in addressing vapor constituents within the subsurface and not in groundwater.

7.3.3.2 Soil Vapor Extraction (SVE) at the Southern Site Boundary

SVE uses an applied vacuum to remove VOCs and some semi-volatile organic compounds (SVOCs) from the vadose zone. Vacuum is applied to the subsurface via one or several extraction wells. Soil vapor is drawn toward the extraction well from the surrounding subsurface. If there is a relatively impermeable layer above the extraction well, the Radius of Influence (ROI) of the extraction wells may be increased. The ROI is also a function of the applied vacuum. Extracted soil vapor frequently requires treatment prior to discharge, depending on local and state regulations.

At the site, a SVE system would be applied at the southern property boundary to collect and treat LFG-related constituents in the soil vapor. This SVE system is differentiated from the "air curtain" technology by the lack of air inlet wells. The SVE system would be installed so that LFG-related COCs would be intercepted and removed from the subsurface prior to offsite migration across the property boundary. A series of extraction wells would be installed linearly along the property boundary with overlapping ROI to create a vertical vapor barrier. Proper O&M and monitoring would be necessary for system optimization and to be compliant with discharge permit requirements. Offsite soil vapor wells would provide a means to monitor the effectiveness of the SVE system.

The relative ability of this alternative to achieve the stated remedial objective is high. SVE is a proven technology for removal of VOCs from the subsurface, but site-specific parameters must be accounted for in design. Soil with high moisture content typically would require a higher extraction vacuum and resulting condensation within

process piping typically requires special handling. Soil with low permeability also limits the effectiveness of SVE.

The relative ability of this alternative to be implemented at the site is moderate to high. However, implementation of this technology would only mitigate the symptom of impacts rather than mitigate the source. SVE technology requires that long-term O&M, monitoring, and reporting be performed, which results in elevated O&M costs. The relative magnitude of cost to implement SVE at the site is moderate to high with respect to capital costs and is high with respect to O&M costs. The ability to implement this corrective measure to mitigate migration of LFG-related constituents is feasible, but the technology would only be effective in addressing vapor constituents within the subsurface and not in groundwater.

7.3.3.3 Enhancement of the Current Landfill Gas Extraction System

Controlling LFG is typically accomplished by an extraction system that includes a series of extraction wells screened within the waste. Landfill gas extraction systems are typically designed, constructed, and operated for the purpose of extracting large quantities of LFG that contain high quantities of methane, which can be flared with no additional fuels required for combustion. These systems are not typically designed to address low LFG volumes. However, low concentrations of LFG can impact groundwater. If mitigation of LFG impacts to groundwater becomes an objective for a LFG extraction system where low LFG volumes are being observed, additional LFG extraction wells can be added to an existing system to enhance the capability of the LFG system to control these smaller quantities of gas without adversely affecting system performance. In these cases a higher number of wells operating at low flow, low vacuum pressure, with smaller ROI are used to extract LFG from within isolated portions of the waste.

During April and May 2006, GeoSyntec conducted manometer tests on soil vapor wells screened within landfill waste (Appendix G). The tests were performed to study performance of the existing LFG extraction system and potential vapor migration pathways. Pressure readings within the waste at the toe of the landfill suggest that barometric pressure changes induce significantly greater influence than the negative pressure created by the LFG extraction system. In addition, the manometer tests suggest the soil cap over the landfill is relatively permeable. These data indicate connectivity of the waste with the atmosphere in the vicinity of the soil vapor wells installed near the toe of the landfill, and may explain the relatively high oxygen concentrations that have been observed in the LFG samples collected at the site. Enhancements to the LFG system, including increased well coverage in the southern portion of the landfill, and modified operation time may result in improved system performance.

Enhancement of the LFG extraction system may potentially be highly effective and represents a low degree of difficulty to implement. As a result, enhancements to the LFG system have been assessed to be a favorable corrective action measure. The ability of this corrective measure to mitigate landfill impacts to levels consistent with soil vapor quality criteria is likely, and would address impacts due to landfill gas migration. This alternative would be effective for both soil vapor and groundwater. Prior to implementing this alternative, a detailed evaluation of the LFG extraction system should be performed.

7.3.4 Source Removal Alternatives

7.3.4.1 Excavation of Waste and Disposal Off-Site

The most effective method for mitigating future migration of vapors is to remove the source (i.e. landfill). Removal of the waste would include excavation, loading, hauling, and disposing of the waste material at an approved facility. Final grading and significant confirmation sampling would also be required after the waste material is removed. The difficulty to implement this option is medium, however, due to the large volume of waste at the site, this alternative is considered to be cost-prohibitive. In addition, removal of the waste would not address the existing impacts to soil vapor and groundwater outside the limits of waste.

7.4 Summary

The engineering feasibility study presented herein assessed the conceptual cost, effectiveness, and implementability of several remedial alternatives including: no further action; MNA; air curtain; SVE, LFG extraction system enhancements; and excavation and off-site disposal. Enhancements to the LFG extraction system, along with soil vapor monitoring, appear to be effective remedial alternatives for eliminating discharges of waste and soil vapor migration in the subsurface from the site. In addition, MNA appears to be an effective remedial alternative to address the relatively low concentrations of VOCs in groundwater samples collected near the site boundary. Collectively, these alternatives should be able to mitigate apparent landfill-related impacts.

8. CORRECTIVE ACTION PROGRAM

8.1 General

The corrective action program recommended for the Poway Landfill addresses source control and soil vapor monitoring for the apparent landfill-related impacts as methods for mitigating the discharge of waste constituents and migration of impacted subsurface vapor in the southern portion of the site. In addition, monitored natural attenuation of landfill-related impacts at the site is proposed for mitigation of impacted groundwater. The specific Corrective Action Program includes:

- Source Control – LFG System Enhancements;
- Soil Vapor Monitoring; and
- Monitored Natural Attenuation (MNA) of Groundwater.

8.2 Source Control

Sources of soil vapor impacts at the southern site boundary appear to include LFG migration and VOCs potentially partitioning from impacted groundwater. Three options for source control were selected as potential alternatives to mitigate the discharge of waste constituents and soil vapor impacts outside the limits of waste as described in the following sections.

8.2.1 Cover and Storm Water Maintenance

In accordance with Waste Discharge Requirements (WDRs) established for the site by the RWQCB in Order No. 94-165 (RWQCB, 1994), the County will continue to maintain storm water BMPs during the rainy season (October through April). The BMPs include grading of the cover system, maintaining vegetation on the cover system, and controlling precipitation runoff through a surface water management system. With the continued maintenance and management of these engineering controls, the infiltration of precipitation and surface water into the waste will be minimized, thereby minimizing the generation of LFG and leachate.

8.2.2 Enhancement of the LFG System

Based on the manometer testing and the current configuration of the LFG system, waste in the southern portion of the landfill does not appear to be adequately influenced by the LFG extraction system. Enhancements to the LFG system are recommended near the toe of the landfill to improve the system's coverage and effectiveness (Figure 12).

Prior to implementing this alternative, the County will perform a detailed evaluation of the LFG extraction system.

To monitor the performance of the LFG extraction system enhancements, the County will continue to conduct monthly routine monitoring of probes MP-1 through MP-5 along the property boundaries.

8.3 Soil Vapor Monitoring

Based on the current soil vapor data, LFG appears to have migrated to the southern property boundary. The concentrations of VOCs in soil vapor are significantly attenuated from the waste to the southern property boundary. Potential offsite sources of VOCs in soil vapor other than the landfill in the area south of the site include atmospheric fallout, storm water infiltration, and impacts from underground storm drains and sanitary sewer lines. Furthermore, BTEX and other VOCs detected in offsite soil vapor samples may have been introduced during residential site construction, chemical use at individual residences from the late 1960s to the present, historical agricultural activities and other sources unrelated to the landfill. In addition, results of the risk assessment suggest that VOCs in soil vapor samples collected south of the site do not pose an unacceptable risk according to USEPA, DTSC, and DEH. Background soil vapor wells PVP-5 and PVP-6, shallow soil vapor wells PVP-1A through PVP-4A (located on the southern site boundary), and shallow soil vapor wells VW-1A through VW-8A, VW-4B and VW-12 through VW-14 will be monitored to further evaluate concentrations of VOCs in soil vapor south of the site. Analytical soil vapor data collected from the soil vapor wells will be used to determine if additional action is warranted. These data will be summarized in the semi-annual monitoring reports.

8.4 Monitored Natural Attenuation

Natural attenuation appears to be occurring in groundwater to some degree at the site as discussed in the ROWD/EFS (GeoSyntec, 2005b). As a remedial alternative, MNA includes analysis of groundwater samples for additional parameters to monitor the inherent capabilities of the native microorganisms to degrade and naturally attenuate COCs. The degradation rate is usually predictable based on modeling of environmental factors such as electron acceptor and donor concentrations, VOC concentrations, groundwater flow characteristics, and geochemical characteristics of the matrix. Physical and chemical processes should also contribute to natural attenuation of VOCs in groundwater.

To support MNA, groundwater samples will continue to be collected from downgradient site and offsite monitor wells during routine monitoring events and analyzed for VOCs, chloride, total dissolved solids, dissolved oxygen, oxidation-reduction potential (ORP), and pH. A subset of the site-specific MNA parameters will be collected from monitor wells POGW-15, -16, -17B, 18B and the two new monitor wells POGW-20 and -21.

9. CORRECTIVE ACTION MONITORING AND REPORTING PROGRAM

9.1 General

Corrective action soil vapor and groundwater monitoring will be used to monitor the effectiveness of the proposed corrective measures and to evaluate seasonal fluctuations in chemical quality within the subsurface. Landfill gas migration and further evaluation of VOCs in soil vapor will be assessed by collecting vapor samples from existing shallow soil vapor wells located at the southern property boundary and soil vapor wells located within Dehia and Mirando Streets, Los Olivos and El Mar Avenues and Sunset View Road (Figure 12).

9.2 Source Control

Based on the findings of the manometer testing, further evaluation is needed to enhance the LFG system's coverage and effectiveness near the toe of the landfill (Figure 12). The County will perform a detailed evaluation of the LFG system prior to implementing corrective action.

9.3 Corrective Action Groundwater Monitoring

Per Order No. 94-165, the monitoring network at the site currently consists of thirteen groundwater monitor wells. In addition, monitor wells POGW-20 and POGW-21 will be added to the monitoring network during the third quarter 2006 semi-annual monitoring event. Most of these monitor wells are not needed to evaluate the effectiveness of corrective measures. The County previously requested that monitor wells POGW-10, -12, -17A, and -18A be converted to piezometers because they provide redundant data (GeoSyntec, 2005b). The proposed groundwater monitoring network is summarized as follows:

Well Name	Purpose
POGW-6	Background Monitor Well
POGW-9	Background Monitor Well
POPW-1	Cross Gradient Monitor Well
POGW-11	Downgradient Monitor Well
POGW-13	Downgradient Monitor Well
POGW-15	Downgradient Monitor Well
POGW-16	Downgradient Monitor Well
POGW-17B	Downgradient Monitor Well
POGW-18B	Downgradient Monitor Well
POGW-20	Downgradient Monitor Well
POGW-21	Downgradient Monitor Well

9.4 Corrective Action Monitoring Parameters

In compliance with Section C.3.b of MRP No. 94-165 and the revised MRP [GeoSyntec, 2000b] approved by the RWQCB in a letter dated 10 August 2000 [RWQCB, 2000], groundwater samples are collected from the monitor wells semi-annually, and analyzed as follows:

Parameter	Method
Chloride	SM4500-Cl-B
Nitrate as nitrogen	EPA 353.3
Field pH, field conductivity	Field Method
Sulfate	EPA 375.4
Total Dissolved Solids (TDS)	EPA 160.1
Bicarbonate, carbonate	EPA 310.1
Chemical Oxygen Demand (COD)	EPA 410.4
Dissolved calcium, potassium, magnesium, and sodium	EPA 6010B
Volatile Organic Compounds (VOCs)	EPA 8260B

Based on the initial screening of MNA parameters presented in the ROWD/EFS, the selected site-specific MNA parameters that support evidence that natural attenuation is occurring in groundwater at the site and within the site vicinity are presented in the table below. Groundwater samples collected from downgradient monitor wells POGW-15, -16, -17B and -18B and the two new monitor wells POGW-20 and POGW-21 will be analyzed for MNA parameters in addition to the routine parameters during semi-annual monitoring events. The additional MNA parameters include:

Parameter	Method
Dissolved Oxygen	Field Measurement
Oxidation Reduction Potential	Field Measurement

9.5 Corrective Action Soil Vapor Monitoring

Currently, there are ten onsite soil vapor wells and twenty-two offsite soil vapor wells for the Poway landfill. Most of these soil vapor wells are not needed to evaluate the effectiveness of corrective measures. The proposed soil vapor monitoring network is summarized as follows:

Well Name	Depth (feet bgs)	Purpose
PVP-5	5	Background Soil Vapor Well
PVP-6	5	Background Soil Vapor Well
PVP-1A	9	Downgradient Onsite Soil Vapor Well
PVP-2A	8	Downgradient Onsite Soil Vapor Well

Well Name	Depth (feet bgs)	Purpose
PVP-3A	10	Downgradient Onsite Soil Vapor Well
PVP-4A	8	Downgradient Onsite Soil Vapor Well
VW-1A	10	Downgradient Offsite Soil Vapor Well
VW-1B	5	Downgradient Offsite Soil Vapor Well
VW-2A	5	Downgradient Offsite Soil Vapor Well
VW-3A	5	Downgradient Offsite Soil Vapor Well
VW-4A	5	Downgradient Offsite Soil Vapor Well
VW-5A	5	Downgradient Offsite Soil Vapor Well
VW-6A	5	Downgradient Offsite Soil Vapor Well
VW-7A	5	Downgradient Offsite Soil Vapor Well
VW-8A	5	Downgradient Offsite Soil Vapor Well
VW-4B	10	Downgradient Offsite Soil Vapor Well
VW-10	5	Downgradient Offsite Soil Vapor Well
VW-11	5	Downgradient Offsite Soil Vapor Well
VW-12	5	Downgradient Offsite Soil Vapor Well
VW-13	5	Downgradient Offsite Soil Vapor Well
VW-14	5	Downgradient Offsite Soil Vapor Well

Soil vapor wells PVP-1, PVP-2B, PVP-4B, VW-2B, VW-3B, VW-5B, VW-6B, VW-7B, and VW-9 could not be samples during the April and May 2006 sampling events due to saturated or impermeable subsurface conditions. During each sampling event, each of these wells will be tested to see if a vapor sample can be obtained. The test will consist of connecting the soil vapor well to a Magnehelic gauge and applying a vacuum. If a vacuum of greater than 100 inches of water is developed in the soil vapor well, no sample will be collected.

9.6 Corrective Action Soil Vapor Monitoring Parameters

Soil vapor sampling and testing procedures will be conducted in accordance with DTSC soil vapor sampling guidelines (Cal-EPA, 2004). Vapor samples will be collected from the soil vapor wells and analyzed as follows:

Parameter	EPA Method
VOCs (including carbon disulfide, trans-1,4-dichloro-2-butene and methyl iodide)	TO-15
Fixed Gases	Field Methods

9.7 Monitoring and Reporting Frequency

Shallow onsite soil vapor wells and shallow offsite soil vapor wells located within Dehia and Mirando Streets, Los Olivos and El Mar Avenues and Sunset View Road will be monitored semi-annually in August 2006, February 2007, and August 2007.

A summary report will be submitted to the RWQCB and LEA following the completion of each semi-annual soil vapor sampling event. The effectiveness of these results will be discussed in the regularly scheduled semi-annual groundwater monitoring reports for the Poway Landfill which will describe results of the soil vapor sampling and updated human health risk assessment. These reports will be uploaded into the GeoTracker data base.

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