# Landfill Gas Investigation and Characterization Study
# Eubank Landfill

**Prepared for** **City of Albuquerque**
**Albuquerque, New Mexico**

**April 5, 2002**

*Daniel B. Stephens & Associates, Inc.*

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

# Table of Contents

# Table of Contents (continued)



# List of Figures

# List of Tables



# List of Appendices

# Acronyms and Technical Terms

| | |
|---|---|
| AEHD | Albuquerque Environmental Health Department |
| AP-42 | 1995 EPA publication entitled *Compilation of Air Pollutant Emission Factors,* which provides default values for k and $L_0$ |
| APS | Albuquerque Public Schools |
| bgs | below ground surface |
| Campbell 21X | self-contained datalogger. |
| cf/lb-yr | cubic feet per pound per year |
| cfm | cubic feet per minute |
| $CH_4$ | methane |
| City | City of Albuquerque |
| $CO_2$ | carbon dioxide |
| DBS&A | Daniel B. Stephens & Associates, Inc. |
| Dwyer DL8 | A multi-channel datalogger that interfaces with common transducer and transmitter outputs and can monitor temperature, relative humidity, pressure, wind speed, current, voltage and power |
| Dwyer Minihelic | A compact gage designed for panel mounting in a single 2⅝-inch-diameter hole |
| EPA | U.S. Environmental Protection Agency |
| $ft^3$/lb | cubic feet per pound |
| $ft^3$/min | cubic feet per minute |
| $ft^3$/ton | cubic feet per ton |
| GasTech monitor | gas monitor with built-in datalogging capability that allows for short-term, stand alone monitoring |
| GIA | gas in air |
| GPS | global positioning system |
| $H_2S$ | hydrogen sulfide |
| hp | horsepower |
| IDLH | immediately dangerous to life and health |
| k | methane generation rate constant (estimated fraction of waste that decays annually and produces methane to project annual landfill gas generation at 50 percent methane equivalent) |

# Acronyms and Technical Terms (continued)

| | |
|---|---|
| LandGEM | U.S. Environmental Protection Agency Landfill Gas Emissions Model |
| Landtec GA™-90 | portable, data logging field analyzer designed to monitor methane, carbon dioxide, and oxygen |
| Landtec GEM™ 500 | portable datalogging field analyzer designed to analyze gas content and determine flow from LFG collection wellheads using an on-board computer to integrate nine LFG instruments |
| $lbs/ft^3$ | pounds per cubic feet |
| LEL | lower explosive limit |
| LFG | landfill gas |
| LFG generation rate | rate at which a given landfill will produce landfill gas (influenced by the volume of waste, the percentage of degradable materials in the waste, the age of the waste, and the amount of moisture in the waste) |
| $L_0$ | ultimate methane generation rate (ultimate amount of methane which a ton of refuse produces over time) |
| Mcf | millions of cubic feet |
| Mg | megagrams |
| MSW | municipal solid waste |
| NIOSH | National Institute for Occupational Safety and Health |
| NSPS | New Source Performance Standards |
| $O_2$ | oxygen |
| PCE | tetrachloroethene (or perchloroethylene) |
| PID | photoionization detector |
| ppm | parts per million |
| ppbv | parts per billion, volume |
| psi | pounds per square inch |
| PVC | polyvinyl chloride |
| QA/QC | quality assurance/quality control |
| RFP | request for proposal |
| ROI | radius of influence |
| scfm | standard cubic feet per minute |
| SCS | SCS Engineers |
| Summa canister | 1-liter stainless steel vessel with chemically inert internal surfaces |

# Acronyms and Technical Terms (continued)

| | |
|---|---|
| TCE | trichloroethylene |
| TSI VelociCalc® meter | handheld instrument that measures volumetric flow rate, velocity and other parameters |
| TO-14 | EPA-approved method for determining VOCs in ambient air using a Summa canister for sampling and gas chromatography or gas chromatography/mass spectroscopy |
| Usft. | U.S. survey foot (equals 0.3048006096 meters) |
| VOC | volatile organic compound |
| WC | water column |

# Executive Summary

# Executive Summary – Eubank Landfill
# Landfill Gas Investigation and Characterization Study

This report presents the findings of a study conducted for the City of Albuquerque Environmental Health Department (City) by the engineering firms of Daniel B. Stephens & Associates, Inc. and SCS Engineers (study team) between July 2001 and March 2002. The study assessed whether landfill gas is present in seven closed landfills formerly owned and/or operated by the City. The study is part of the City's effort to prevent current and future risks related to landfill gas.

The study was conducted with the primary goal of providing new information to assist future land use plans regarding properties in close proximity to the former landfills. The City has established *Interim Guidelines for Development Within 1,000 Feet of Landfills* (Interim Guidelines), which provides for City review of development plans to ensure protection of public health and safety.

The former City owned and/or operated landfills covered by this report are:

- Atrisco Landfill
- Coronado Landfill
- Eubank Landfill
- Nazareth Landfill
- Sacramento Landfill
- San Antonio Landfill
- Yale Landfill

This Executive Summary provides (1) an overview of the investigation methods used in the landfill gas study and (2) presents the results and recommendations specific to the Eubank Landfill.

## 1. Overview of the Study

### *1.1 Landfill Gas Characteristics*

Landfills have the potential to emit gases as a result of natural decomposition of the materials they contain. Landfill gas is typically composed of methane (about 50 to 60 percent) and carbon dioxide (about 40 to 50 percent). Neither methane nor carbon dioxide is toxic to humans in small amounts. However, methane concentrations between 5 and 15 percent (of the total gas in air) can create a risk of explosion. The minimum concentration that can be explosive (5 percent) is called the lower explosive limit.

Landfill gas may also contain trace amounts of toxic substances such as volatile organic compounds (VOCs), some of which are classified by the U.S. Environmental Protection Agency (EPA) as carcinogens. Hydrogen sulfide, an inorganic gas that is toxic at relatively low concentrations, can be produced in landfills from the degradation of gypsum wallboard.

The rate of landfill gas generation is influenced by the percentage of degradable materials in the waste (i.e. food, paper, lawn clippings, textiles, wood, etc.) and the amount of moisture in the waste (increased moisture causes more rapid degradation). Larger landfills with more waste have a greater potential to generate gas and present a more significant likelihood of landfill gas migrating off-site.

The study team measured gas concentrations underground at the seven former landfills to identify the potential for present and future problems. Landfill gas detected underground may never reach the surface and pose a public health threat. However, landfill gas can migrate underground, through soils or along utility corridors, and therefore can present a concern for nearby properties.

## *1.2 Study Methods*

The study team reviewed existing documents and records about each landfill, then performed field investigations to determine landfill gas concentrations and waste characteristics. Using the data obtained, modeling was performed for each landfill to estimate current and future landfill gas generation rates.

### *Site History and Access*

Site histories were compiled that summarize the types of materials that may have been disposed of at each landfill and the time periods during which disposal occurred. General background information was also collected on landfill boundaries, site hydrogeology, and existing development in the area.

The landfill properties have numerous public and private owners. The study team obtained formal access agreements with property owners at each site for permission to conduct field investigations.

***Field Investigations***

Several methods were used to determine the current and future behavior of landfill gas at each of the seven landfills studied. These methods include:

1) Landfill gas surveys using underground sampling with field and laboratory gas testing
2) Waste characterization to sample and describe waste types
3) Landfill gas pumping tests to establish site-specific gas generation rate parameters
4) Gas generation modeling to estimate the long-term gas generation potential.

The study was performed according to customary engineering practices and industry standards.

- *Landfill gas survey.* The study team performed a landfill gas survey at each site between September 10 and October 5, 2001 to establish concentrations of landfill gas. Boreholes were driven 10 feet below ground surface to collect gas samples in the underlying waste. Temporary and/or permanent monitoring probes were drilled on a grid pattern across the surface of each landfill.

  Landfill gas samples were tested in the field for methane, carbon dioxide, oxygen, and hydrogen sulfide using portable instruments. Gas samples were also submitted to a laboratory for additional testing of volatile organic compounds. A total of 163 gas sampling points were field tested during the study, and samples for laboratory testing were collected at approximately half of these sampling points. All samples were carefully collected, labeled, and transported to the laboratory for testing following established procedures.

- *Waste characterization.* A bucket auger drill rig or a backhoe was used to sample landfill materials at 12 locations. The study team maintained logs of waste composition and samples were collected for moisture content testing. Waste material decomposition rates were categorized as follows:

- Rapidly degradable – food waste
- Moderately degradable – green waste, paper, and cardboard
- Slowly degradable – wood and textiles
- Inert/inorganic – rubber, glass, metal, plastics, concrete, and construction debris
- Fines/unknown – soil and fines

- *Landfill gas pumping tests.* Multi-day landfill gas pumping tests were conducted at the two largest landfills studied (Eubank and Yale Landfills) where the gas surveys indicated relatively high landfill gas concentrations. These tests established site-specific data related to gas generation rates.

  Pumping tests indicate whether accumulated gases within a landfill consist of a limited reservoir of gas (i.e., one that can be extracted and depleted in a short time), or if gas is continually generated at a sustainable rate. The gas generation rate affects the likelihood of potential gas migration and provides information for the design of venting or containment systems, if needed.

- *Landfill gas generation modeling.* The study team estimated how much gas may be generated at each site using the EPA's LandGEM computer model. The model used various input parameters based on industry standards and site-specific data from the field investigation. Model calculations consider the volume and age of waste at each landfill as key factors in potential gas generation.

# 2. Eubank Landfill Study Results and Recommendations

## *2.1 Landfill History*

The Eubank Landfill is located in southeast Albuquerque at the south end of Eubank Boulevard, northwest of the Tijeras Arroyo, east of Sandia National Laboratories and a PNM substation, and south of the South Pointe Village mobile home park. While development is located near the Eubank Landfill, the landfill acreage itself is unoccupied and serves as open space. A new business center development, the Sandia Science and Technology Park (Phase I), is planned at a site located northwest of the Eubank Landfill.

The City operated the Eubank Landfill from 1963 to 1984. The Eubank Landfill is divided into two fill areas: the northeast fill area covers 21 acres and the southwest fill area covers 60 acres. The landfill is unlined and has a waste depth of about 35 feet.

### *2.2 Landfill Gas Survey*

The landfill gas survey at the Eubank Landfill consisted of (1) installing 36 temporary gas sampling probes across the landfill and at the boundary of the South Pointe Village mobile home park and the proposed technology park, (2) installing 2 permanent monitoring probes at the boundary of the proposed technology park, (3) testing gas samples for methane, carbon dioxide, oxygen, and hydrogen sulfide using field instruments, and (4) conducting laboratory analysis of 11 samples for 35 volatile organic compounds commonly found in landfill gas. The findings of this investigation included:

- *Methane concentrations ranged from 0 to 61 percent*. The majority of methane readings in the northeast fill area exceeded the explosive limit (5 percent methane). Probes measured no methane at the off-site locations near the mobile home park and the proposed technology park. However, elevated levels of carbon dioxide and depleted oxygen in the probes near the mobile home park indicate the possible presence of low levels of landfill gas. No evidence of landfill gas was found at the probe locations near the proposed technology park. Methane levels above the explosive limit were also found within the southwest fill area. The elevated methane levels indicate a moderate potential for off-site gas migration.

- *Low levels of 27 volatile organic compounds* were detected in landfill gas samples taken beneath the ground surface of the northeast and southwest fill areas. This volatile organic compound data will be used in further studies.

### *2.3 Waste Characterization*

A waste characterization study was conducted at the Eubank Landfill and included (1) drilling four borings with a large-diameter bucket auger to depths of 7 to 30 feet, and (2) collecting and analyzing the waste samples to establish their composition, percentage of degradable material, and moisture content. Results of the waste characterization study included:

- *Waste was encountered from 2.5 to 27 feet below the ground surface.* Most of the waste found at the site consisted of paper, plastic, concrete, metal, green waste, wood, glass, cloth, rubber and cardboard. Most of this waste decomposes at a moderate rate.

- *Moisture content ranged from 14.0 to 32.1 percent by weight.* This level of moisture indicates moderate waste decomposition and gas generation rates.

### *2.4 Landfill Gas Pumping Tests and Landfill Gas Generation Modeling*

Landfill gas pumping tests were conducted at the Eubank Landfill, which included (1) installing a landfill gas extraction well and three monitoring probes (located 50, 100, and 200 feet away from the extraction well), and (2) a five-day series of three pumping tests to measure methane flows and concentrations. Based on landfill gas generation rates measured during the pumping tests, site-calibrated methane generation values were calculated.

The landfill gas generation rate at the Eubank Landfill was estimated with the EPA computer model, LandGEM, using input values based on site-specific data from the study. Four different projections were modeled using a combination of site-calibrated and "typical" landfill values. The results of the modeling indicate that for the Eubank Landfill:

- The peak year for landfill gas generation was 1985, which was one year after the landfill closed. The model indicates that landfill gas generation will continue to steadily decline as long as conditions do not change.

- The projected landfill gas generation rate in 2002 ranges from 205 to 302 standard cubic feet per minute. This is a moderate gas generation rate from this relatively large landfill, and suggests there is a moderate potential for off-site gas migration.

### *2.5 Recommendations*

This report makes a number of recommendations as to actions that should be taken by the City. These recommendations are worded in terms of actions that should be taken by the City because the City is the party that requested recommendations. It is the City that has taken the lead in dealing with landfill gas problems. This report takes no position on whether it is properly the City's role or responsibility to deal with the concerns raised by these recommendations.

***Reduce the Buffer Zone in the City's Interim Guidelines***

The City could reduce the buffer zone in the Interim Guidelines, provided a landfill gas monitoring plan is implemented (see recommendation below). Following initial monitoring, the buffer zone can be reduced immediately to the boundary of the Sandia Science and Technology Park Phase I. In all other areas, the buffer zone can be reduced to 500 feet if methane is not found above specified limits after two years of monitoring perimeter probes and selected underground utilities. Maintaining a minimum 500-foot setback is recommended because the landfill is expected to continue to generate gas and pose a potential risk for the long term.

***Develop a Comprehensive Landfill Management Plan***

The City should consider developing a landfill management plan for the Eubank Landfill to include:

- *Implement a landfill gas monitoring plan.* This monitoring plan should include the installation of perimeter monitoring probes spaced approximately 250 feet apart near the mobile home park, and approximately 500 feet apart elsewhere. Methane should be monitored quarterly for at least two consecutive years at probes and selected underground utilities. If methane is not detected above safe limits for two years, the monitoring period can be extended to every six months. If elevated levels are detected, the monitoring frequency should be increased. If impervious surfaces (e.g., pavement or structures) are developed on the landfill, increased monitoring may be necessary. This increased monitoring may include the Sandia Science and Technology Park (Phases 1 and 2).

- *Maintain positive drainage* across the landfill to minimize water infiltration into the waste. The existing landfill cover has numerous depressions that collect storm water. A site drainage study is recommended to identify improvements that may minimize methane generation.

- *Control and clean up illegal dumping.* Implement a combination of access restrictions (e.g. fencing, blocked roads), patrols, and enforcement. Existing debris scattered across the site should be cleaned up to promote positive drainage and deter continued dumping.

- *Continue to require design, monitoring, and/or landfill gas abatement* as stated in the Interim Guidelines, such as directing storm water away from the landfill, sealing off underground utilities, installing venting systems beneath structures, and/or installing interior monitors in buildings.

- *Implement a landfill gas control plan* if sustained, elevated methane levels are found*.* Install passive or active gas control systems capable of reducing methane to safe levels.

*For further detail on study methods, findings, and recommendations, please refer to the full report.*

# Part 1

# General Section

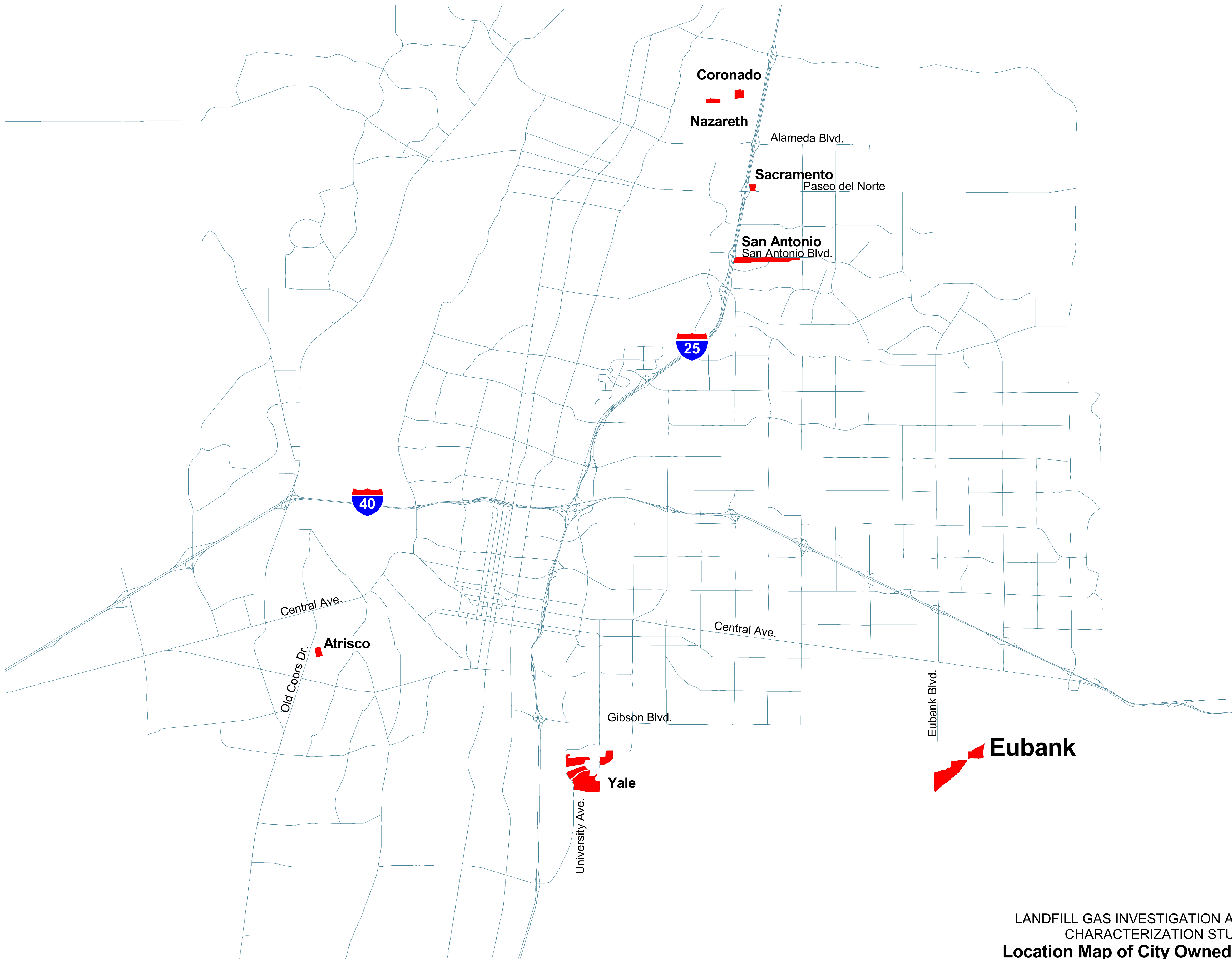
# 1. Introduction

This report details the approach used to perform a landfill gas (LFG) investigation to characterize the gas generation potential of former City of Albuquerque (City) owned and/or operated landfills being studied as part of the City's Landfill Gas Investigation and Characterization study. The study is being conducted under the direction of the Albuquerque Environmental Health Department (AEHD) by Daniel B. Stephens & Associates, Inc. (DBS&A) and SCS Engineers (SCS). The purpose of the study is to determine if LFG currently exists or could be generated at former City owned and/or operated landfill sites and how LFG might impact development and the public.

The City of Albuquerque currently has issued *Interim Guidelines for Development within 1,000 feet of Landfills*. The City's guidelines provide for review of development plans for public and private properties on or within a 1,000-foot buffer around former landfills. This includes not only City owned and/or operated landfills, but also permitted private landfills. This review is intended to ensure that appropriate landfill gas abatement measures are taken, based on the site-specific LFG conditions for a particular development. This LFG investigation and characterization study, as well as future studies, will assist the City in revising these Interim Guidelines, if needed, for each individual former City owned and/or operated landfill, and will provide planning and development guidance for future and existing development on and/or near the former City owned and/or operated landfills.

Part 1 of this report, which contains the first two sections, presents information on the overall Landfill Gas Investigation and Characterization study, which includes seven former City owned and/or operated landfill sites located within the City and Bernalillo County (Figure 1). These seven sites include:

- Atrisco Landfill
- Coronado Landfill (north cell only)
- Eubank Landfill
- Nazareth Landfill
- Sacramento Landfill




## City of Albuquerque Zone Atlas Map

| Landfill | Page |
|---|---|
| Atrisco | K-11 |
| Coronado | B-18 |
| Eubank | M-12 |
| Nazareth | B-17 |
| San Antonio | E-18 |
| Sacramento | C-18 |
| Yale | M-15 |

N

0 1 2 miles

**Explanation**

Landfill

T:\VDR\PROJECTS\9398\AlbLF_Landfill Locations- all-sites.apr (Layout = L6 - Eubank Landfill Location Map, B-size, 1:96,000)

*Daniel B. Stephens & Associates, Inc.*
3-18-02 2:30 PM JN 9398

LANDFILL GAS INVESTIGATION AND
CHARACTERIZATION STUDY

**Location Map of City Owned or Operated Landfills Studied**

Figure 1

- San Antonio Landfill
- Yale Landfill

Components of the investigation include a LFG survey, waste characterization study, and LFG gas pump tests. Part 2 of this report presents the landfill-specific field investigation methods and results for the Eubank Landfill. Results from individual landfill investigations were combined with modeling results and formed the basis for the conclusions and recommendations presented at the end of this report.

## 1.1 Composition and Measurement of Landfill Gas

LFG is composed primarily of methane ($CH_4$) and carbon dioxide ($CO_2$), naturally occurring byproducts of waste degradation that are not considered toxic to humans. Waste degradation occurs when organic landfill materials are exposed to moisture. The amount of methane generated by waste degradation depends on a number of factors, but primarily on the amount of water exposed to the organic waste under anaerobic (no oxygen) conditions.

Methane is a concern because concentrated accumulations of methane can be explosive and can displace oxygen, which may lead to asphyxiation. LFG can also carry trace concentrations of other gases with potential toxicity concerns. The most significant trace gases carried by LFG are volatile organic compounds (VOCs), some of which are classified by the U.S. Environmental Protection Agency (EPA) and other national public health organizations as carcinogens. In addition, LFG may include hydrogen sulfide ($H_2S$), an inorganic gas that can be toxic at relatively low concentrations, and is produced in landfills primarily from the degradation of gypsum wallboard.

Pure LFG within waste disposal cells typically contains approximately 50 to 60 percent methane and 40 to 50 percent carbon dioxide. LFG may also be diluted with air in the subsurface, which reduces methane and carbon dioxide concentrations and adds oxygen and nitrogen. Natural atmospheric barometric pressure changes, otherwise known as barometric pumping, mix air into the soil, and closed landfills that are covered with relatively permeable soil may have significant gas exchange with the atmosphere. This barometric pumping both dilutes the LFG deeper in the subsurface and oxygenates the soil gas. Through this process, methane breaks down in the subsurface and is prevented from reaching the shallow soils or the atmosphere.

Methane gas concentrations are measured using one of two reporting scales: (1) as a percentage of methane gas in the total gas or simply “percent”, or (2) as a percentage of the lower explosive limit (LEL). The LEL for methane is equivalent to 5 percent methane gas in atmospheric air, which contains approximately 20 percent oxygen. The upper explosive limit is 15 percent methane in air. Methane is explosive only in the range of 5 to 15 percent and is not explosive if methane concentrations exceed 15 percent or if oxygen is depleted. In this report, methane and other gas constituents are reported as percent of total gas, and the methane concentration is referred to as being above or below the LEL, depending upon whether the methane concentration exceeds 5 percent total gas. A methane concentration of 100 percent of the LEL is the lower range of methane that will explode.

## 1.2 Landfill Gas Standards

Standards for allowable levels of LFG have been established to avoid explosion hazards. LFG can accumulate in enclosed structures and migrate away from the landfill through soils and along subsurface utility corridors. The rate of LFG generation is influenced by the percentage of degradable materials in the waste (i.e. food, paper, lawn clippings, textiles, wood, etc.) and the amount of moisture in the waste. Larger landfills with more waste have a greater potential to produce LFG and present a more significant likelihood of off-site LFG migration. The City of Albuquerque Fire Marshall’s standard requires that methane concentrations must not exceed 10 percent of the LEL (0.5 percent) in an occupied structure.

Additional standards address the potential toxic hazard associated with VOCs and $H_2S$ that may be present in LFG. Relatively low concentrations of certain gases, in the parts per million (ppm) range, may be a concern for human exposure. Allowable exposure limits for workers are published in a guide sponsored the National Institute for Occupational Safety and Health (NIOSH). These standards are not intended to protect non-workers against short- or long-term exposure, but may be used as an available guideline to evaluate potential hazards posed by trace gases in LFG.

The NIOSH guide provides standards for exposure limits to many VOCs that can be present in LFG. The NIOSH guide indicates a long-term permissible exposure limit for hydrogen sulfide of 10 ppm for workers. The guide also indicates that a hydrogen sulfide concentration of 300 ppm is immediately dangerous to life and health (IDLH). These NIOSH standards may be used as a guide to consider the relative toxicity of various trace gases that can be carried with LFG.

The results of the VOC sampling at each of the landfills indicate whether or not these trace gases exist below the ground surface of the landfills. However, the results obtained do not provide a basis to determine whether these values are toxic to the public, since it is unknown how these gases will migrate to the surface or how they may degrade and become diluted as they migrate up to the surface.

## 1.3 Future Land Use Considerations

Final land use plans are an integral part of landfill closures, and considerable work has been done across the country to complete landfill closures in a manner that provides for safe development of closed landfill sites. Development of closed landfills has included parks, industrial development, golf courses, and open space. The solid waste management industry in the United States has devised technologies to develop closed landfill sites in a manner that is protective of human health and safety and the environment.

Many of the significant issues concerning the development of a closed landfill are related to structures and facilities that are built directly on the closed landfill disposal cells. The following issues are generally addressed in developing a closed landfill:

- *LFG accumulation in enclosed structures*. LFG consists primarily of methane and carbon dioxide. If allowed to accumulate within a confined area in the presence of an ignition source, methane can explode if the concentration exceeds 100 percent of the LEL (5 percent). Development must prevent the potential for accumulation of explosive methane concentrations within buildings and smaller enclosures such as light poles, fence posts, and utility corridors and vaults.

- *Settlement of waste that affects structures built on the landfill*. Permanent structures and utilities must be designed in a manner to account for differential settlement that occurs as landfill waste degrades and consolidates over many years.

- *Infiltration of water into the landfill as a result of precipitation and irrigation*. The infiltration of water into a landfill from irrigation or precipitation must be minimized to prevent generation of leachate that can contribute to groundwater contamination. An increase in moisture content of the waste can also cause accelerated generation of LFG. Synthetic membranes or earthen covers are often used to cover landfills to prevent infiltration of precipitation/irrigation water into the waste. Landfill covers should also be graded to maintain positive drainage at all times.

By ensuring that these issues are addressed, development has been completed safely at many closed landfill sites.

# 2. Technical Approach

The technical approach for the landfill gas investigation and characterization project is described in this section. Several tasks were conducted including:

- Review of records on site history
- Obtaining permission for site access to landfill property
- LFG survey using push-probe sampling with field and laboratory gas testing
- Drilling waste characterization borings to characterize waste types
- LFG pumping tests to establish site-specific gas generation rate parameters
- LFG generation modeling to estimate the long-term gas generation potential

This section presents the methodology used for these tasks. Field investigation methods to implement the technical approach are provided in Section 4, and results are provided in Section 5.

## 2.1 Site History Records Review

The site history of each former landfill was obtained through a review of available records related to the landfill's operating history and previously completed investigations. Sources of data for this section were compiled by AEHD and include reports and files prepared by various organizations. A primary source of data was a report entitled *Past and Present Solid Waste Landfills in Bernalillo County, New Mexico* (Nelson, 1997), which focused on all seven landfills covered in the present study, as well as other private landfills not owned or operated by the City. Nelson's report provided details on the general backgrounds of the landfills including site history, landfill operational data, and site hydrogeology. Most importantly, Nelson (1997) carefully considered the landfill boundaries using past records such as aerial photographs and more recent on-site observations. These boundaries were used in the current investigation and are presented in the site maps included in this report.

## 2.2 Site Access

The seven former landfills being investigated have numerous landowners, and most are subdivided into several parcels under different ownership. The majority of properties are privately owned, with some public owners including the City of Albuquerque and the New Mexico State Land Office. The first task in arranging the LFG survey was to establish formal access agreements with property owners at each landfill to ensure access for field investigation.

Site access activities were initiated by obtaining zone atlas pages and identifying lots within the boundaries of the seven landfills. Property owners were identified using the Bernalillo County Tax Assessor's website in conjunction with the City of Albuquerque website. Information gathered from these websites was confirmed at the Bernalillo County Tax Assessor's office because the websites are updated only on an annual basis. Therefore, any changes in property ownership that had occurred during 2001 could be found only in the tax assessor's database at the County Assessor's office.

Once ownership was determined, formal access agreements were requested from property owners at each landfill to allow access for field investigation. Information gathered from the tax assessor's records was entered into a database and written access agreements were sent to each property owner for signature.

## 2.3 Landfill Gas Survey

A LFG survey was performed to establish the existing concentration of LFG at each of the seven former landfills. The survey fieldwork was conducted during September 10 to October 5, 2001. The LFG survey involved collection of LFG samples using a probe driven 10 feet below ground surface (bgs), through the landfill cover and into the underlying waste. The survey was performed using temporary and/or permanent probe installations distributed across each landfill and in selected off-site locations. LFG samples were tested in the field using portable instruments, and samples were also collected and submitted to a laboratory for additional testing.

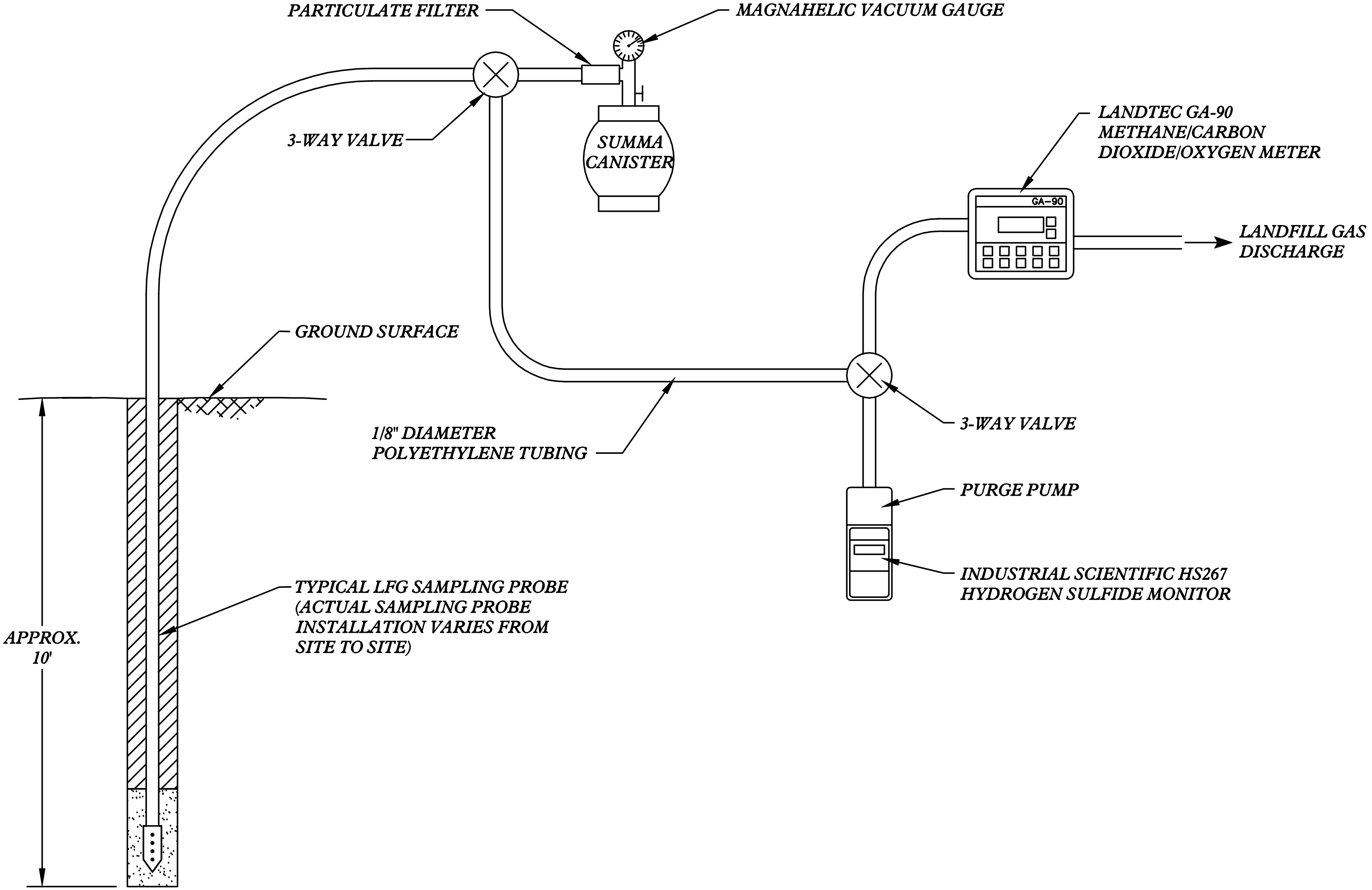
Sampling was performed on a grid pattern submitted to and approved by the City prior to sampling. Sampling locations were staked/marked using global positioning system (GPS) survey equipment. This survey method allowed for efficient sampling point identification during the LFG survey and provided the ability to make adjustments in the field. The sampling grids at the landfills were based on the following general spacing and adjusted to fit the landfill configuration.

- Atrisco Landfill — 200 x 200-foot grid
- Coronado Landfill — 200 x 200-foot grid
- Eubank Landfill — 400 x 400-foot grid
- Nazareth Landfill — 200 x 200-foot grid
- Sacramento Landfill — 200 x 200-foot grid
- San Antonio Landfill — 200 x 200-foot grid
- Yale Landfill (northern, central, and hotel areas) — 200 x 200-foot grid
  (southern area) — 400 x 400-foot grid

LFG samples were collected at each landfill location using a hydraulically driven, truck-mounted geoprobe. ESN Rocky Mountain, of Golden, Colorado was retained by DBS&A to perform the gas probe drilling at all of the landfills. In addition, Geo-Test, Inc. of Albuquerque was retained to provide a four-wheel drive drill rig to access steep terrain at the Yale Landfill for installation of seven gas probes. Temporary gas probe installations used a small-diameter drive probe to penetrate the landfill cover and allow LFG extraction and sampling from the underlying waste. At certain locations, where the City intends to conduct additional monitoring, permanent monitoring probes were installed. Details of the gas probe installation methods are provided in Section 4.3.

At each probe installation, several field instruments were connected in a sampling train to test for LFG constituents. The sampling train (Figure 2) consisted of a Landtec GA™-90 infrared gas analyzer, a hydrogen sulfide meter, and a Summa canister connection valve to facilitate the collection of VOC samples for laboratory analysis. The Landtec GA™-90 was used to measure concentrations of methane, carbon dioxide, and oxygen as well as LFG pressure and

S:\PROJECTS\9398\SHEETS\FIGURES\EUBANK\Figure_2.dwg




Not to Scale

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Landfill Gas Survey Sampling Train Detail**

Daniel B. Stephens & Associates, Inc.

3-19-02

JN 9398

Figure 2

atmospheric pressure. Calibration of field instruments was performed daily during the survey, using bottled calibration gas with standard gas concentrations.

The LFG static pressure is measured relative to atmospheric pressure; negative readings indicate a pressure lower than atmospheric and positive readings indicate a pressure greater than atmospheric. These pressure measurements show the influence of barometric pumping (Section 1.1). At the time a given sample is collected, negative LFG pressure indicates that atmospheric air has a tendency to move downward through the landfill cover. Positive LFG pressure indicates that LFG has a tendency to move upward through the landfill cover. LFG static pressures tend to be negative in the morning hours when atmospheric pressure is rising and neutral or positive in the mid to late afternoon when atmospheric pressure is falling.

LFG samples were collected for laboratory analysis in accordance with AEHD's guidance regarding the number, and for some landfills, the location of sampling sites. Samples for VOC analysis were collected from all seven landfills studied. Additional samples were collected for laboratory analysis of methane, carbon dioxide, oxygen, and nitrogen for quality assurance/quality control (QA/QC) purposes. These QA/QC samples were collected in duplicate on 5 percent of the samples tested with field instruments.

Samples for laboratory analysis were collected by attaching a Summa canister to the sampling train ahead of the field instruments (Figure 2). The entire sampling train was then purged while the field parameters were measured. Once the purge was complete and stable readings were measured, the valve on the Summa canister was opened, allowing the canister to fill with LFG. Samples were sent to Air Toxics Ltd. in Folsom, California, where they were analyzed for 35 of the most commonly found LFG constituents using a modified version of the standard test for toxic organics at ambient air temperature (TO-14 test). Samples for QA/QC purposes were analyzed by U.S. EPA Method 3C. Chain-of-custody forms provided by the laboratory were filled out and signed by DBS&A's field technician and submitted with the samples.

## 2.4 Waste Characterization Analysis

A waste characterization program was implemented to determine whether the former landfills contain decomposable materials that may continue to produce LFG in the future. Waste characterization describes the type of waste present, its current state of decomposition, and its moisture content. These waste characteristics identify both the degree of degradation that has occurred since waste deposition and the potential for further waste degradation.

### *2.4.1 Waste Sampling, Testing, and Monitoring*

Waste characterization exploration was conducted by drilling with a large-diameter bucket auger or excavating a test pit with a backhoe. Koda Drilling, Inc., of Grapevine, Texas, was retained by DBS&A to drill bucket auger borings at four of the landfills in the study (Coronado, Eubank, San Antonio, and Yale). Rodgers Environmental, Inc., of Albuquerque, was retained to excavate a test pit at the Atrisco Landfill. Waste characterization was not performed at the Nazareth Landfill, which is under City ownership, or at the Sacramento Landfill, which is the smallest landfill in the study.

Key elements conducted during the waste sampling task were:

- Documentation of drilling and excavation
- Preparation of waste logs
- Gas monitoring for health and safety
- Collection of waste samples for moisture content analysis
- Characterization of waste into waste types and degradability categories

All sampling activities were observed and logs were prepared that contained specific waste data such as odor, color, temperature (when available), organic content, and general material description of the waste samples. The temperature of the debris retrieved from the borehole was recorded by inserting either a standard thermometer or a probe-mounted thermocouple connected to a Campbell 21X datalogger. Temperature measurements, odor, color, and organic content of the waste are included in the boring logs (Appendix A).

A GasTech gas monitor (Model 90) was used to monitor levels of hydrogen sulfide and methane for health and safety purposes of the drill crew and field staff. All air monitoring results were below the short-term health and safety thresholds of 15 ppm for hydrogen sulfide and 5 percent for methane. A photoionization detector (PID) was also used to monitor for the presence of VOCs. All readings were collected from the breathing zone.

### *2.4.2 Degradation Rates*

Waste material from each waste characterization boring was observed, categorized, and percentages assigned. Examples of the waste categories used include:

- Food waste
- Wood
- Metal
- Green waste
- Rubber
- Plastics
- Paper
- Textiles
- Concrete
- Cardboard
- Glass
- Soil

Percentages were assigned to each waste category by volume, according to what was observed during the removal of the waste from the borehole or excavation pit. The percent volume was then converted to percent weight using the average densities provided by Peavy, et al. (1985) (Appendix B). After the weight percentages were calculated, decomposability ratings were estimated. The waste types listed above were divided into the following subjective categories:

- Rapidly degradable – food waste
- Moderately degradable – green waste, paper, and cardboard
- Slowly degradable – wood and textiles
- Inert/inorganic – rubber, glass, metal, plastics, concrete, and construction debris
- Fines/unknown – soil and fines

### 2.4.3 Moisture Content Analysis

Samples were collected for moisture content testing from the waste characterization borings that recovered substantial waste (Yale, Eubank, Atrisco, and San Antonio). Soil and other inert materials such as concrete encountered during drilling were not sampled for moisture content. Moisture content samples were collected only from the degradable portion of waste, since this is the only component of the waste stream that will have the potential to generate landfill gas.

Samples were selected at varying depths in the upper, middle, and bottom of each waste boring. The samples were placed in 5-gallon buckets with sealed lids and transported to the DBS&A Hydrologic Testing Laboratory in Albuquerque for moisture content analysis. The samples were labeled with a unique identification number indicating the date, time, and depth of each sample. Chain-of-custody was maintained and documented from the time of sample collection to completion of analyses.

## 2.5 Landfill Gas Pumping Tests

The purpose of pumping tests is to indicate whether the accumulated LFG within a landfill is a limited reservoir of gas (i.e., one that can be extracted and depleted in a short time) or whether high rates of gas generation will continue to replenish the gas extracted by pumping. The gas generation rate affects the likelihood of off-site LFG migration. During the multi-day pumping test, the rate of gas generation was estimated by observing whether LFG concentrations and flow rates were sustained during long-term extraction or whether LFG concentrations declined substantially after the initial reservoir of accumulated LFG was removed.

As part of this study, LFG pumping tests were conducted only at the two largest landfills studied (Yale and Eubank), in portions of the landfills where the LFG survey indicated relatively high LFG concentrations. For the Yale Landfill, the pump test was conducted from December 27, 2001 through December 30, 2002. For the Eubank Landfill, the pump test was conducted from January 4, 2002 through January 8, 2002. These tests were conducted to establish site-specific data pertaining to LFG generation for these two Albuquerque landfills. The data was used as a check on the validity of the LFG generation model used to estimate LFG generation for all seven landfills studied.

The LFG pumping tests were conducted by installing a LFG extraction well and three pressure monitoring probes at both the Eubank and Yale Landfills. Koda Drilling, Inc., of Grapevine, Texas, installed the extraction wells at the Eubank and Yale Landfills within one of the bucket auger borings drilled for waste characterization sampling. Rodgers Environmental, Inc. was retained by DBS&A to drill and construct three monitoring probes at each landfill using a hollow-stem auger drill rig.

LFG was pumped from the extraction well with a blower powered by an electric generator. Vacuum was measured in the three pressure probes installed at distances of 50, 100, and 200 feet from the extraction well. By monitoring the pressure drop resulting from LFG pumping, the radius of influence of the pumping well can be determined. Based on the LFG extraction rate and radius of influence, site-calibrated LFG generation input parameters were calculated for use in modeling LFG generation rates, as discussed in Section 2.6.

## 2.6 Landfill Gas Generation Modeling

Landfill gas generation projections were performed for each landfill evaluated in this study. Several input variables were assessed and used in the LFG generation estimations. The volume of in place waste at each landfill is a primary input variable and varying this number greatly influences the projected LFG generation rate. Another key factor in the estimation of LFG generation is the age of the in-place waste. Numerous information sources were used to determine the modeling input parameters, to provide for valid estimates of the expected range of LFG generation rates. Landfill gas generation projections were performed up to year 2020. Beyond 2020, the accuracy of the model declines without more recent site-specific data. The site-specific LFG generation model input and results are described in Section 5.

LFG generation was estimated using SCS's spreadsheet version of the EPA's Landfill Gas Emissions Model (LandGEM). LandGEM is a first-order decay model required by the EPA to be used for New Source Performance Standards (NSPS) evaluations, Title V permitting, and other

Clean Air Act permitting projects. This model is the industry recognized standard for predicting LFG generation rates. SCS has converted the LandGEM model to an Excel spreadsheet format for ease of use. LandGEM uses (1) annual waste disposal rates, (2) the ultimate amount of methane which a ton of refuse produces over time (ultimate methane generation rate or "$L_0$" value), and (3) the estimated fraction of waste that decays annually and produces methane (the methane generation rate constant or "k" value) to project annual LFG generation at 50 percent methane equivalent.

### *2.6.1 LFG Model Inputs: Annual Waste Disposal Rates*

Information used to establish the waste disposal history needed as input for LFG models was obtained from the following sources:

- Information provided by the City of Albuquerque in Appendix C of the Request for Proposals (RFP) for the current project, including site acreage, refuse depths, and years that the landfill was open for disposal.
- Historical documents provided by the City of Albuquerque, which include reports documenting the results of field investigations and other prior studies with information relevant to waste disposal at the landfills.
- The present study, including drawings that define landfill areas, and field investigations to determine the locations, composition, and moisture content of refuse.

Based on data from previous studies and this field investigation, certain assumptions were made regarding the size, average soil cover thickness, average refuse thickness, and estimated volume and weight of refuse at the landfill.

Some of the landfills studied contain more than one disposal cell. In particular, the Yale Landfill is divided into four cells and the Eubank Landfill is divided into two cells. Other landfills may be divided into individual cells, although the configuration of cells is unknown. Detailed information on the age, acreage, and depth of the waste in individual waste cells is unavailable for the landfills studied. As a result, each landfill was modeled to estimate the total LFG production from the entire waste mass.

### *2.6.2 LFG Model Inputs: Ultimate Methane Generation Rate ($L_0$)*

The $L_0$ value is estimated based on information from the following sources:

- U.S. EPA's estimated default (AP-42) $L_0$ value for dry landfills (EPA, 1995).

- The SCS default $L_0$ value, which is based on the SCS LFG database. This database includes actual LFG recovery data from over 100 U.S. landfills, representing over 300 years of flow data. The data indicate that the $L_0$ value is influenced by moisture and provide a correlation between average annual precipitation and the $L_0$ value.

- Waste characterization data, which include information on degradability categories (percentage of waste that is rapidly degradable, moderately degradable, etc.) and moisture content. The characteristics of wastes at each landfill were compared to the typical waste characteristics of landfills in the U.S. to estimate the likely effects of any deviation from average landfill conditions on the $L_0$ value.

Waste characterization data were generated for the landfills where waste borings and test pits were excavated (Atrisco, Coronado, Eubank, San Antonio, and Yale Landfills). At the Nazareth and Sacramento Landfills, where waste characterization was not studied, only default values were available.

### *2.6.3 LFG Model Inputs: Methane Generation Rate Constant (k)*

The k value was estimated based on the following information sources:

- U.S. EPA's estimated default (AP-42) k value for dry landfills (EPA, 1995).

- The SCS default k value, which is based on the SCS LFG database. Data in this database indicate that the k value is strongly influenced by moisture, and provide a correlation between average annual precipitation and the k value.

- Results of the field evaluation of the moisture content of waste samples from the landfill under investigation. The moisture content of the sampled waste was compared to the moisture content of typical U.S. waste to estimate the likely effects of a significant variation from average refuse moisture content on the k value.

Waste moisture content data were generated from waste characterization sampling at the Atrisco, Eubank, San Antonio, and Yale Landfills. At the Coronado, Nazareth, and Sacramento Landfills, waste moisture was not studied through field testing, and only default values were available.

#### *2.6.4 LFG Generation Projections*

Multiple LFG model runs and resulting LFG generation projections were prepared for each landfill to cover the range of possible LFG generation rates. These included projections to delineate potential minimum and maximum LFG generation, and to estimate the effect of increasing moisture at selected landfills. The LFG generation projections used the following variables:

- EPA default (AP-42) projection using the default values for $L_0$ and k (EPA, 1995).

- The SCS default projection using the SCS precipitation-based values for $L_0$ and k.

- Site-calibrated projection(s) using the $L_0$ and/or k values derived from analyses of field data.

- Modified site-specific projection that uses the $L_0$ and k values derived from analyses of field data, but also shows the potential effects of adding moisture on LFG generation.

LandGEM simulates increased LFG generation rates when the waste moisture is increased. A projection with added moisture was modeled for the larger landfills in the study (Yale, Eubank, and San Antonio), where relatively high overall LFG generation rates are expected because of the large amounts of solid waste. A projection with added moisture was also modeled for the Sacramento Landfill, because this landfill has very poor drainage and is at a low topographic level that collects storm water runoff from surrounding areas. The added moisture scenario was not examined for the smaller landfills with positive drainage and/or no detection of methane during the LFG survey (Atrisco, Coronado, and Nazareth), because the added moisture would simulate a relatively small change in LFG generation.

LFG generation rates are adjusted to 50 percent methane content (standard normalization procedure) to reflect the typical methane content of LFG as it is generated.

#### *2.6.5 Model Validation*

Model validation of LandGEM is provided by the results of the LFG pumping tests conducted at the Eubank and Yale Landfills. These tests provided site-calibrated k values based on actual measurements of LFG production. The calibrated k values for Eubank and Yale were found to be consistent with k input parameters assigned through default values for the Albuquerque region. The consistency between pumping test results and regional default values for these two Albuquerque landfills support the application of the model to other landfills investigated in this study where no pumping tests were conducted. Adjusting LandGEM input parameters to reflect site-specific conditions for the remainder of the landfills should then provide reasonable estimates of the LFG generation rate.

The pumping test results for Eubank and Yale indicated the range of k values appropriate for the Albuquerque region and guided the adjustment to the k values made for these landfills based on waste moisture content. At the Atrisco and San Antonio Landfills, where no pumping tests were conducted, site-calibrated k values were assigned based on site-specific testing for the waste moisture content. At the Sacramento Landfill, which is characterized by storm water ponding and poor site drainage, a modeling scenario was analyzed using a k value adjusted upward from the default value to reflect a probable elevated waste moisture. For Coronado and

Nazareth Landfills, where neither pumping test nor waste moisture content results were obtained, the default k input values are expected to provide for reasonable estimates of the LFG generation rate using LandGEM.

Site-calibrated $L_0$ values were assigned by adjusting the regional default $L_0$ based on the percentage of degradable waste determined from waste characterization studies (Atrisco, Coronado, Eubank, San Antonio, and Yale). At the Nazareth and Sacramento Landfills, where waste characterization was not conducted, the default $L_0$ values were used to provide reasonable estimates of the LFG generation rate using LandGEM.

# Part 2

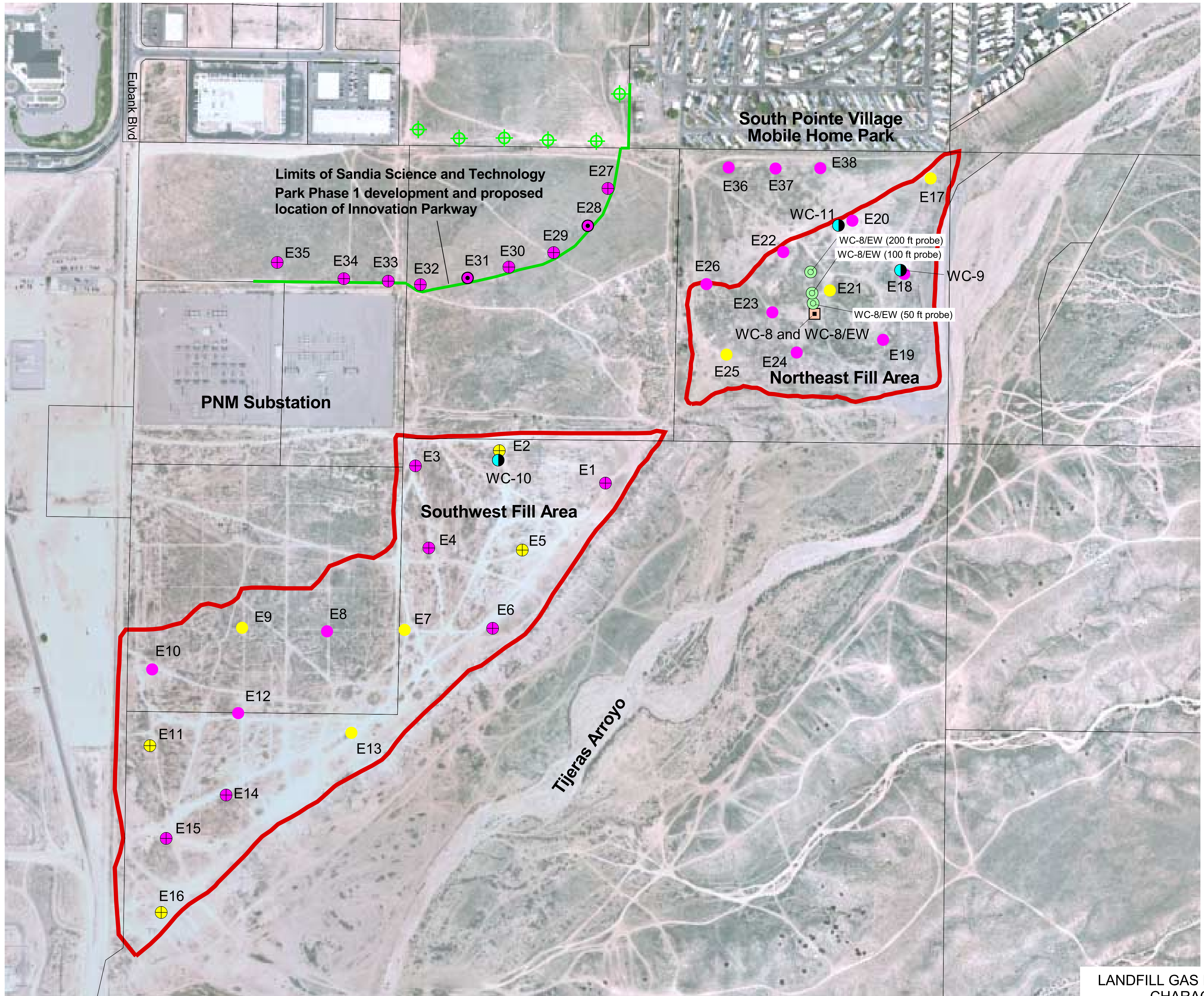
# Landfill-Specific Section

# 3. Site Background and Previous Investigations

The Eubank Landfill is located in southeast Albuquerque at the south end of Eubank Boulevard, northwest of the Tijeras Arroyo, east of Sandia Laboratories and the PNM Substation, and south of the South Pointe Village mobile home park (Figure 1). The Eubank Landfill consists of two distinct fill areas, the northeast fill area and the southwest fill area (Figure 3). Currently, there is a small amount of development around the perimeter of the landfill consisting mainly of the mobile home park to the north and a Public Service Company of New Mexico (PNM) electric substation to the northwest. There are plans to build a science and technology park to the north and west of the Eubank Landfill, with portions of the development to occur on the landfill itself. The initial phase of construction will not involve building on the landfill, but the second phase plans development on both the northeast and southwest fill areas.

The northeast area of the landfill was operated by the City between 1963 and 1973 on property leased from the New Mexico State Land Office. The landfill is unlined and covers approximately 21 acres, with a waste depth in the range of approximately 30 to 40 feet. Material placed at the landfill was reported to be mainly residential and commercial waste (Nelson, 1997). There are also reports that chemical drums from a GTE (Siemens) manufacturing plant were dumped at the Eubank Landfill. (The GTE plant operated in Albuquerque from 1972 to 1986, at which time it was sold to Siemens.) Reports are unclear about whether these drums were placed in the northeast fill area, the southwest fill area, or both areas of the landfill (Nelson, 1997).

In 1968, the Shaw Mobile Home Park (now the South Pointe Village mobile home park, located directly north of the northeast fill area) leased approximately 5 acres for installation of a septic tank and a sewage lagoon. From 1973 until 1984, RECO Corporation leased the site for trailer park predevelopment, drainage, and sewer services. During the lease period, complaints were reported concerning the illegal dumping of waste, the presence of improper sewer lines and sewage lagoons, and improper storm water drainage. Eventually, the mobile home park was connected to City sewer services and the lagoons were drained (Nelson, 1997). It is unclear exactly where the sewer lines were installed, but according to the State Land Office, a portion of the sewer lines were installed over waste. If this is the case, these pipes probably had some leakage of water into the waste over their service life.




**Source:**

1999 Aerial photograph provided by
Bernalillo County

N

0 500 ft

**Explanation**

- Sampling probe locations
- Sampling probe/lab sample locations
- Permanent probe locations
- Tubing left in place for future sampling
- Methane monitor well (installed by others)
- Waste characterization sample point
- Waste characterization sample point and extraction well
- Pressure probe
- Parcels
- Landfill boundary

( T:\VDR0-VDR-PROJECTS\9398 (PROJECT = albif_eubank.apr ) (VIEW EXTENTS = Temp) (VIEW NAME = V6-Eubank ) (LAYOUT = L6-Eubank )

*Daniel B. Stephens & Associates, Inc.*
3-28-02 4:40 PM
JN 9398

LANDFILL GAS INVESTIGATION AND
CHARACTERIZATION STUDY
**Eubank Landfill Test Locations**

Figure 3

As part of the lease agreement between the City and the State Land Office, the City was required to cover the waste with several feet of soil. During construction of the cover it is likely that some grading activities were performed. A Lease Compliance Report detailing the cover thickness was issued to the City Solid Waste Department on July 22, 1987 (Rhombus, 1987). In 1996, a soil cement stabilization project was completed by Leedshill-Herkenhoff, Inc. and Pioneer Industries on the east and southeast portion of the northeast fill area along Tijeras Arroyo. This stabilization effort was undertaken because the toe of the waste slope extended to the bottom of the arroyo, and waste could be washed away. The stabilized waste slope continues to serve as the northwest bank of the arroyo (Nelson, 1997).

The southwest area of the landfill was leased by the City for use as a landfill in 1974 from the Cathedral of St. John and Margaret Glasbrook. The City operated the southwest fill area from 1974 to 1984, and the lease expired in 1986. This portion of the landfill is also unlined and covers approximately 60 acres, with a maximum waste depth of approximately 36 to 40 feet. It is reported that this fill area also received residential and commercial waste.

Currently, both the northeast and southwest fill areas have soil covers consisting of on-site soils covered by sparse to moderate vegetation. The southwest area of the Eubank Landfill has been graded to some degree to prevent ponding, but water-collecting depressions still exist. The northeast fill area has areas where piles of soil have been dumped and these hummocky areas contain numerous small water catchments. Because of minimal grading and waste settlement, storm water continues to flow across the landfill and collect in depressions. Storm water runoff has contributed to the erosion of the bank of the Tijeras Arroyo on the east side and southern corner of the northeast fill area. Illegal dumping activities occur in both the southwest and northeast fill areas and surrounding land on a daily basis.

The Eubank Landfill is located on the broad alluvial slope between the Sandia/Manzano Mountains (approximately 3 miles to the east) and the Rio Grande, (about 7.5 miles to the west). Alluvial fan deposits from the Sandia/Manzano Mountains and the Santa Fe Group underlie the landfill. These poorly sorted deposits consist mainly of sand and gravel with lesser amounts of silts and clays (Kelley, 1977). Depth to groundwater is approximately 560 to 610 feet bgs, and the groundwater flow direction is primarily north-northwest (COA, 2002).

A moderate amount of landfill gas monitoring has been performed at the Eubank Landfill. In 1996, CH2M Hill performed monitoring activities on the northern section of the Eubank Landfill. Trace levels of both tetrachlorethene (PCE), trichlorethylene (TCE), and methane were measured during the study (CH2M Hill, 1996). In 1996, the City analyzed samples as part of a storm sewer investigation and detected trace levels of several parameters such as TCE, PCE, and vinyl chloride (Analytical Technologies, Inc., 1996). Most recently, on June 6, 2001, methane concentrations were measured across the landfill from west to east (from the PNM substation to the Tijeras Arroyo); concentrations ranging from 0 to 60 percent LEL were reported (PNM, 2001).

# 4. Field Investigation Methods

The field investigation methods used at the Eubank Landfill are described in this section. The field investigation tasks included:

- Obtaining permission for site access to landfill property
- Clearing underground utilities prior to subsurface investigation activities
- LFG survey using push-probe sampling with field and laboratory gas testing
- Waste characterization borings to sample and categorize waste composition
- LFG pumping test to determine site-specific landfill gas generation characteristics

Sections 4.1 through 4.5 present the detailed methodology used for these tasks at the Eubank Landfill.

## 4.1 Site Access

Access agreements were obtained from the property owners at the Eubank Landfill, to provide site access for the field investigation. Based on records from the City of Albuquerque and the Bernalillo County Tax Assessor's Office, property owners were identified at the Eubank Landfill. Access agreements for the LFG investigation and characterization study were established with the New Mexico State Land Office and other private landowners.

In addition, property adjacent to the northwest side of the Eubank Landfill, which is owned by Albuquerque Public Schools (APS), and private land further to the north, is targeted for development of the new Sandia Science and Technology Park (SSTP) (Figure 3). At AEHD's request, the LFG survey included a portion of the APS property that will be included in the first phase of the two-phase SSTP development process. An access agreement was obtained from APS to allow access for the LFG survey.

## 4.2 Utility Survey

Before the investigation commenced, New Mexico One Call was contacted to ensure that no utilities would be encountered during subsurface work. Due to the size of the Eubank Landfill, meetings with some utility locators were necessary to explain precisely where sampling was to occur. Information provided by New Mexico One Call indicated that no utilities would be encountered during subsurface activities on or adjacent to the landfill. As described in Section 3, historical records indicate that an abandoned sewer line and sewage lagoons exist at an unknown location on the northeast fill area at Eubank Landfill. However, accurate records of the sewer line location were unavailable.

## 4.3 Landfill Gas Survey

LFG sampling locations at the Eubank Landfill are shown on Figure 3. The sampling grid at Eubank Landfill was established at approximately 400 x 400-foot spacings with adjustments made to fit the irregular shape of the landfill. In addition to the 26 sampling locations that were established across the landfill surface, 12 sampling locations were added north of the Eubank Landfill waste fill areas. These included locations along the property boundary of the mobile home park north of the landfill and along the Phase I boundary of the SSTP (Figure 3).

At the Eubank Landfill, a geoprobe drill rig was used to drive with a 1-inch-diameter drive probe to a depth of 10 feet bgs (see photographs, Appendix C) and install sacrificial stainless steel, screened sampling points (⅜-inch diameter by 2.5-inch length, perforated with eight 0.1-inch-diameter holes). Once the sampling tip was in place, 10-20 silica sand was poured into the lower 1 to 2 feet of the borehole, around the tip, to provide for landfill gas transmission. The remainder of the borehole was sealed with a slurry of hydrated bentonite. Polyethylene tubing (⅛-inch diameter) connected to the sampling point was left protruding from the ground surface with a cap on the end. After installation of the tubing, a LFG sample was obtained and analyzed as discussed in Section 2.3.

Two permanent monitoring probes were installed on APS property located northwest of the landfill at the boundary of the SSTP Phase 1 development (Figure 3), to allow for future monitoring at this location. These probes were installed by hydraulically driving a 2-inch-diameter steel rod 10 feet into the soil to create a pilot hole. The rod was then removed and 1-inch, Schedule 40 polyvinyl chloride (PVC) casing was installed in the borehole. The bottom 3 feet of casing pipe was perforated (0.01-inch slots) to allow for transmission of LFG into the probe, and the perforated section of pipe was backfilled with 10-20 silica sand. The remaining annular space was sealed with hydrated bentonite powder. Sampling valves with a 0.25-inch barb for the sample hose connection were fitted to the top of the probes. Permanent wellhead completions consist of steel well shrouds, approximately 2 to 3 feet above grade, installed in 2-foot by 2-foot by 4-inch thick concrete pads to secure and protect the probes. A schematic diagram of the permanent monitoring probes is shown in Figure 4.

## 4.4 Waste Characterization Analysis

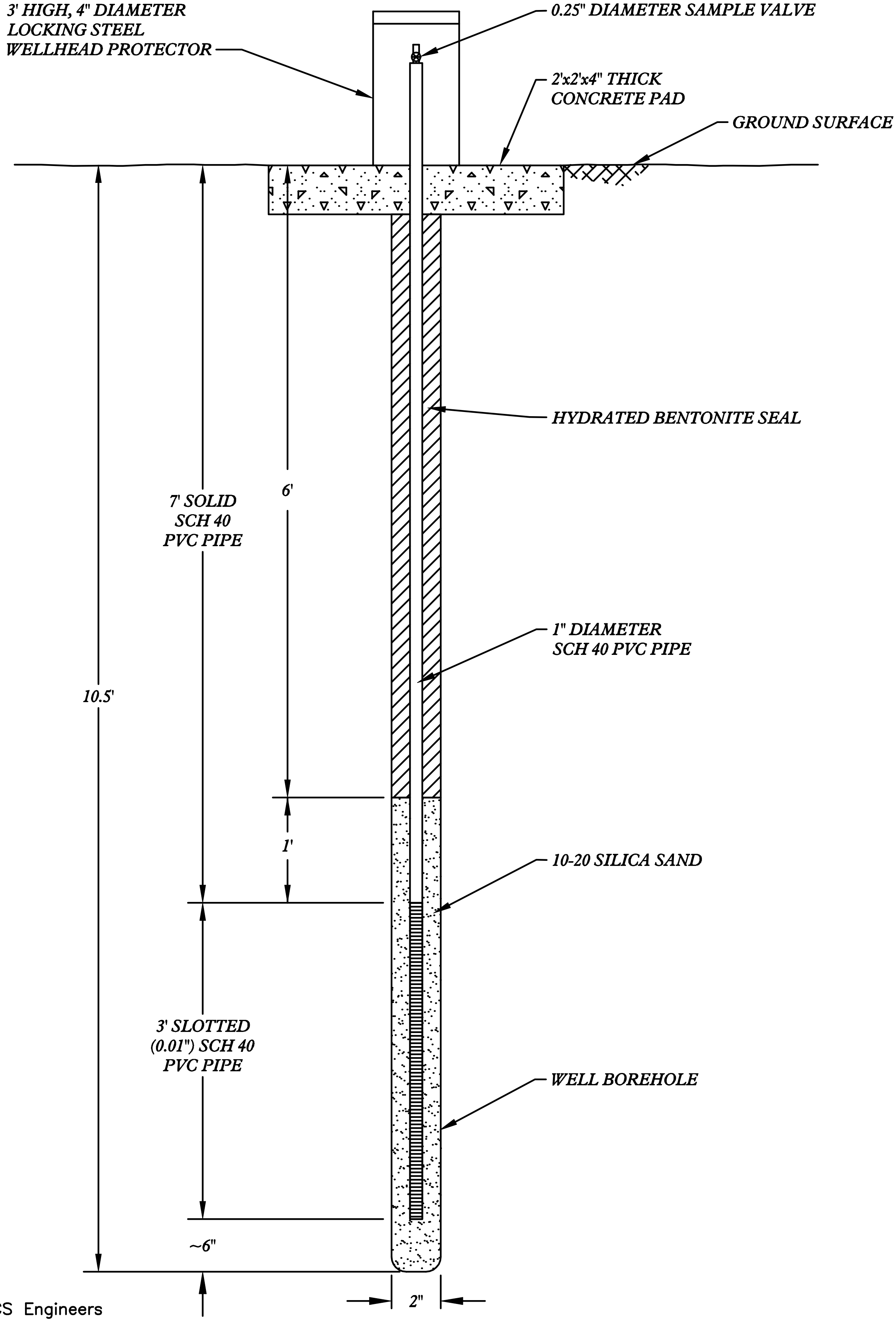
At the Eubank Landfill, four borings were drilled through the waste to allow for examination of the waste characteristics (Figure 3). The locations of the borings (designated WC-8, WC-9, WC-10 and WC-11) drilled at the Eubank Landfill are shown on Figure 3. Waste borings were drilled with a 30-inch-diameter bucket auger to collect samples of waste materials and soil, as shown in photographs provided in Appendix C. Boring locations were selected based on the results of the LFG survey, and recommended locations were submitted to AEHD for approval prior to drilling.

## 4.5 Pumping Tests

A series of three pumping tests at variable flow rates were conducted at the Eubank Landfill from January 4, 2002 through January 8, 2002. The following sections describe the field methodology used to conduct the tests. Results of the tests are discussed in Section 5.4.

### *4.5.1 LFG Pumping Test Extraction Well*

In conjunction with drilling the waste characterization borings (Section 4.4), Koda Drilling, Inc. installed a LFG pumping test extraction well (WC-8/EW) at one of the waste characterization borings at the Eubank Landfill (Figure 3). Waste characterization boring WC-8 was completed




Source: SCS Engineers

Not to Scale

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**

**Permanent Monitoring Probe Detail**

Daniel B. Stephens & Associates, Inc.

3-18-02 JN 9398

S:\PROJECTS\9398\SHEETS\FIGURES\EUBANK\Figure_4.dwg

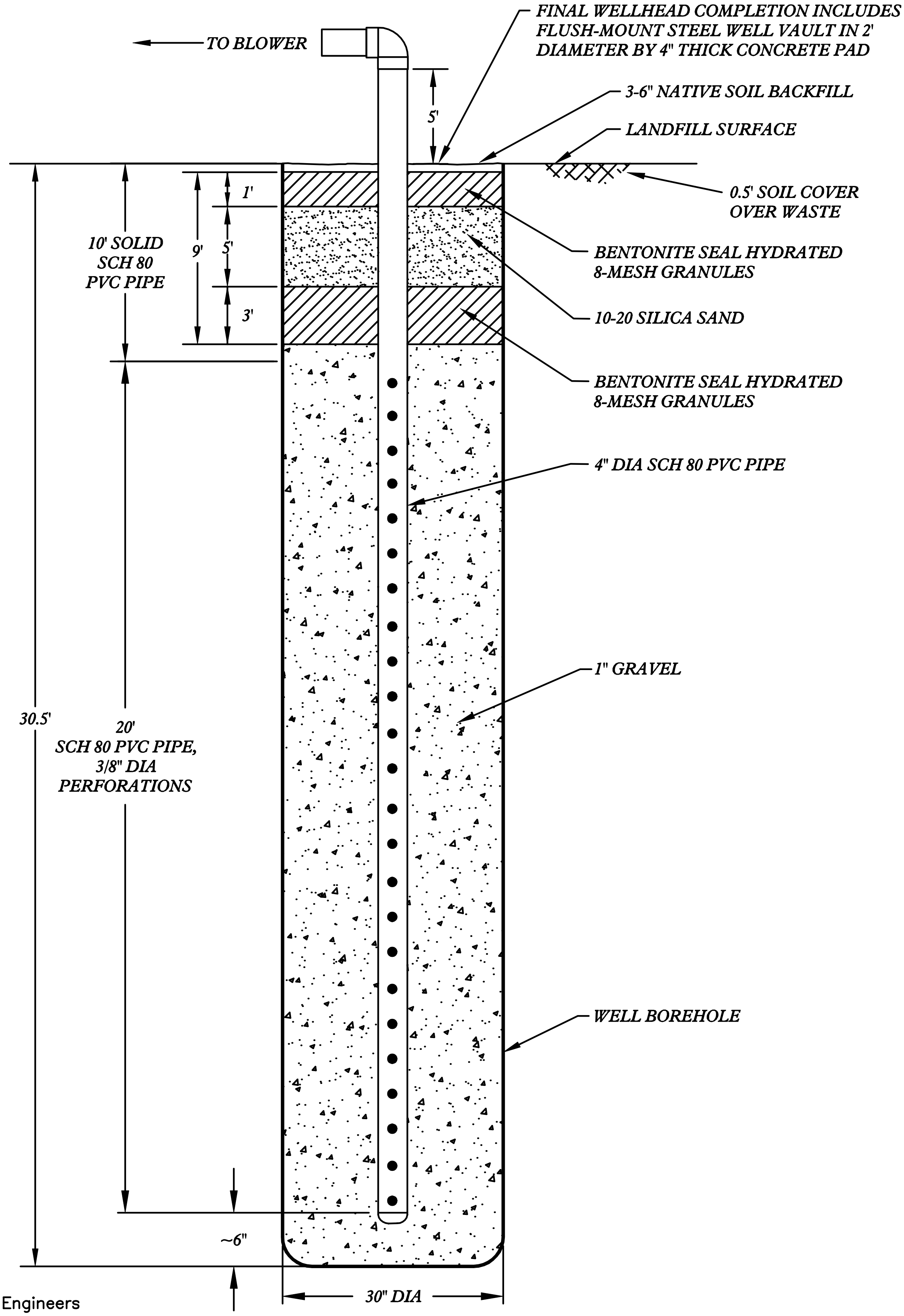
Figure 4

as an extraction well (EW), after which the designation of this well was changed to WC-8/EW. The extraction well was drilled using a 30-inch-diameter bucket auger to a depth of 30 feet bgs. The well was constructed with 4-inch-diameter, Schedule 80 PVC casing. The lower 20 feet of casing was perforated with ⅜-inch-diameter holes and the upper 10 feet was solid blank casing. To facilitate airflow into the perforated portion of the casing, the lower 21 feet of the borehole was backfilled with 1-inch-diameter gravel. Hydrated bentonite was emplaced from 6 to 9 feet bgs to form a “seal” above the gravel. The well was completed with sand from 1 to 6 feet bgs and a 1-foot-thick hydrated bentonite seal was placed at the surface. Initially, the well casing extended above ground surface for piping connection during the pumping test. Following completion of the pumping test, the wellhead was completed with a permanent, flush-mount steel well vault installed in a 2-foot-diameter by 4-inch-thick concrete pad. Details of the extraction well are illustrated in Figure 5 and photographs of the well installation process are provided in Appendix C.

### *4.5.2 Pressure Monitoring Probes*

Three pressure monitoring probes were installed at the Eubank Landfill to detect vacuum response during the pumping test. A 4-inch diameter hollow-stem auger drill rig installed the monitoring probes. The monitoring probes were installed approximately 50, 100, and 200 feet from the extraction well (Figure 3) to measure vacuum responses at varying distances. The probes were designated as WC-8/EW 50-foot probe, WC-8/EW 100-foot probe, and WC-8/EW 200-foot probe.

Each of the monitoring probes was installed to approximately 33 feet bgs. The probes were constructed with 1-inch-diameter Schedule 40 PVC casing. The bottom 25 feet of casing was factory slotted screen with 0.02-inch slots, and the upper 8-foot section was solid blank casing. Each probe was backfilled with 8-12 Colorado silica sand from 7 to 33 feet bgs with a seal of hydrated granular bentonite from 5 to 7 feet bgs and native soil fill from ground surface to 5 feet bgs. Each wellhead was completed with a permanent, flush-mount steel well vault installed in a 2-foot diameter by 4-inch-thick concrete pad. A well completion diagram for the monitoring probes is shown in Figure 6.




Source: SCS Engineers

Not to Scale

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

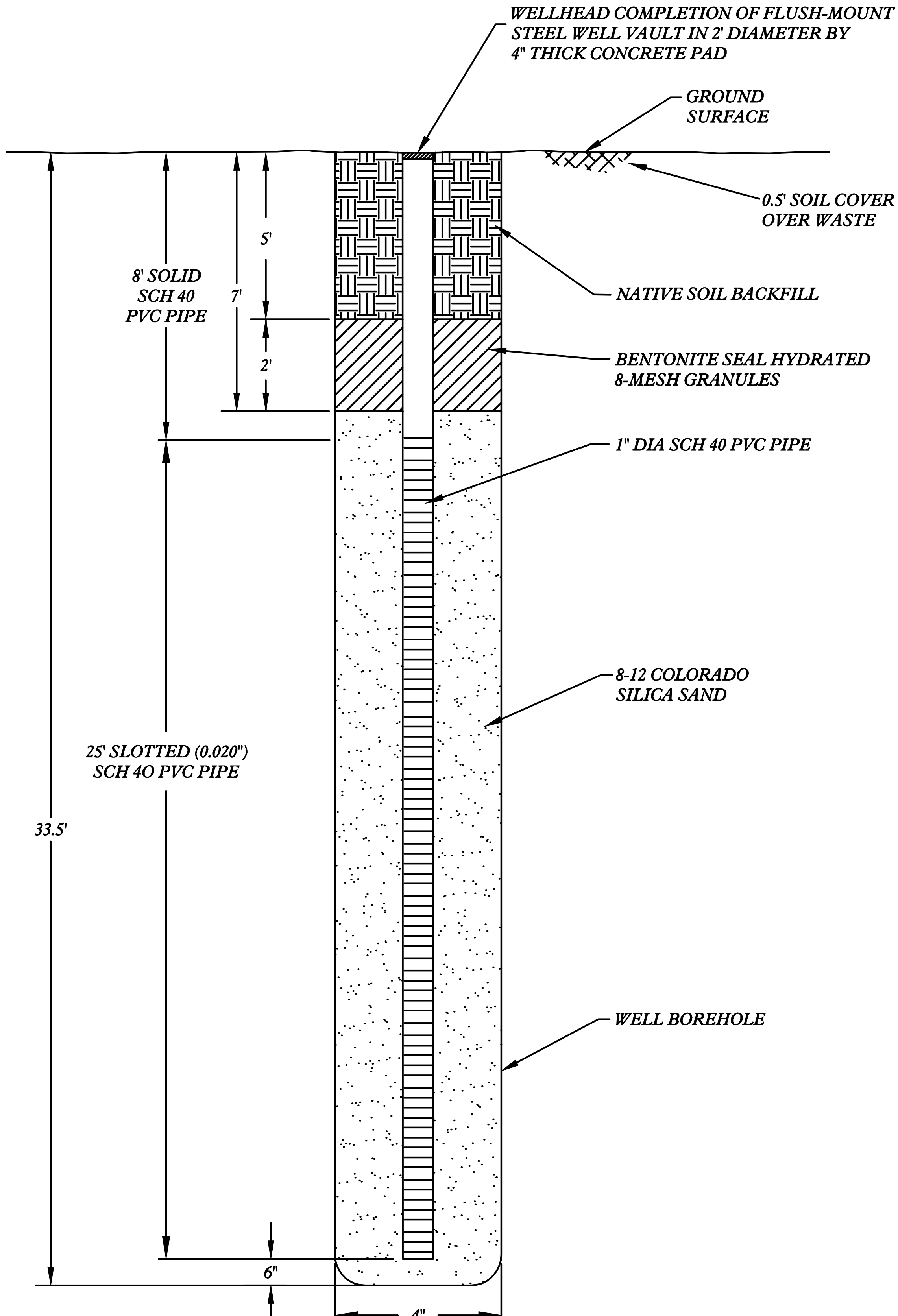
**Eubank Landfill**
**Extraction Well Detail**

Daniel B. Stephens & Associates, Inc.

3-14-02 JN 9398

Figure 5

S:\PROJECTS\9398\SHEETS\FIGURES\EUBANK\Figure_5.dwg




Source: SCS Engineers

Not to Scale

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**
**Pressure Probe Detail**

*Daniel B. Stephens & Associates, Inc.*
3-14-02 JN 9398

Figure 6

S:\PROJECTS\9398\SHEETS\FIGURES\EUBANK\Figure_6.dwg

### 4.5.3 LFG Pumping Test Blower and Test Equipment

The pumping tests were performed using a 3 horsepower (hp), Paxton regenerative blower powered by a portable generator. The blower was connected to the extraction well with a field-fabricated PVC piping manifold. The manifold included an air dilution valve, a flow control valve, and three sample ports. A schematic of the manifold is depicted in Figure 7.

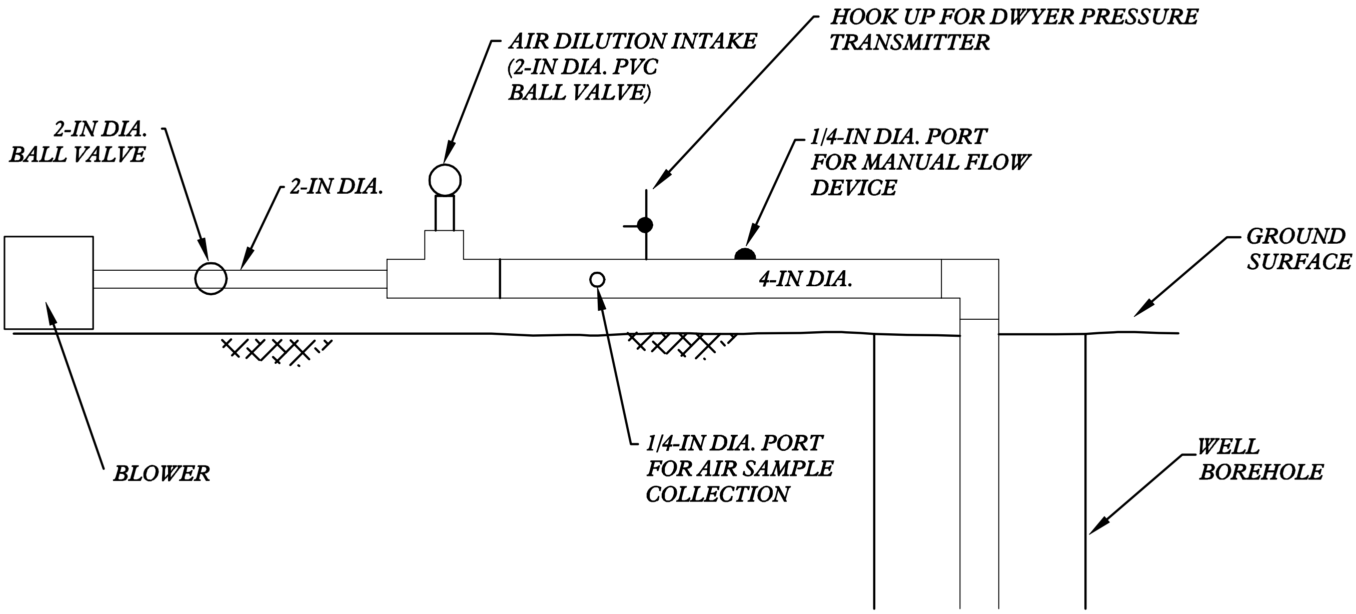
Equipment used to gather data during the pumping tests included the following:

- Landtec GEM™ 500 to measure methane, carbon dioxide, and oxygen ($O_2$)
- Dwyer Flow Sensor (Series 600, various models used depending on sensitivity) to measure differential pressure (used to calculate air flow)
- TSI VelociCalc® (Model 8345) to measure air temperature, velocity, and flow rate

Dwyer Minihelic differential pressure indicating transmitters (Series 600), powered by a portable generator, were mounted to each monitoring probe to measure the vacuum response during the pumping tests. At the Eubank Landfill, the transmitters installed on the 50- and 100-foot probes had a sensitivity of 0 to 1 inch of water column (WC), and the transmitter installed on the probe 200 feet from the test well had a sensitivity of 0 to 0.5 inch of WC. The monitoring probes were connected to a datalogger for continuous data collection. The transmitters relayed readings to a datalogger (Dwyer Model DL8). The datalogger recorded the vacuum readings, converted the vacuum readings from WC to pounds per square inch (psi), and graphed the data points.

### 4.5.4 Pumping Test Procedures

Pumping tests were conducted at various flow rates for varying durations until the methane concentrations stabilized (i.e., reached near-constant concentrations). At the Eubank Landfill, three sequential pumping tests were performed at flow rates of 47 standard cubic feet per minute (scfm), 20 scfm, and 10 scfm. Monitoring probes and vacuum readings from the datalogger were monitored throughout the test to ensure proper data collection. Since only the




Source: SCS Engineers

Not to Scale

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**

**Extraction Well Pump Test Setup**

Daniel B. Stephens & Associates, Inc.

3-14-02 JN 9398

Figure 7

S:\PROJECTS\9398\SHEETS\FIGURES\EUBANK\Figure_7.dwg

differential pressures between the probes and extraction well were used for the analysis, atmospheric pressures were not recorded or used. Gas stream readings, flow rates, and vacuum readings were recorded approximately every 15 minutes for the first two hours and thereafter approximately every hour, except overnight. Details of the duration of the pumping tests are presented, along with a discussion of the data and results, in Section 5.4.

# 5. Results

Results of the LFG investigation and characterization study of the Eubank Landfill are presented in this section. The results include the following:

- LFG survey results for methane, carbon dioxide, oxygen, VOCs, and hydrogen sulfide
- Waste characterization results that categorize the waste composition from borings
- LFG pumping test field procedures and results
- LFG generation modeling results

These items are addressed in Sections 5.1 through 5.5.

## 5.1 LFG Survey Field Analysis Results

A methane concentration map is presented on Figure 8 to graphically show the LFG concentrations at the landfill. The map displays numeric results for methane, carbon dioxide, and oxygen. Methane concentrations at the Eubank Landfill ranged from 0 to 61.3 percent and are also summarized in Table 1.

The northeast area of the landfill possessed the highest methane concentrations. The highest level of methane detected (61.3 percent) at the landfill occurred in the center of the northeast area of the Eubank Landfill. The LFG survey found that the majority of the northeast fill area exceeded 100 percent of the LEL (explosive range).

Due to the high levels of methane found, additional gas probes (E36, E37, and E38) were installed and sampled at the northern boundary of the State Land Office property. These additional gas probes were located immediately south of the South Pointe Village mobile home park. No methane was found in this area, and the only evidence of landfill gas at the property boundary was a slightly elevated carbon dioxide level. Gas probes were also installed and sampled at the boundary of the SSTP Phase 1 development (E27 through E35). No methane was found along this boundary, at a distance of more than 500 feet from the landfill. This area

**Source:**
1999 Aerial photograph provided by Bernalillo County

N

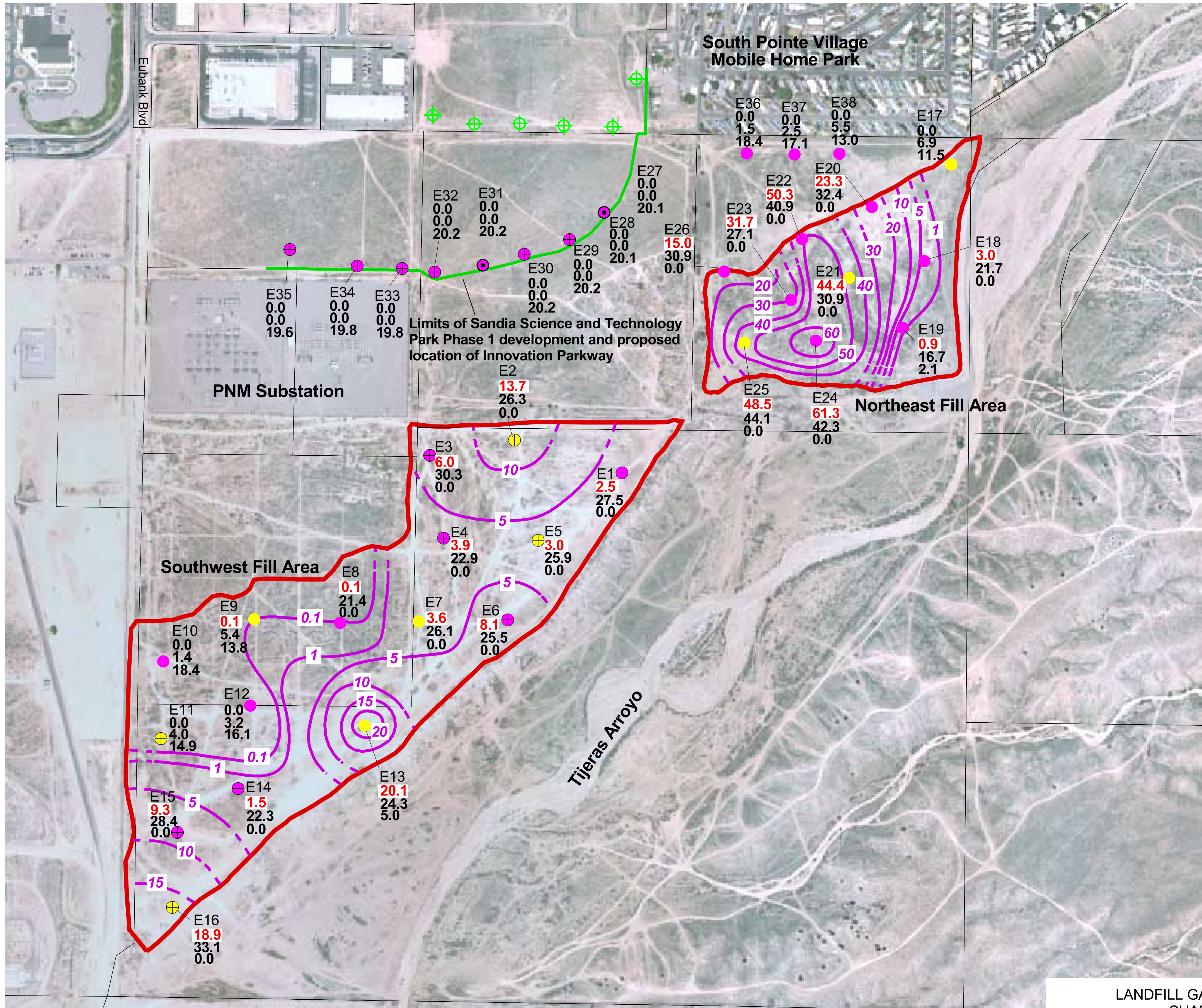
0 500 ft

**Explanation**

- Sampling probe locations
- Sampling probe/lab sample locations
- Permanent probe locations
- Tubing left in place for future sampling
- Methane monitor well (installed by others)
- Parcels
- Landfill boundary
- -10- Methane concentration contour (%), dashed where inferred
- 6.0 Methane (%) / 30.3 Carbon dioxide (%) / 0.0 Oxygen (%)

**Notes:**

1. Methane concentrations of 0.0 are shown in black text
2. Only survey data used to determine methane concentration contours




( T:\VDR0-VDR-PROJECTS\9398 (PROJECT = albf_eubank.apr ) (VIEW EXTENTS = temp) (VIEW NAME = V4-Euba ) (LAYOUT = L4-Euba )

*Daniel B. Stephens & Associates, Inc.*
3-26-02 1:46 PM JN 9398

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY
**Eubank Landfill Gas Survey Results**

Figure 8

# Table 1. Landfill Gas Survey Results
## Eubank Landfill
## Page 1 of 2

| Sampling Point | Date | Time | Methane Concentration (%) | Carbon Dioxide Concentration (%) | Oxygen Concentration (%) | Hydrogen Sulfide Concentration (ppm) | Landfill Gas Temperature (°F) | Landfill Gas Static Pressure [a] (inches $H_2O$) | Atmospheric Pressure [a] (inches Hg) | Lab Sample Collected (Y or N) | Approximate Cover Thickness [b] (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E1 | 09/20/01 | 11:35 AM | 2.5 | 27.5 | 0.0 | 0.0 | NM | 0.00 | 24.5 | N | U |
| E2 | 09/20/01 | 11:20 AM | 13.7 | 26.3 | 0.0 | 0.0 | NM | 0.00 | 24.5 | Y | U |
| E3 | 09/20/01 | 11:15 AM | 6.0 | 30.3 | 0.0 | 0.0 | NM | 0.00 | 24.5 | N | U |
| E4 | 09/20/01 | 11:10 AM | 3.9 | 22.9 | 0.0 | 0.0 | NM | –0.20 | 24.5 | N | U |
| E5 | 09/20/01 | 9:40 AM | 3.0 | 25.9 | 0.0 | 1.0 | NM | –0.10 | 24.5 | Y | U |
| E6 | 09/20/01 | 9:20 AM | 8.1 | 25.5 | 0.0 | 1.0 | NM | –0.40 | 24.6 | N | 2.0 |
| E7 | 09/20/01 | 9:55 AM | 3.6 | 26.1 | 0.0 | 0.0 | NM | –0.40 | 24.5 | Y | U |
| E8 | 09/20/01 | 10:10 AM | 0.1 | 21.4 | 0.0 | 2.0 | 80.1 | 0.00 | 24.5 | N | U |
| E9 | 09/20/01 | 10:30 AM | 0.1 | 5.4 | 13.8 | 3.0 | NM | –0.10 | 24.5 | Y | U |
| E10 | 09/19/01 | 4:00 PM | 0.0 | 1.4 | 18.4 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E11 | 09/19/01 | 3:45 PM | 0.0 | 4.0 | 14.9 | 0.0 | NM | –0.50 | 24.4 | Y | U |
| E12 | 09/19/01 | 4:30 PM | 0.0 | 3.2 | 16.1 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E13 | 09/20/01 | 9:10 AM | 20.1 | 24.3 | 5.0 | 3.0 | NM | –0.30 | 24.6 | Y | 2.5 |
| E14 | 09/20/01 | 8:50 AM | 1.5 | 22.3 | 0.0 | 0.0 | 80.1 | –0.30 | 24.7 | N | U |
| E15 | 09/19/01 | 3:20 PM | 9.3 | 28.4 | 0.0 | 3.0 | NM | 0.00 | 24.4 | N | U |
| E16 | 09/19/01 | 3:10 PM | 18.9 | 33.1 | 0.0 | 6.0 | 86.7 | 0.00 | 24.4 | Y | U |
| E17 | 09/20/01 | 11:50 AM | 0.0 | 6.9 | 11.5 | 0.0 | NM | 0.00 | 24.4 | Y | U |
| E18 | 09/20/01 | 2:05 PM | 3.0 | 21.7 | 0.0 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E19 | 09/20/01 | 2:20 PM | 0.9 | 16.7 | 2.1 | 0.0 | NM | 0.10 | 24.4 | Y | U |

[a] Landfill gas static pressure and atmospheric pressure measurement was provided by the Landtec GA™-90.
[b] Approximate cover thickness is based on driller's "feel" of breakthrough from cover soil to waste; this data may be subjective and is not a scientific measurement.

ppm = Parts per million
°F = Degrees Fahrenheit
NM = Not measured
U = Unknown, could not be determined by the driller

## Table 1. Landfill Gas Survey Results
## Eubank Landfill
## Page 2 of 2

| Sampling Point | Date | Time | Methane Concentration (%) | Carbon Dioxide Concentration (%) | Oxygen Concentration (%) | Hydrogen Sulfide Concentration (ppm) | Landfill Gas Temperature (°F) | Landfill Gas Static Pressure [a] (inches $H_2O$) | Atmospheric Pressure [a] (inches Hg) | Lab Sample Collected (Y or N) | Approximate Cover Thickness [b] (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E20 | 09/20/01 | 12:40 PM | 23.3 | 32.4 | 0.0 | 0.0 | 83.1 | 0.00 | 24.4 | N | U |
| E21 | 09/20/01 | 1:55 PM | 44.4 | 30.9 | 0.0 | 4.0 | 94.1 | 0.00 | 24.4 | Y | U |
| E22 | 09/20/01 | 12:50 PM | 50.3 | 40.9 | 0.0 | 5.0 | NM | 0.00 | 24.4 | N | U |
| E23 | 09/20/01 | 1:45 PM | 31.7 | 27.1 | 0.0 | 10.0 | NM | 0.00 | 24.4 | N | U |
| E24 | 09/20/01 | 2:45 PM | 61.3 | 42.3 | 0.0 | 4.0 | NM | 0.10 | 24.4 | N | U |
| E25 | 09/20/01 | 1:15 PM | 48.5 | 44.1 | 0.0 | 4.0 | NM | 0.00 | 24.4 | Y | U |
| E26 | 09/20/01 | 1:00 PM | 15.0 | 30.9 | 0.0 | 69.0 | NM | 0.00 | 24.4 | N | U |
| E27 | 09/20/01 | 4:20 PM | 0.0 | 0.0 | 20.1 | 0.0 | 88.9 | 0.10 | 24.4 | N | U |
| E28 | 09/21/01 | 8:55 AM | 0.0 | 0.0 | 20.1 | 0.0 | NM | 0.00 | 24.5 | N | U |
| E29 | 09/21/01 | 4:05 PM | 0.0 | 0.0 | 20.2 | 0.0 | NM | 0.10 | 24.4 | N | U |
| E30 | 09/20/01 | 3:55 PM | 0.0 | 0.0 | 20.2 | 0.0 | NM | 0.10 | 24.4 | N | U |
| E31 | 09/21/01 | 8:40 AM | 0.0 | 0.0 | 20.2 | 0.0 | NM | 0.00 | 24.6 | N | U |
| E32 | 09/20/01 | 3:40 PM | 0.0 | 0.0 | 20.2 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E33 | 09/20/01 | 3:30 PM | 0.0 | 0.0 | 19.8 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E34 | 09/20/01 | 3:20 PM | 0.0 | 0.0 | 19.8 | 0.0 | 81.3 | 0.00 | 24.4 | N | U |
| E35 | 09/20/01 | 3:05 PM | 0.0 | 0.0 | 19.6 | 0.0 | NM | 0.00 | 24.4 | N | U |
| E36 | 09/21/01 | 9:25 AM | 0.0 | 1.5 | 18.4 | 0.0 | NM | –0.10 | 24.5 | N | U |
| E37 | 09/21/01 | 9:40 AM | 0.0 | 2.5 | 17.1 | 0.0 | 80.1 | –0.10 | 24.6 | N | U |
| E38 | 09/21/01 | 10:00 AM | 0.0 | 5.5 | 13.0 | 0.0 | NM | –0.20 | 24.6 | N | U |

[a] Landfill gas static pressure and atmospheric pressure measurement was provided by the Landtec GA™-90.
[b] Approximate cover thickness is based on driller's "feel" of breakthrough from cover soil to waste; this data may be subjective and is not a scientific measurement.

ppm = Parts per million
°F = Degrees Fahrenheit

NM = Not measured
U = Unknown, could not be determined by the driller

P:\9398\COA-LndfilGas.3-2002\Eubank\T1_LFGSurvey-Eubank.doc also showed carbon dioxide and oxygen levels consistent with atmospheric air, indicating this area was not impacted by landfill gas.

The southwest area of the landfill had three distinct zones of high methane levels. The first zone (gas probe E2) was located at the northern edge of the fill area. The methane concentration at this location was 13.7 percent. Methane was at its highest level in the south-central portion of the southwest fill area (gas probe E13), where the methane concentration was measured at 20.1 percent. The final high methane zone (gas probe E16) was located at the southern tip of the southwest fill area. Methane at this location peaked at 18.9 percent.

Hydrogen sulfide concentrations at the Eubank Landfill generally ranged from 0 to no more than 10 ppm (Table 1). A single LFG sample from gas probe E26 indicated a hydrogen sulfide concentration of 69 ppm in the northeast fill area (Figure 8). This elevated concentration may be caused by an isolated portion of the landfill that contains construction debris with gypsum wallboard, which decays to produce hydrogen sulfide. The generally low concentrations suggest that hydrogen sulfide is being generated only at low rates in the landfill and is not likely to present a high likelihood of significant adverse impacts.

## 5.2 LFG Survey Laboratory Results

During the LFG survey (described in Section 2.3), 11 vapor samples were collected at the Eubank Landfill for laboratory analysis. Each sample was analyzed using a modified version of Method TO-14, which analyzes for the most commonly occurring VOCs found in LFG.

Results of the laboratory analyses are summarized in Table 2. Eubank Landfill VOC maps illustrating the concentrations measured for selected VOCs are included in Appendix D. The VOCs shown were specified by AEHD based on review of the VOC data to determine the significant parameters detected. Full laboratory reports and laboratory chain-of-custody forms are provided in Volume II.

## Table 2. Laboratory Results
## Eubank Landfill

| Compound Name | E2 | E5 | E7 | E9 | E11 | E13 | E16 | E17 | E19 | E21 | E25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Modified Method TO-14 [a] (ppbv)* | | | | | | | | | | | |
| 1,1,1-Trichloroethane | --- | --- | --- | --- | --- | --- | --- | --- | 13 | --- | --- |
| 1,1,2-Trichloroethane | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1,1-Dichloroethane | 180 | 1,800 | 37 | 22 | 420 | 340 | 470 | --- | --- | 24 | 850 |
| 1,1-Dichloroethene | --- | 49 | --- | --- | 64 | 20 | --- | --- | --- | --- | 100 |
| 1,2,4-Trimethylbenzene | 180 | 290 | 1,100 | 130 | 170 | 140 | 1,200 | 110 | 79 | 200 | 560 |
| 1,2-Dichlorobenzene | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1,2-Dichloroethane | --- | 70 | --- | --- | --- | --- | 190 | --- | --- | --- | --- |
| 1,2-Dichloropropane | --- | 260 | --- | --- | --- | --- | 54 | --- | --- | --- | 160 |
| 1,3,5-Trimethylbenzene | 170 | 290 | 920 | 100 | 95 | 88 | 900 | 78 | 50 | 160 | 540 |
| 1,3-Dichlorobenzene | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1,4-Dichlorobenzene | --- | --- | 250 | 27 | 20 | 19 | 260 | 26 | 19 | 52 | 86 |
| 2-Propanol | 24,000 | 9,400 | 130 | 54 | 26 | 310 | 150 | 130 | --- | 190 | 2,200 |
| Benzene | 120 | 300 | 30 | 22 | --- | 240 | 360 | --- | --- | 150 | 430 |
| Bromomethane | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Carbon tetrachloride | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Chlorobenzene | --- | --- | --- | --- | --- | --- | --- | --- | --- | 46 | 42 |
| Chloroethane | --- | 330 | --- | --- | --- | 140 | 510 | --- | --- | 120 | 1,300 |
| Chloroform | --- | --- | --- | --- | 24 | --- | --- | --- | --- | --- | --- |
| Chloromethane | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| cis-1,2-Dichloroethene | 3,800 | 2,400 | 730 | 48 | 34 | 5,000 | 8,100 | 77 | 19 | 110 | 1,900 |
| Ethylbenzene | 1,100 | 2,200 | 640 | 150 | 78 | 800 | 1,700 | 140 | 140 | 1,000 | 2,600 |
| Ethylene dibromide | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Freon 11 | --- | 320 | --- | 50 | 66 | --- | 69 | --- | 68 | 33 | --- |
| Freon 113 | --- | --- | --- | --- | 52 | --- | --- | --- | --- | --- | --- |
| Freon 114 | 180 | 610 | 2,000 | 59 | 110 | 67 | 780 | 46 | 40 | 280 | 480 |
| Freon 12 | 880 | 12,000 | 940 | 620 | 1,500 | 330 | 8,300 | 480 | 520 | 480 | 29,000 |
| m,p-Xylene | 3,900 | 4,900 | 960 | 350 | 220 | 1,000 | 3,500 | 470 | 100 | 380 | 1,700 |
| Methyl tertiary-butyl ether | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Methylene chloride | 900 | 6,700 | 92 | 39 | --- | 550 | 1,100 | --- | --- | 13 | 280 |
| o-Xylene | 1,200 | 1,700 | 390 | 120 | 100 | 450 | 1,600 | 170 | 42 | 200 | 520 |
| Tetrachloroethene | 3,900 | 7,100 | 990 | 670 | 600 | 2,200 | 2,800 | 1,100 | 87 | 170 | 630 |
| Toluene | 10,000 | 12,000 | 1,000 | 480 | 130 | 2,500 | 6,800 | 550 | 130 | 400 | 3,400 |
| trans-1,2-Dichloroethene | 110 | 110 | --- | --- | --- | 69 | 140 | --- | --- | --- | 120 |
| Trichloroethene | 2,000 | 1,800 | 230 | 120 | 330 | 1,000 | 1,400 | 59 | 15 | 47 | 620 |
| Vinyl chloride | 100 | 630 | 36 | --- | --- | 340 | 640 | --- | --- | 1,800 | 13,000 |

[a] Detection limit for method is 5 ppbv; reporting limits vary depending on dilution factor (see laboratory results, Volume II).

--- = Not detected NS = Not sampled ppbv = Parts per billion by volume

## 5.3 Waste Characterization Analysis

Four waste characterization borings (WC-8, WC-9, WC-10, and WC-11) were drilled at the Eubank Landfill (Figure 3). To penetrate the waste at given locations, the depths of WC-8, WC-9, WC-10, and WC-11 were 30, 15, 23, and 7 feet bgs, respectively. Waste was found to extend to only 5 feet bgs in WC-10 and up to 27 feet bgs in WC-8. Strong odors were present at WC-8 and WC-10, while slight odors were present at WC-9 and WC-11. Methane and hydrogen sulfide gas were not detected during monitoring for worker health and safety purposes at any of the boring locations. The soil encountered in the waste characterization borings at the Eubank Landfill generally consisted of slightly moist, brown, silty, coarse sand. A summary of the waste composition encountered in each boring is provided in Table 3, and additional details for each waste sample are provided in the boring logs in Appendix A and field notes in Volume II.

The primary types of materials encountered at WC-8 (along with the estimated percentage by weight) included paper (26.7 percent), concrete (21.5 percent), plastic (20.4 percent), and wood (10.8 percent). In addition, the following materials were encountered in small quantities: green waste (9.4 percent), metal (7.2 percent), rubber (2.9 percent), and cardboard (1.1 percent).

The types of materials encountered at WC-9 included metal (10 percent), concrete (10 percent), and soil (80 percent). Because of the nature of the material encountered, no samples were taken for moisture content analysis.

The primary types of materials encountered at WC-10 included paper (36.1 percent), plastic (12.3 percent), wood (11.3 percent), and concrete (11.3 percent). In addition, the following materials were encountered in small quantities: green waste (9.9 percent), metal (7.5 percent), glass (4.6 percent), rubber (3.1 percent), cardboard (2.4 percent) and cloth (1.5 percent). Three samples of waste were collected from WC-10 and analyzed for moisture content.

The primary types of materials encountered at WC-11 included paper (42.4 percent), plastic (18.0 percent), glass (21.6 percent), and green waste (11.6 percent). In addition, cloth (3.6 percent) and cardboard (2.8 percent) were discovered in small quantities.

## Table 3. Waste Characterization Boring Summary
## Eubank Landfill

| Boring Number | Depth (feet) | Boring Location [a] | Depth Interval of Waste/Debris | Weight Percentages and Nature of Waste/Debris | Decomposability Rating |
|---|---|---|---|---|---|
| WC-8 | 30 | • N 1474346 Usft.<br>• E 1559062 Usft. | 4.5 to 27 feet bgs | • 9.4% Green waste [b]<br>• 1.1% Cardboard [b]<br>• 7.2% Metal<br>• 2.9% Rubber<br>• 26.7% Paper [b]<br>• 21.5% Concrete<br>• 20.4% Plastic<br>• 10.8% Wood [b] | Degradable fraction<br>• 0% Rapid<br>• 37.2% Moderate<br>• 10.8% Slow<br>Non-degradable fraction<br>• 52.0% Inert |
| WC-9 | 15 | • N 1474554 Usft.<br>• E 1559468 Usft. | Intermittent waste throughout | • Metal 10%<br>• Concrete 10%<br>• Silty sand 80% | NA |
| WC-10 | 23 | • N 1473655 Usft.<br>• E 1557566 Usft. | 2.5 to 21 feet bgs | • 9.9% Green waste [b]<br>• 2.4% Cardboard [b]<br>• 7.5% Metal<br>• 3.1% Rubber<br>• 4.6% Glass<br>• 36.1% Paper [b]<br>• 11.3% Concrete<br>• 12.3% Plastic<br>• 11.3% Wood [b]<br>• 1.5% Cloth [b] | Degradable fraction<br>• 0% Rapid<br>• 48.4% Moderate<br>• 12.8% Slow<br>Non-degradable fraction<br>• 38.8% Inert |
| WC-11 | 7 | • N 1474766 Usft.<br>• E 1559175 Usft. | 3.5 to 5 feet bgs | • 11.6% Green waste [b]<br>• 2.8% Cardboard [b]<br>• 3.6% Cloth [b]<br>• 42.4% Paper [b]<br>• 18.0% Plastic<br>• 21.6% Glass | Degradable fraction<br>• 0% Rapid<br>• 56.8% Moderate<br>• 3.6% Slow<br>Non-degradable fraction<br>• 39.6% Inert |

[a] New Mexico Planes Central Zone (NAD 83).
[b] Compose degradable fraction (see Table 9).

Usft. = U.S. survey foot (equals 0.3048006096 meters)
feet bgs = Feet below ground surface

NA = Not applicable

A summary of moisture content data is included in Table 4. Complete laboratory moisture content results are contained in Appendix E. The moisture content of the decomposable fraction of all waste collected ranged from 14.0 to 32.1 percent (moisture percentage by weight).

The methane concentration initially was at 45.6 percent, rose to 48.1 percent, and gradually leveled off at approximately 36.5 percent.

**Table 4. Waste Moisture Content Laboratory Results**

| Location | Depth (feet) | Sample Number | Moisture Content (%, g/g) |
|---|---|---|---|
| Boring WC-8 (Eubank northeast fill area) | 9-10 | EW 9-10 | 32.1 |
| | 24-25 | EW 24-25 | 14.0 |
| | 26-27 | EW 26-27 | 31.6 |
| Boring WC-10 (Eubank southwest fill area) | 9-10 | S 9-10 | 23.7 |
| | 12-13 | S 12-13 | 27.2 |
| | 14-15 | S 14-15 | 15.8 |

g/g = Grams per gram

## 5.4 Pumping Test Results

A series of three pumping tests was performed on extraction well WC-8/EW at the Eubank Landfill, with extraction flow rates varied from 10 scfm to 47 scfm. Information about well installation and pumping test equipment is provided in Sections 2.6 and 4.5. The pumping test results are summarized in Tables 5 through 7 and additional pumping test data is provided in Appendix F. Operating procedures for the tests are summarized below:

- Test No. 1
  - The first pumping test began at approximately 6:34 p.m. on Friday, January 4, 2002, and ended at 7:30 a.m. on Sunday, January 6, 2002.
  - This test was conducted at a flow rate of approximately 47 scfm to rapidly extract methane from the landfill.
  - The methane concentration initially was at 45.6 percent, rose to 48.1 percdent, and gradually leveled off at approsimately 36.5 percent.

**Table 5. Pump Test No.1 Landfill Gas Readings**
**Eubank Landfill**

| Date | Time | $CH_4$ (%) | $CO_2$ (%) | $O_2$ (%) | Balance (%) | Temperature (°F) | Flow Rate ($ft^3$/min.) |
|---|---|---|---|---|---|---|---|
| 01/04/02 | 18:34 | 45.6 | 27.0 | 7.0 | 20.4 | 77 | 46.2 |
| | 18:55 | 48.0 | 30.4 | 0.9 | 20.7 | 78 | 47.0 |
| | 19:15 | 48.1 | 28.6 | 0.7 | 22.6 | 76 | 47.0 |
| | 19:30 | 47.5 | 28.8 | 0.9 | 22.8 | 76 | 47.0 |
| | 19:45 | 46.0 | 29.0 | 0.6 | 24.4 | 76 | 47.2 |
| | 20:00 | 44.1 | 28.2 | 0.7 | 27.0 | 76 | 47.1 |
| | 20:30 | 44.0 | 28.0 | 0.6 | 27.4 | 76 | 47.6 |
| | 21:00 | 44.0 | 28.0 | 0.5 | 27.5 | 76 | 47.0 |
| | 21:30 | 43.7 | 28.9 | 0.4 | 28.0 | 77 | 47.0 |
| | 22:00 | 44.4 | 29.1 | 0.9 | 25.6 | 78 | 47.5 |
| | 23:00 | 44.0 | 28.2 | 0.5 | 27.2 | 77 | 46.9 |
| | 23:59 | 43.0 | 28.3 | 0.5 | 28.2 | 77 | 46.9 |
| 01/05/02 | 01:00 | 43.2 | 28.9 | 0.6 | 27.3 | 78 | 47.0 |
| | 01:30 | 42.9 | 29.0 | 0.7 | 27.4 | 78 | 47.0 |
| | 07:00 | 38.0 | 27.3 | 1.6 | 33.1 | 77 | 44.5 |
| | 07:30 | 39.9 | 27.9 | 0.9 | 31.3 | 77 | 46.0 |
| | 10:00 | 37.4 | 28.0 | 0.8 | 34.8 | 78 | 46.5 |
| | 11:15 | 37.6 | 27.9 | 0.8 | 33.7 | 77 | 46.5 |
| | 13:00 | 38.0 | 27.6 | 0.7 | 33.7 | 78 | 47.0 |
| | 14:00 | 38.2 | 27.0 | 0.5 | 34.3 | 77 | 47.1 |
| | 15:30 | 37.6 | 27.0 | 0.4 | 35.0 | 77 | 47.2 |
| | 18:30 | 36.8 | 27.5 | 0.4 | 35.3 | 78 | 47.3 |
| | 19:00 | 36.7 | 27.7 | 0.4 | 35.2 | 78 | 47.5 |
| | 19:30 | 37.0 | 27.9 | 0.4 | 34.7 | 77 | 47.3 |
| | 20:00 | 37.1 | 27.8 | 0.4 | 34.7 | 77 | 47.0 |
| | 20:30 | 36.1 | 27.5 | 0.4 | 35.2 | 77 | 47.0 |
| | 21:00 | 36.7 | 27.0 | 0.5 | 35.8 | 77 | 46.9 |
| | 21:30 | 36.9 | 27.0 | 0.6 | 35.3 | 78 | 47.0 |
| | 22:00 | 36.8 | 26.9 | 0.5 | 35.8 | 77 | 47.0 |
| 01/06/02 | 06:30 | 35.9 | 26.9 | 1.0 | 36.2 | 77 | 46.0 |
| | 07:00 | 36.0 | 26.7 | 0.9 | 36.6 | 77 | 46.0 |

$CH_4$ = Methane
$CO_2$ = Carbon dioxide
$O_2$ = Oxygen

°F = Degrees Fahrenheit
$ft^3$/min. = Cubic feet per minute

## Table 6. Pump Test No. 2 Landfill Gas Readings
## Eubank Landfill

| Date | Time | $CH_4$ (%) | $CO_2$ (%) | $O_2$ (%) | Balance (%) | Temperature (°F) | Flow Rate ($ft^3$/min.) |
|---|---|---|---|---|---|---|---|
| 01/06/02 | 07:30 | 36.4 | 26.9 | 0.7 | 36.0 | 73 | 20.3 |
| | 07:45 | 36.9 | 26.3 | 1.0 | 35.8 | 74 | 21.0 |
| | 08:00 | 37.8 | 26.5 | 1.2 | 34.5 | 73 | 20.4 |
| | 08:15 | 38.5 | 26.9 | 1.1 | 33.5 | 72 | 20.3 |
| | 08:30 | 39.2 | 26.0 | 0.9 | 33.9 | 73 | 20.2 |
| | 08:45 | 40.0 | 26.1 | 0.7 | 32.2 | 74 | 20.2 |
| | 09:00 | 40.5 | 25.9 | 0.6 | 33.0 | 73 | 20.3 |
| | 10:00 | 41.0 | 26.0 | 0.5 | 32.5 | 74 | 20.5 |
| | 11:00 | 40.1 | 25.8 | 0.4 | 33.7 | 75 | 20.2 |
| | 12:00 | 39.4 | 26.2 | 0.5 | 33.9 | 76 | 20.5 |
| | 14:30 | 38.0 | 26.5 | 0.6 | 34.9 | 77 | 20.3 |
| | 14:45 | 38.9 | 26.7 | 0.7 | 33.7 | 77 | 20.5 |
| | 15:00 | 41.0 | 26.7 | 0.7 | 31.6 | 77 | 20.4 |
| | 16:00 | 38.0 | 26.7 | 0.7 | 34.6 | 77 | 20.5 |
| | 18:00 | 36.7 | 26.4 | 0.7 | 36.3 | 77 | 20.6 |
| | 20:00 | 35.5 | 26.5 | 0.8 | 36.8 | 77 | 20.5 |
| | 22:00 | 34.4 | 26.8 | 0.7 | 38.1 | 77 | 20.4 |
| 01/07/02 | 07:00 | 34.6 | 26.9 | 0.7 | 38.0 | 74 | 21.2 |
| | 07:30 | 34.5 | 27.0 | 0.7 | 37.8 | 74 | 21.3 |
| | 08:00 | 32.9 | 26.8 | 0.7 | 39.6 | 74 | 21.0 |
| | 08:30 | 33.7 | 27.1 | 0.6 | 38.6 | 75 | 20.7 |
| | 09:20 | 33.6 | 26.9 | 0.6 | 38.9 | 75 | 20.8 |
| | 10:00 | 34.8 | 27.0 | 0.5 | 38.0 | 75 | 21.0 |
| | 10:30 | 35.4 | 27.0 | 0.5 | 37.1 | 75 | 19.9 |
| | 11:00 | 36.5 | 27.2 | 0.2 | 36.1 | 75 | 20.2 |

$CH_4$ = Methane
$CO_2$ = Carbon dioxide
$O_2$ = Oxygen
°F = Degrees Fahrenheit
$ft^3$/min. = Cubic feet per minute

## Table 7. Pump Test No. 3 Landfill Gas Readings
## Eubank Landfill

| Date | Time | $CH_4$ (%) | $CO_2$ (%) | $O_2$ (%) | Balance (%) | Temperature (°F) | Flow Rate ($ft^3$/min.) |
|---|---|---|---|---|---|---|---|
| 01/07/02 | 11:45 | 39.3 | 27.3 | 0.9 | 32.5 | 75 | 10.2 |
| | 12:00 | 40.3 | 27.0 | 0.7 | 32.0 | 75 | 10.6 |
| | 12:15 | 41.9 | 26.7 | 0.8 | 30.4 | 75 | 10.7 |
| | 12:30 | 42.0 | 26.4 | 0.6 | 31.0 | 74 | 10.3 |
| | 13:30 | 41.1 | 27.1 | 0.5 | 31.3 | 74 | 10.2 |
| | 14:00 | 40.6 | 27.0 | 0.5 | 31.9 | 75 | 10.2 |
| | 14:30 | 38.2 | 28.0 | 0.5 | 33.3 | 75 | 10.1 |
| | 15:00 | 38.4 | 26.9 | 0.4 | 34.3 | 75 | 10.2 |
| | 15:30 | 38.0 | 27.0 | 0.5 | 35.5 | 74 | 10.5 |
| | 16:00 | 36.9 | 27.0 | 0.4 | 36.1 | 73 | 10.8 |
| | 16:30 | 36.7 | 26.8 | 0.5 | 36.5 | 72 | 10.6 |
| | 17:45 | 35.0 | 26.7 | 0.6 | 37.7 | 70 | 10.4 |
| | 18:30 | 33.4 | 26.8 | 0.5 | 39.5 | 70 | 10.6 |
| | 19:15 | 34.2 | 26.7 | 0.5 | 38.6 | 70 | 10.4 |
| | 20:00 | 34.0 | 26.5 | 0.5 | 39.0 | 69 | 10.5 |
| | 21:00 | 33.0 | 26.7 | 0.6 | 39.7 | 70 | 10.3 |
| | 22:00 | 33.5 | 26.9 | 0.4 | 39.2 | 70 | 10.4 |
| 01/08/02 | 06:30 | 35.0 | 27.9 | 0.5 | 36.6 | 66 | 10.2 |
| | 07:00 | 35.2 | 27.0 | 0.4 | 38.0 | 66 | 10.2 |
| | 07:30 | 35.4 | 27.6 | 0.4 | 37.2 | 66 | 10.2 |
| | 08:00 | 35.5 | 27.5 | 0.4 | 36.6 | 66 | 10.2 |
| | 08:30 | 35.0 | 27.0 | 0.5 | 37.5 | 66 | 10.3 |
| | 09:00 | 34.5 | 26.8 | 0.4 | 38.0 | 67 | 10.2 |
| | 09:30 | 33.9 | 26.5 | 0.4 | 39.2 | 67 | 10.2 |
| | 10:00 | 34.2 | 26.5 | 0.3 | 39.0 | 66 | 10.1 |
| | 11:00 | 35.1 | 26.2 | 0.2 | 38.5 | 67 | 10.2 |
| | 12:00 | 35.5 | 26.3 | 0.3 | 37.9 | 67 | 10.2 |
| | 12:30 | 35.7 | 26.5 | 0.3 | 37.5 | 66 | 10.2 |

$CH_4$ = Methane
$CO_2$ = Carbon dioxide
$O_2$ = Oxygen

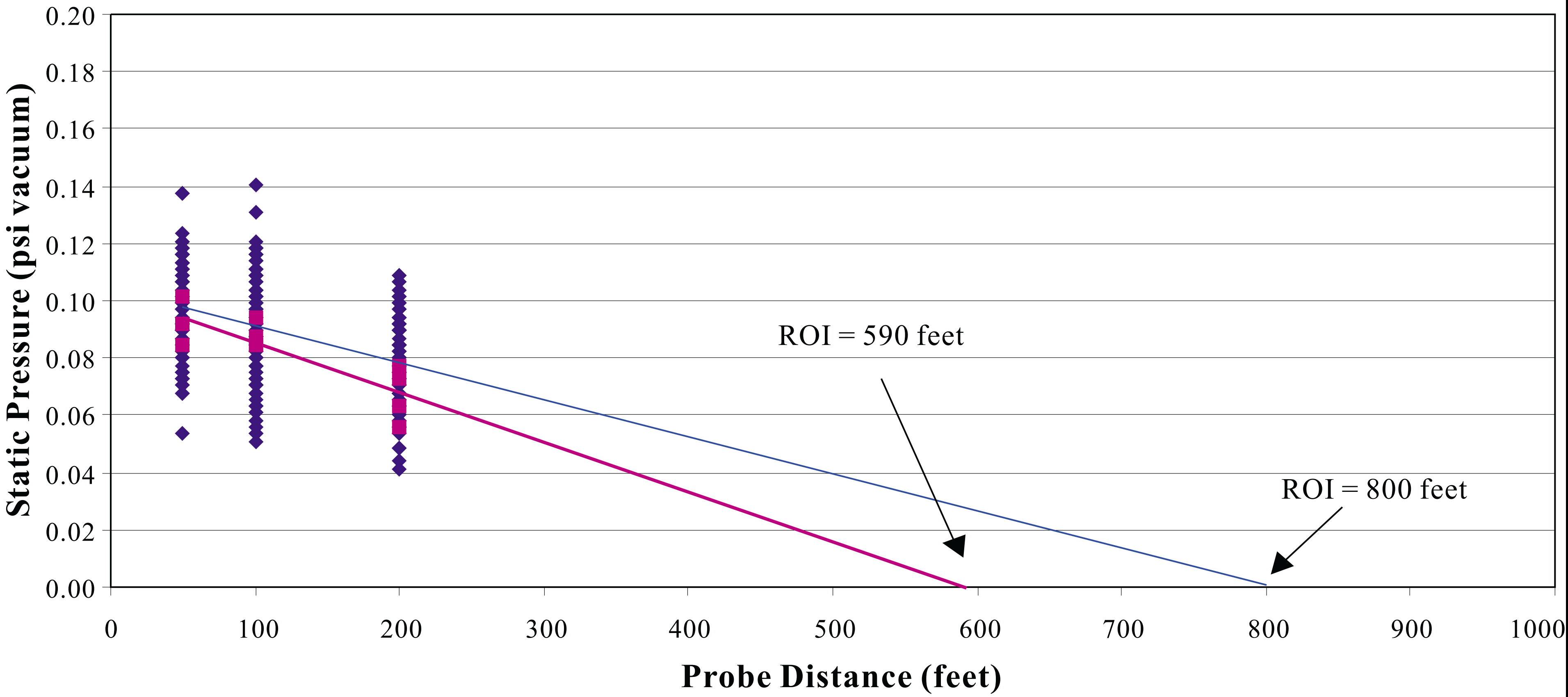
°F = Degrees Fahrenheit
$ft^3$/min. = Cubic feet per minute

- Test No. 2
  - Test No. 2 began at approximately 7:30 a.m. on Sunday, January 6, 2002, and ended at 11:40 a.m. on Monday, January 7, 2002.
  - The test was conducted at a flow rate of approximately 20 scfm.
  - The methane concentration initially was at 36.4 percent, rose to 41.0 percent, and gradually leveled off at approximately 34.3 percent.
- Test No. 3
  - Test No. 3 began at approximately 11:40 a.m. on Monday, January 7, 2002, and ended at 12:30 p.m. on Tuesday January 8, 2002.
  - The test was conducted at a flow rate of approximately 10 scfm.
  - The methane concentration initially was at 39.3 percent, rose to 42.0 percent, and gradually leveled off at approximately 35.0 percent.

Figures 9 through 11 summarize the results of the three pumping tests, including projections of the radius of influence, which is defined as the horizontal distance from the extraction well where measured vacuum is estimated to reach a value of zero (through a linear regression of the data). As seen in Figures 9 through 11, only Pumping Test 1 yielded results that allowed for a projection of the radius of influence. It is speculated that the other two pumping tests, which were performed at a lower flow rate than Pump Test 1, did not have sufficient flow rate and vacuum applied at the extraction well to consistently influence the probes in order to calculate a radius of influence.

Two estimated radii of influence are shown in Figure 9, one at 800 feet and one at 590 feet. The 800-foot radius of influence is derived from all of the data collected during Pumping Test 1. The 590-foot radius of influence is derived from data collected during only the last hour of the

S:\Projects\9398\Sheets\Figures\Eubank\Figure_9.cdr




**Explanation**

| | |
|---|---|
| Test 1 | Linear (Test 1) |
| Last Hour | Linear (Last Hour) |

ROI = radius of influence
psi = pounds per square inch
scfm = standard cubic feet per minute

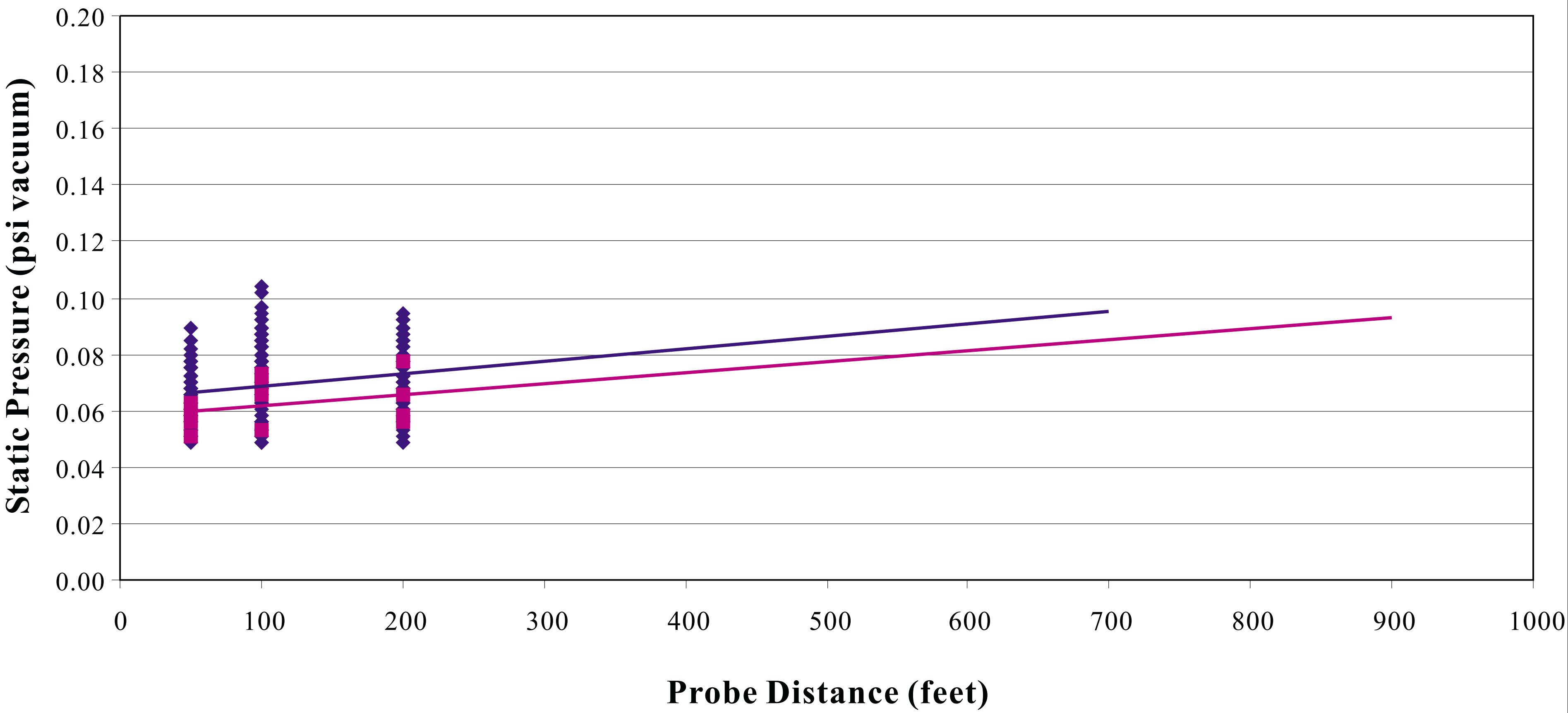
LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**
**Results of Pumping Test 1**
**Flow Rate of 47 scfm**

*Daniel B. Stephens & Associates, Inc.*
3-18-02
JN 9398

Figure 9

S:\Projects\9398\Sheets\Figures\Eubank\Figure_10.cdr




**Explanation**

| | |
|---|---|
| Test 2 | Linear (Test 2) |
| Last Hour | Linear (Last Hour) |

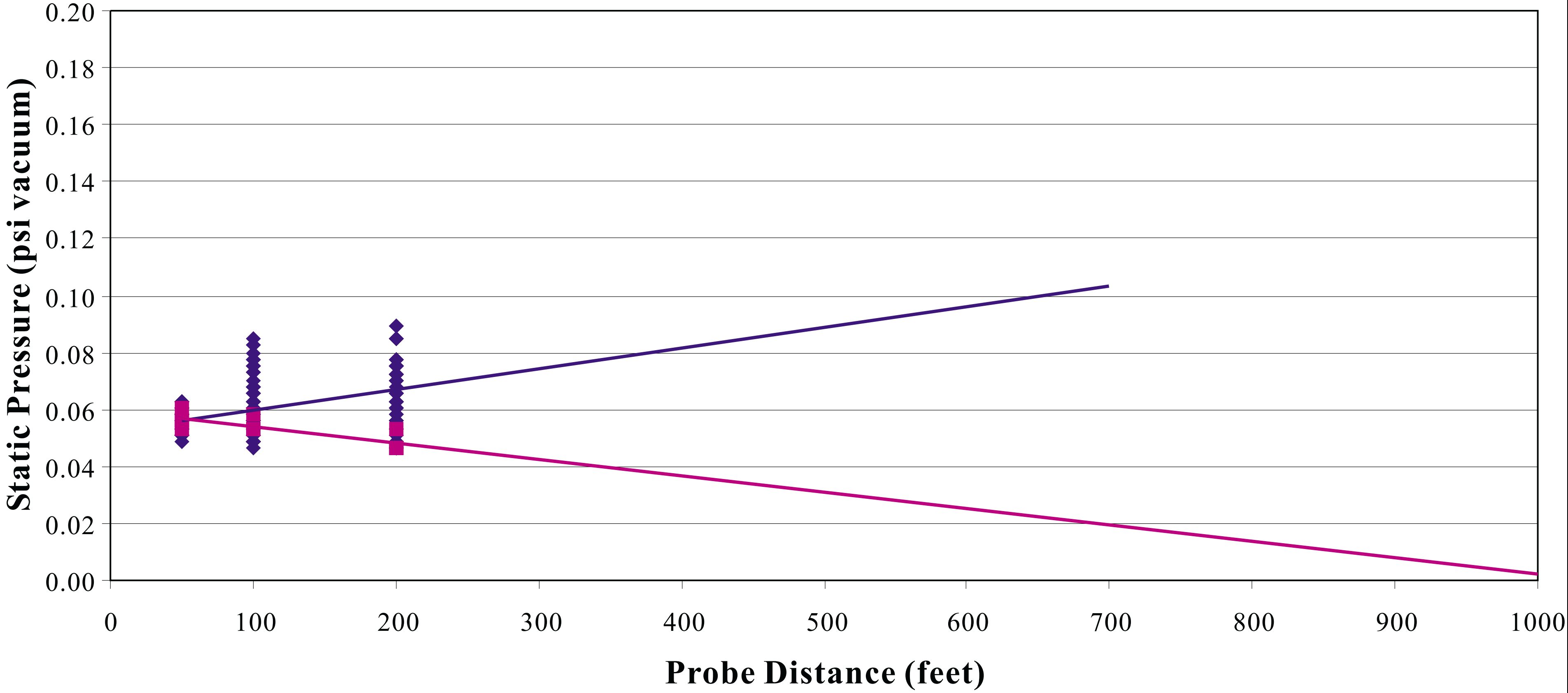
psi = pounds per square inch
scfm = standard cubic feet per minute

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**
**Results of Pumping Test 2**
**Flow Rate of 20 scfm**

*Daniel B. Stephens & Associates, Inc.*
3-18-02 JN 9398

Figure 10




**Explanation**

- Test 3
- Last Hour
- Linear (Test 3)
- Linear (Last Hour)

psi = pounds per square inch
scfm = standard cubic feet per minute

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**
**Results of Pumping Test 3**
**Flow Rate of 10 scfm**

*Daniel B. Stephens & Associates, Inc.*
3-18-02
JN 9398

Figure 11

test. The 590-foot radius is used for this study because it was achieved after the methane content of LFG measured at the extraction well reached equilibrium at 36.5 percent.

Using the 590-foot radius of influence, a volume of waste under the influence of the extraction well was estimated and converted to mass, assuming a 1,000 pounds per cubic yard ($lbs/yd^3$) refuse density (Appendix B). A unit LFG generation rate was then calculated based on the measured flow rate and the estimated amount of waste within the influence of the extraction well, as shown in the calculations below.

$$\text{Unit generation rate} = \frac{\text{Average flow rate during pump test x Number of minutes per year}}{\text{Tons in place x 2,000 lbs/ton}}$$

Using the estimated tons of waste in place (329,562 tons), as shown in Appendix B, and an average flow rate of 34.3 cfm (standardized to 50 percent methane from 47 cfm at 36.5 percent methane), the following unit generation rate is obtained:

$$0.0274 \text{ ft}^3/\text{lb - yr} = \frac{34.3 \text{ ft}^3/\text{min x } 525{,}600 \text{ min/yr}}{329{,}562 \text{ tons x } 2{,}000 \text{ lbs/ton}}$$

As calculated in the above equation, a unit generation rate of 0.0274 $ft^3/lb$ per year was estimated for Eubank Landfill Pump Test Number 1. From this unit generation rate, a site-calibrated k value was estimated for Eubank Landfill based on the LFG generation model. The k-calibration model run is described in Section 5.5.1.3.

## 5.5 Landfill Gas Generation Modeling Results

This section presents the model inputs used to estimate LFG generation at the Eubank Landfill and summarizes the model results.

### 5.5.1 Input Parameters

As described in Section 2.6, LFG generation modeling requires setting model input parameters for (1) waste disposal history, (2) $L_0$ value, and (3) k value. The selected average waste volumes used as input to the LFG generation model are provided in Table 8. Information was gathered from field investigations, laboratory analyses of waste samples, historical documents, and the RFP. Numerous information sources were used to provide for reliable estimates of the expected range LFG generation rates. The following model input parameters were chosen:

- Waste disposal history: 2,010,506 tons of refuse were disposed between 1963 and 1984
- $L_0$ values ranging from 3,204 $ft^3$/ton to 3,550 $ft^3$/ton
- k values ranging from 0.010/yr to 0.025/yr

Development of the waste disposal history, $L_0$ values, and k values for LFG generation modeling for the Eubank Landfill is described below.

#### *5.5.1.1 Waste Disposal History*

Annual waste volumes are a required input parameter for the LFG generation model. Since specific records do not exist for waste disposal at the Eubank Landfill, several possible historical waste disposal rates were calculated for the Eubank Landfill using the following data:

- Aerial extent of the landfill (81.5 acres) multiplied by average waste thickness provided in the City's RFP for this project (35.4 feet), which yields 4,654,914 cubic yards.

- Aerial extent of the landfill (81.5 acres) multiplied by average estimated refuse thickness based on information obtained from the waste characterization borings (25.8 feet), which yields 3,390,106 cubic yards.

- Aerial extent of the landfill (81.5 acres) multiplied by the average thickness derived from a combination of field values from this investigation and historical studies (30.6 feet), which yields 4,021,012 cubic yards.

## Table 8. Available Information on Waste Disposal History and Volumes Eubank Landfill

| Source of Information | Dates of Operation | Size (acres) | Average Soil Cover Thickness (feet) | Average Refuse Thickness (feet) | Estimated Refuse Volume [a] (cubic yards) | Estimated Waste in Place [b] (tons) | Notes |
|---|---|---|---|---|---|---|---|
| City of Albuquerque RFP for this project | 1967-1978 | 81.505 | --- | 35.4 | 4,654,914 | 2,327,457 | Reports a maximum refuse depth of 40 feet. Subtracts an estimated cover soil depth of 4.6 feet (calculated below). |
| Field investigation (present study), site totals | 1963-1984 | 81.45 | 3.0 | 25.8 | 3,390,106 | 1,695,053 | Dates of operation provided by Nelson, 1997. Acreage and volume are the sum of each area. Cover thickness is the area-weighted average. Refuse thickness is back-calculated from total volume and acreage. |
| Southwest landfill area | 1963-1984 | 60.38 | 2.5 | 27.0 | 2,625,230 | 1,312,615 | Dates of operation provided by Nelson, 1997. Acreage from drawing. Cover thickness from borehole WC-10. Refuse thickness is an average of WC-10 refuse thickness and RFP reported refuse thickness, since WC-10 is near the landfill perimeter and may underestimate refuse thickness. |
| Northeast landfill area | 1963-1984 | 21.07 | 4.5 | 22.5 | 764,876 | 382,438 | Dates of operation provided by Nelson, 1997. Cover and refuse thickness are from borehole WC-8 only. Only intermittent waste found in WC-9. WC-11 data not included since near landfill perimeter and borehole only 7 feet deep (not representative). Acreage from drawing. |
| Rhombus Civil Engineers, 1987 | --- | --- | 3.15 | --- | --- | --- | Cover thickness average from 56 boreholes. |
| Vinyard and Associates, 2001 | --- | --- | 7.5 | 7.5 | 985,542 | 492,771 | Cover and refuse thickness are the average for 4 boreholes where trash found (22 boreholes total drilled). |
| Values used for present study | 1963-1984 | 81.45 | 4.6 | 30.6 | 4,021,012 | 2,010,506 | Acreage is from present study. Cover thickness is average of field-derived value and historical reports. Refuse thickness is average of RFP reported value and field-derived value. |

[a] Uses 81.45 acres for entire site (from present study) when site acreage not reported.
[b] Assumes an average in-place density equal to 1,000 pounds per cubic yard.

RFP = Request for proposal
--- = No data

- Historical studies, which indicate the refuse thickness is approximately 7.5 feet and yield a refuse volume of 985,542 cubic yards (Vinyard and Associates, 2001).

Additional assumptions used for the study include:

- The years of disposal (1963 to 1984) as reported in Nelson (1977)
- An estimated average refuse density of 1,000 $lbs/yd^3$

Table 8 shows a range of in-place volume of waste based on this information. For modeling the LFG generation for the Eubank Landfill, a disposal volume of 4,021,012 cubic yards (2,010,506 tons) of refuse was used.

*5.5.1.2 Ultimate Methane Generation Rate ($L_0$)*

As outlined in Section 2.6.2, $L_0$ values used for LFG generation model runs for the Eubank Landfill were assigned one of the following three values:

- EPA default value of 3,204 $ft^3$/ton, which is converted from the EPA (AP-42) value of 100 cubic meters ($m^3$) of methane per Mg of waste (EPA, 1995).

- The SCS default value of 3,550 $ft^3$/ton based on the precipitation for the Albuquerque region, (8.7 inches per year according to the Desert Research Institute [www.wrcc.dri.edu]).

- Site-calibrated value of 3,550 $ft^3$/ton based on the amount of degradable refuse found. This value was compared with the expected fraction of degradable waste remaining for a "typical" U.S. waste stream that had degraded the same number of years as the waste at Eubank Landfill. The ratio of degradable waste measured in the field to the expected value was multiplied by the SCS default value to estimate the site-calibrated value.

Table 9 summarizes the waste composition data and $L_0$ adjustments used for developing the site-specific $L_0$ value for the Eubank Landfill. Because the fraction of degradable refuse analyzed at Eubank Landfill was almost exactly the same as the typical value, the site-calibrated $L_0$ was not adjusted, but remained the same as the SCS default value of 3,550 $ft^3$/ton.

**Table 9. Derivation of a Site-Calibrated $L_0$ Value for Eubank Landfill**

| Avg. Age of Landfill Refuse (years) | Typical MSW Degradable Fraction [a] | Site Sample Degradable Fraction [b] | Ratio of Site to Typical Degradable | SCS Default $L_0$ ($ft^3$/ton) | Site-Calibrated $L_0$ (Ratio x SCS $L_0$) ($ft^3$/ton) |
|---|---|---|---|---|---|
| 28.5 | 53.9% | 54.2% | 1.00 | 3,550 | 3,550 |

[a] Derived from EPA's *Characterization of Waste in the United States: 1996 Update* (EPA, 1997) which shows that an average of 67.4 percent of municipal solid waste (MSW) is decomposable as delivered to the landfill. Value shown is the expected fraction of decomposable refuse remaining as of the end of 2001 based on the age of waste in the landfill and the estimated rates of decomposition for waste components.

[b] Represents average decomposable fraction of waste samples from WC-8 (48% degradable) and WC-11 (60.5% degradable) (See Table 3). Sample location WC-9 was near the landfill perimeter and not considered representative. WC-10 is the only sample from the southwest area of the landfill. Because the pump test was conducted in the northeast area, waste composition data from WC-10 was excluded so that the adjustment to $L_0$ would be valid for use in the pump test data analysis.

MSW = Municipal solid waste $L_0$ = Ultimate methane generation rate $ft^3$/ton = Cubic feet per ton

### *5.5.1.3 Methane Generation Rate Constant (k)*

As outlined in Section 2.6.3, k values used for the LFG generation model runs for the Eubank Landfill were as follows:

- EPA default k value of 0.02 per year (for landfills experiencing less than 25 inches per year of precipitation)(EPA, 1995).
- The SCS default k value of 0.019 per year for the Albuquerque region.
- Site-calibrated k value of 0.01 per year based on refuse moisture data and pump test data. Because the average refuse moisture derived from the field testing program (24.1 percent) was not significantly different from the moisture content for typical wastes (20 percent), no adjustment to the k value was made based on the refuse moisture content. The site-calibrated k value was estimated by performing a k-calibration model run with the unit LFG generation rate of 0.027 $ft^3$/lb-yr, as calculated in Section 5.4. The k-calibration model run uses the estimated amount of waste within the influence of the extraction well, based on the pumping test results. As shown in Table 10, a k value of 0.010 is required to generate 0.027 $ft^3$ of LFG per lb of refuse in 2001.

## Table 10. Methane Generation Rate Constant (k) Calibration Model Run Eubank Landfill

| Year | Disposal Rate (tons per year) | Refuse In-Place (tons) | LFG Generation Rate (scfm) | (Mcf/day) | (cf/lb-yr) |
|---|---|---|---|---|---|
| *Methane content of LFG adjusted to:* | | | *50%* | | |
| *Methane generation rate constant (k):* | | | *0.010* | | |
| *Ultimate methane generation rate ($L_0$):* | | | *3,550* [a] | | |
| 1963 | 14,980 | 14,980 | 0 | 0.00 | 0.000 |
| 1964 | 14,980 | 29,960 | 2 | 0.00 | 0.018 |
| 1965 | 14,980 | 44,940 | 4 | 0.01 | 0.023 |
| 1966 | 14,980 | 59,920 | 6 | 0.01 | 0.026 |
| 1967 | 14,980 | 74,900 | 8 | 0.01 | 0.028 |
| 1968 | 14,980 | 89,881 | 10 | 0.01 | 0.029 |
| 1969 | 14,980 | 104,861 | 12 | 0.02 | 0.029 |
| 1970 | 14,980 | 119,841 | 14 | 0.02 | 0.030 |
| 1971 | 14,980 | 134,821 | 15 | 0.02 | 0.030 |
| 1972 | 14,980 | 149,801 | 17 | 0.02 | 0.030 |
| 1973 | 14,980 | 164,781 | 19 | 0.03 | 0.031 |
| 1974 | 14,980 | 179,761 | 21 | 0.03 | 0.031 |
| 1975 | 14,980 | 194,741 | 23 | 0.03 | 0.031 |
| 1976 | 14,980 | 209,721 | 25 | 0.04 | 0.031 |
| 1977 | 14,980 | 224,701 | 26 | 0.04 | 0.031 |
| 1978 | 14,980 | 239,681 | 28 | 0.04 | 0.031 |
| 1979 | 14,980 | 254,662 | 30 | 0.04 | 0.031 |
| 1980 | 14,980 | 269,642 | 31 | 0.05 | 0.031 |
| 1981 | 14,980 | 284,622 | 33 | 0.05 | 0.031 |
| 1982 | 14,980 | 299,602 | 35 | 0.05 | 0.031 |
| 1983 | 14,980 | 314,582 | 36 | 0.05 | 0.030 |
| 1984 | 14,980 | 329,562 | 38 | 0.05 | 0.030 |
| 1985 | 0 | 329,562 | 40 | 0.06 | 0.032 |
| 1986 | 0 | 329,562 | 39 | 0.06 | 0.031 |
| 1987 | 0 | 329,562 | 39 | 0.06 | 0.031 |
| 1988 | 0 | 329,562 | 39 | 0.06 | 0.031 |
| 1989 | 0 | 329,562 | 38 | 0.06 | 0.030 |
| 1990 | 0 | 329,562 | 38 | 0.05 | 0.030 |
| 1991 | 0 | 329,562 | 37 | 0.05 | 0.030 |
| 1992 | 0 | 329,562 | 37 | 0.05 | 0.030 |
| 1993 | 0 | 329,562 | 37 | 0.05 | 0.029 |
| 1994 | 0 | 329,562 | 36 | 0.05 | 0.029 |
| 1995 | 0 | 329,562 | 36 | 0.05 | 0.029 |
| 1996 | 0 | 329,562 | 36 | 0.05 | 0.028 |
| 1997 | 0 | 329,562 | 35 | 0.05 | 0.028 |
| 1998 | 0 | 329,562 | 35 | 0.05 | 0.028 |
| 1999 | 0 | 329,562 | 35 | 0.05 | 0.028 |
| 2000 | 0 | 329,562 | 34 | 0.05 | 0.027 |
| 2001 | 0 | 329,562 | 34 | 0.05 | **0.027** |

[a] Cubic feet per ton.

LFG = Landfill gas
scfm = Standard cubic feet per minute
Mcf/day = Million cubic feet per day
cf/lb-yr = Cubic feet per pound per year

- An elevated k value of 0.025 per year based on the estimated effect of adding moisture starting in 2002.

### 5.5.2 Model Validation Results

Validation of LandGEM's application to the Eubank Landfill is provided by the site-calibrated k values, which are based on actual measurements of LFG production from pumping tests conducted at the Eubank Landfill. The calibrated k value of 0.010 for Eubank is close to the predicted k input parameters assigned through default values (0.019 and 0.020). This confirms the validity of the model runs that use default values for the input parameters .

### 5.5.3 LFG Generation Model Results

Model results, provided in Table 11 and Figure 12, show estimated LFG generation through 2020 for the Eubank Landfill under four different projection scenarios, including the effect of adding moisture to the refuse mass. Table 11 also provides the estimated disposal rates and the k and $L_0$ values used for each projection. All LFG generation rates shown are adjusted to 50 percent methane content (standard normalization procedure) to reflect the typical methane content of LFG as it is generated.

Except for the projection showing the effect of adding moisture starting in 2002 (Projection 4), all projections show LFG generation reaching a peak in 1985, one year following landfill closure, and declining at a rate of 1 to 2 percent annually thereafter. LFG generation in 2002 is estimated to range between 205 and 302 standard cubic feet per minute (scfm). For all years prior to 2003, the highest generation rates occur under the SCS default projection (Projection 2), which uses the highest $L_0$ value of any projection. The lowest generation rates occur under the site-calibrated projection (Projection 3), which uses a k value of 0.010 based on the results of the pumping tests.

After 2002, the highest generation rates occur under the modified (moisture added) site-calibrated projection (Projection 4), which uses the site-calibrated k and $L_0$ values through 2002, but which increases the k value to 0.025 for generation after 2002 to reflect the effect of adding

# Table 11. LFG Generation Projections
## Eubank Landfill
## Page 1 of 2

| Year | Disposal Rate (tons/yr) | Refuse In-Place (tons) | LFG Generation: Projection 1 (EPA default values) scfm | Projection 1 Mcf/day | Projection 2 (SCS default values) scfm | Projection 2 Mcf/day | Projection 3 (site-calibrated values) scfm | Projection 3 Mcf/day | Projection 4 (site-calibrated values with k adjustment for added moisture) scfm | Projection 4 Mcf/day |
|---|---|---|---|---|---|---|---|---|---|---|
| *Methane content of LFG adjusted to:* | | | *50%* | | *50%* | | *50%* | | *50%* | |
| *Methane generation rate constant (k):* | | | *0.020* | | *0.019* | | *0.010* | | *0.010 and 0.025* [a] | |
| *Ultimate methane generation rate ($L_0$):* | | | *3,204* [b] | | *3,550* [b] | | *3,550* [b] | | *3,550* [b] | |
| 1963 | 91,387 | 91,387 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 |
| 1964 | 91,387 | 182,773 | 22 | 0.031 | 23 | 0.033 | 12 | 0.018 | 12 | 0.018 |
| 1965 | 91,387 | 274,160 | 43 | 0.062 | 46 | 0.066 | 24 | 0.035 | 24 | 0.035 |
| 1966 | 91,387 | 365,547 | 64 | 0.093 | 68 | 0.098 | 36 | 0.052 | 36 | 0.052 |
| 1967 | 91,387 | 456,933 | 85 | 0.122 | 89 | 0.129 | 48 | 0.069 | 48 | 0.069 |
| 1968 | 91,387 | 548,320 | 105 | 0.151 | 111 | 0.160 | 60 | 0.086 | 60 | 0.086 |
| 1969 | 91,387 | 639,706 | 125 | 0.180 | 132 | 0.190 | 72 | 0.103 | 72 | 0.103 |
| 1970 | 91,387 | 731,093 | 144 | 0.208 | 152 | 0.219 | 83 | 0.120 | 83 | 0.120 |
| 1971 | 91,387 | 822,480 | 163 | 0.235 | 172 | 0.248 | 94 | 0.136 | 94 | 0.136 |
| 1972 | 91,387 | 913,866 | 182 | 0.262 | 192 | 0.277 | 106 | 0.152 | 106 | 0.152 |
| 1973 | 91,387 | 1,005,253 | 200 | 0.288 | 212 | 0.305 | 117 | 0.168 | 117 | 0.168 |
| 1974 | 91,387 | 1,096,640 | 218 | 0.314 | 231 | 0.332 | 128 | 0.184 | 128 | 0.184 |
| 1975 | 91,387 | 1,188,026 | 235 | 0.339 | 249 | 0.359 | 139 | 0.200 | 139 | 0.200 |
| 1976 | 91,387 | 1,279,413 | 253 | 0.364 | 268 | 0.385 | 150 | 0.216 | 150 | 0.216 |
| 1977 | 91,387 | 1,370,800 | 269 | 0.388 | 286 | 0.411 | 160 | 0.231 | 160 | 0.231 |
| 1978 | 91,387 | 1,462,186 | 286 | 0.412 | 303 | 0.437 | 171 | 0.246 | 171 | 0.246 |
| 1979 | 91,387 | 1,553,573 | 302 | 0.435 | 321 | 0.462 | 182 | 0.262 | 182 | 0.262 |
| 1980 | 91,387 | 1,644,960 | 318 | 0.458 | 338 | 0.486 | 192 | 0.277 | 192 | 0.277 |
| 1981 | 91,387 | 1,736,346 | 333 | 0.480 | 354 | 0.510 | 202 | 0.291 | 202 | 0.291 |
| 1982 | 91,387 | 1,827,733 | 349 | 0.502 | 371 | 0.534 | 213 | 0.306 | 213 | 0.306 |
| 1983 | 91,387 | 1,919,119 | 364 | 0.524 | 387 | 0.557 | 223 | 0.321 | 223 | 0.321 |
| 1984 | 91,387 | 2,010,506 | 378 | 0.545 | 402 | 0.579 | 233 | 0.335 | 233 | 0.335 |
| 1985 | 0 | 2,010,506 | 393 | 0.565 | 418 | 0.602 | 243 | 0.349 | 243 | 0.349 |
| 1986 | 0 | 2,010,506 | 385 | 0.554 | 410 | 0.590 | 240 | 0.346 | 240 | 0.346 |
| 1987 | 0 | 2,010,506 | 377 | 0.543 | 402 | 0.579 | 238 | 0.342 | 238 | 0.342 |
| 1988 | 0 | 2,010,506 | 370 | 0.532 | 395 | 0.568 | 235 | 0.339 | 235 | 0.339 |
| 1989 | 0 | 2,010,506 | 362 | 0.522 | 387 | 0.558 | 233 | 0.336 | 233 | 0.336 |
| 1990 | 0 | 2,010,506 | 355 | 0.512 | 380 | 0.547 | 231 | 0.332 | 231 | 0.332 |
| 1991 | 0 | 2,010,506 | 348 | 0.501 | 373 | 0.537 | 228 | 0.329 | 228 | 0.329 |
| 1992 | 0 | 2,010,506 | 341 | 0.492 | 366 | 0.527 | 226 | 0.326 | 226 | 0.326 |

[a] The k value changes from 0.01 to 0.025 after 2002 to reflect the addition of moisture.
[b] Cubic feet per ton.

scfm = Standard cubic feet per minute
Mcf/day = Million cubic feet per day

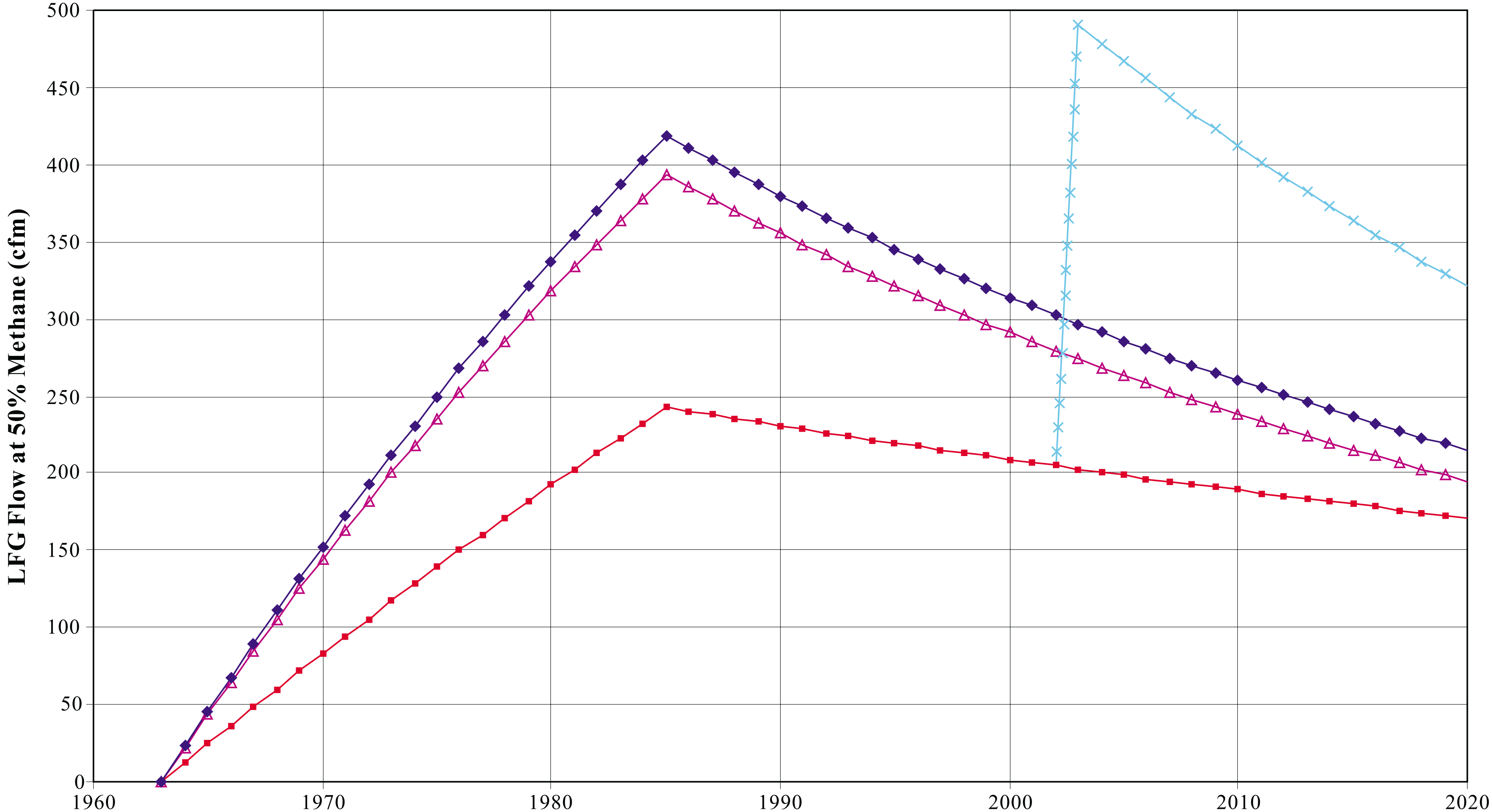
# Table 11. LFG Generation Projections
## Eubank Landfill
## Page 2 of 2

| Year | Disposal Rate (tons/yr) | Refuse In-Place (tons) | LFG Generation: Projection 1 (EPA default values) | | Projection 2 (SCS default values) | | Projection 3 (site-calibrated values) | | Projection 4 (site-calibrated values with k adjustment for added moisture) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | scfm | Mcf/day | scfm | Mcf/day | scfm | Mcf/day | scfm | Mcf/day |
| *Methane content of LFG adjusted to:* | | | *50%* | | *50%* | | *50%* | | *50%* | |
| *Methane generation rate constant (k):* | | | *0.020* | | *0.019* | | *0.010* | | *0.010 and 0.025* [a] | |
| *Ultimate methane generation rate ($L_0$):* | | | *3,204* [b] | | *3,550* [b] | | *3,550* [b] | | *3,550* [b] | |
| 1993 | 0 | 2,010,506 | 335 | 0.482 | 359 | 0.517 | 224 | 0.322 | 224 | 0.322 |
| 1994 | 0 | 2,010,506 | 328 | 0.472 | 352 | 0.507 | 222 | 0.319 | 222 | 0.319 |
| 1995 | 0 | 2,010,506 | 321 | 0.463 | 345 | 0.497 | 219 | 0.316 | 219 | 0.316 |
| 1996 | 0 | 2,010,506 | 315 | 0.454 | 339 | 0.488 | 217 | 0.313 | 217 | 0.313 |
| 1997 | 0 | 2,010,506 | 309 | 0.445 | 333 | 0.479 | 215 | 0.310 | 215 | 0.310 |
| 1998 | 0 | 2,010,506 | 303 | 0.436 | 326 | 0.470 | 213 | 0.307 | 213 | 0.307 |
| 1999 | 0 | 2,010,506 | 297 | 0.427 | 320 | 0.461 | 211 | 0.304 | 211 | 0.304 |
| 2000 | 0 | 2,010,506 | 291 | 0.419 | 314 | 0.452 | 209 | 0.301 | 209 | 0.301 |
| 2001 | 0 | 2,010,506 | 285 | 0.411 | 308 | 0.444 | 207 | 0.298 | 207 | 0.298 |
| 2002 | 0 | 2,010,506 | 279 | 0.402 | 302 | 0.436 | 205 | 0.295 | 205 | 0.295 |
| 2003 | 0 | 2,010,506 | 274 | 0.394 | 297 | 0.427 | 203 | 0.292 | 491 | 0.707 |
| 2004 | 0 | 2,010,506 | 269 | 0.387 | 291 | 0.419 | 201 | 0.289 | 479 | 0.689 |
| 2005 | 0 | 2,010,506 | 263 | 0.379 | 286 | 0.411 | 199 | 0.286 | 467 | 0.672 |
| 2006 | 0 | 2,010,506 | 258 | 0.372 | 280 | 0.404 | 197 | 0.283 | 455 | 0.656 |
| 2007 | 0 | 2,010,506 | 253 | 0.364 | 275 | 0.396 | 195 | 0.280 | 444 | 0.640 |
| 2008 | 0 | 2,010,506 | 248 | 0.357 | 270 | 0.389 | 193 | 0.278 | 433 | 0.624 |
| 2009 | 0 | 2,010,506 | 243 | 0.350 | 265 | 0.381 | 191 | 0.275 | 423 | 0.608 |
| 2010 | 0 | 2,010,506 | 238 | 0.343 | 260 | 0.374 | 189 | 0.272 | 412 | 0.593 |
| 2011 | 0 | 2,010,506 | 233 | 0.336 | 255 | 0.367 | 187 | 0.269 | 402 | 0.579 |
| 2012 | 0 | 2,010,506 | 229 | 0.329 | 250 | 0.360 | 185 | 0.267 | 392 | 0.564 |
| 2013 | 0 | 2,010,506 | 224 | 0.323 | 245 | 0.353 | 183 | 0.264 | 382 | 0.551 |
| 2014 | 0 | 2,010,506 | 220 | 0.317 | 241 | 0.347 | 182 | 0.261 | 373 | 0.537 |
| 2015 | 0 | 2,010,506 | 215 | 0.310 | 236 | 0.340 | 180 | 0.259 | 364 | 0.524 |
| 2016 | 0 | 2,010,506 | 211 | 0.304 | 232 | 0.334 | 178 | 0.256 | 355 | 0.511 |
| 2017 | 0 | 2,010,506 | 207 | 0.298 | 227 | 0.328 | 176 | 0.254 | 346 | 0.498 |
| 2018 | 0 | 2,010,506 | 203 | 0.292 | 223 | 0.321 | 174 | 0.251 | 337 | 0.486 |
| 2019 | 0 | 2,010,506 | 199 | 0.286 | 219 | 0.315 | 173 | 0.249 | 329 | 0.474 |
| 2020 | 0 | 2,010,506 | 195 | 0.281 | 215 | 0.309 | 171 | 0.246 | 321 | 0.462 |

[a] The k value changes from 0.01 to 0.025 after 2002 to reflect the addition of moisture.
[b] Cubic feet per ton.

scfm = Standard cubic feet per minute
Mcf/day = Million cubic feet per day

S:\Projects\9398\Sheets\Figures\Eubank\Figure_12.cdr




**Explanation**

- EPA (AP-42) Default Values k = 0.020 Lo = 3,204 cu.ft./ton
- SCS Default Values k = 0.019 Lo = 3,550 cu.ft./ton
- Site-Calibrated Values w/Added Moisture k = 0.025 Lo = 3,550 cu.ft./ton
- Site-Calibrated Values k = 0.010 Lo = 3,550 cu.ft./ton

**Source:** SCS Engineers

LANDFILL GAS INVESTIGATION AND CHARACTERIZATION STUDY

**Eubank Landfill**
**LFG Generation Projection**

*Daniel B. Stephens & Associates, Inc.*
3-28-02
JN 9398

Figure 12

moisture to the refuse mass. This projection shows LFG generation increasing from 205 scfm in 2002 to 491 scfm in 2003, the first year that the effects of added moisture are reflected in the model results. LFG generation is projected to decline at 2.5 percent annually after 2003 under the added moisture scenario (Projection 4).

# 6. Conclusions and Recommendations

The landfill gas investigation and characterization study was conducted with the primary goal of providing new information to determine appropriate measures to address LFG issues related to the use of properties on and within close proximity to the former landfills. The following conclusions and recommendations related to the Eubank Landfill have been made based on available information and data collected during this investigation. Though it is impossible to precisely predict future LFG generation and migration, careful analysis of data can provide a tool for making an educated prediction of future LFG behavior. These assumptions of future LFG behavior combined with past LFG experience have allowed us to determine the possible effects of LFG on current and future development at and near the former landfills.

This report makes a number of recommendations as to actions that should be taken by the City. These recommendations are worded in terms of actions that should be taken by the City because the City is the party that requested recommendations. It is the City that has taken the lead in dealing with landfill gas problems. This report takes no position on whether it is properly the City's role or responsibility to deal with the concerns raised by these recommendations.

## 6.1 Conclusions

Based on the data and analysis discussed, the following conclusions can be made regarding LFG generation at the Eubank Landfill:

- Based on the modeling results, the peak year for LFG generation at the Eubank Landfill was 1985.

- The estimated LFG generation rate for the Eubank Landfill indicates that the production of LFG is steadily declining in its current state. The projected LFG generation rates in 2002 for the Eubank Landfill ranges from 205 to 302 scfm.

- Due to the LFG concentrations measured and the LFG generation rate predicted for the Eubank Landfill, the potential for significant volumes of LFG to migrate off-site is moderate.

- Temporary gas probes at the northern property boundary adjacent to the mobile home park did not show evidence of methane migration in shallow soils (10 feet bgs), but did show elevated carbon dioxide levels, which suggests that some off-site LFG migration may be occurring.

- Temporary gas probes and permanent monitoring probes located at the boundary of the SSTP Phase I did not show evidence of off-site LFG migration in shallow soils (10 feet bgs).

- VOCs were detected in LFG samples collected at the Eubank Landfill, however, at this time insufficient data exist to form conclusions concerning adverse impacts to public health.

## 6.2 Recommendations

Based on the data and analyses discussed, the following recommendations are provided to address LFG issues relevant to the Eubank Landfill.

### *6.2.1 Buffer Zone Reduction*

The basic requirements of the City's *Interim Guidelines for Development within 1,000 feet of Landfills* should remain in place; however, the buffer zone distance could be reduced contingent on implementing a LFG monitoring plan, as described below.

- *LFG monitoring plan.* The City should consider developing a LFG monitoring plan for the Eubank Landfill to assess potential off-site migration of LFG. The plan should address the following:

- *Installation of perimeter LFG monitoring probes.* These probes should be installed outside the waste disposal areas to confirm the limits of LFG migration. The probes should extend at least 10 feet below the depth of waste, or to approximately 50 feet bgs (typical). The monitoring probes should be spaced at approximate 500-foot intervals along then northern and western boundaries of the southwest fill area. The monitoring probes should be spaced at approximate 500-foot intervals along the western boundary of the northern fill area. Along the northern property boundary, between the northern fill area and the mobile home park, the probes should be spaced at approximate 250-foot intervals. Monitoring probes are not needed adjacent to Tijeras Arroyo, which is expected to remain as open space. Suitable and accessible locations for the monitoring probes will need to be identified. The final number, spacing, and locations of monitoring probes will need to be determined during development of the LFG monitoring plan.

- *Quarterly monitoring*. The perimeter monitoring probes and selected subsurface utility vaults should be monitored for methane gas on a quarterly basis for at least two consecutive years. The utility investigation recommended in Section 6.2.2 should specify which subsurface utility vaults, if any, will be monitored on a regular basis. If methane gas is not detected during the two years of monitoring, the frequency may be reduced to once every six months.

- *Change in frequency of monitoring.* If methane gas is detected at any time exceeding 25 percent of the LEL in selected subsurface utility vaults (new or existing) or 50 percent of the LEL in perimeter LFG monitoring probes, the frequency of monitoring should be increased to monthly for at least six months. Subsequently, if the methane gas content stays below these limits for six months of monthly monitoring, the frequency can be decreased to quarterly.

• *Development of property outside landfill perimeter.* Based on the results of the LFG investigation and characterization study, changes are recommended for the Eubank Landfill in the City's Interim Guidelines.

– *Reduction of setbacks*. A reduction in the setback distance for applicability of the City of Albuquerque's Interim Guidelines is recommended to the boundary of the SSTP Phase I. This recommendation is based on the LFG survey results from the gas probes located at the boundary, which showed that LFG is not present in shallow soils. The probes are located more than 500 feet from the nearest fill area of the Eubank Landfill. This recommended setback reduction is contingent on implementation of the LFG monitoring plan.

  Assuming monitoring of all perimeter probes and selected utility vaults continues to verify that no methane gas is present after the initial two-year period, the setback distance from the property boundary could be decreased to 500 feet for determination of applicability of the City's Interim Guidelines. The recommended setback reduction is contingent on the results of continued LFG monitoring. The detection of methane above 25 percent of LEL in selected utility vaults or above 50 percent of LEL in any perimeter monitoring probe will result in this recommendation being rescinded and a return to a greater setback distance around the entire landfill (northeast and southwest fill areas) of 1,000 feet or other setback distance appropriate for the conditions observed.

  Maintaining a minimum 500-foot setback is recommended because of the existing high methane concentrations and a predicted LFG generation rate that will remain elevated for many years. These conditions will continue to pose a potential risk, and the City may still consider some design, monitoring, and/or LFG abatement measures suitable under the Interim Guidelines. Examples of requirements that could be needed, even with a setback distance from the landfill, include directing storm water away from the landfill, sealing off subgrade utilities to prevent possible LFG migration, installation of subsurface venting systems beneath structures, and/or installing interior monitors in buildings (particularly in basements). Any requirements will depend on the site-specific development plans.

- *Monitoring conditions for reduction of setbacks.* The recommended setback distance reduction is contingent on the results of continued LFG monitoring. The detection of methane above 25 percent of the LEL in selected utility vaults or above 50 percent of LEL in any perimeter monitoring probe will result in this recommendation being rescinded and reinstatement of a setback distance of 1,000 feet (or other setback distance appropriate for the conditions observed).

### 6.2.2 Landfill Management Plan

The City should consider developing a comprehensive landfill management plan for the Eubank Landfill, to address several items that play a significant role in reducing LFG generation and preventing adverse LFG impacts. The LFG monitoring plan, described above, is a component of the overall landfill management plan. The landfill management plan should include the recommended components described below.

- *LFG control plan.* If the methane content exceeds 25 percent of the LEL in selected subsurface utility vaults or 50 percent of the LEL in perimeter monitoring probes, the City should consider developing a LFG control plan. If the methane content exceeds the specified limits for three consecutive months, the City should immediately develop and implement a LFG control plan. The LFG gas control plan should consist of either passive or active landfill control systems capable of reducing the methane content to levels protective of public health and safety.

- *Utility investigation.* Selected subsurface utilities should be monitored for the presence of LFG and included with the quarterly monitoring program discussed above. Utilities should be investigated on and around the Eubank Landfill to determine if existing utility corridors pose a risk by acting as conduits for the migration of LFG. Utility locations should be examined to the fullest extent possible, using all available records and possible on-site investigation. If utilities are identified near the Eubank Landfill, a utility monitoring plan should be developed to select utility monitoring locations where LFG may be detected and monitoring can minimize the risk for utility conduits to transmit LFG. As long as methane concentrations remain below 25 percent of the LEL in selected subsurface utilities, no further utility investigation is needed. However, if methane concentrations increase above 25 percent of LEL, additional investigation of utilities should commence.

As part of this study, utility locations were checked with regard to standard requirements for subsurface work, to avoid damaging utilities. Some information regarding utilities is also contained in historical records reviewed for this study. In particular, the possibility of an abandoned sewer line leading to the South Pointe Village mobile home park should be investigated to determine if a possible LFG migration conduit exists.

- *Development of landfill property.* If development occurs on the Eubank Landfill property, the developer should meet all applicable requirements of the City's Interim Guidelines. If development occurs on the landfill that may increase the potential for off-site LFG migration by sealing the landfill cover surface (e.g. buildings, paved parking areas, and densely vegetated areas), the perimeter probe monitoring frequency may need to be increased and/or additional monitoring probes added. This includes increased monitoring and/or additional monitoring probes that may be needed for the SSTP (Phases I and II).

- *Drainage control.* The existing drainage at the Eubank Landfill is relatively flat and contains low points that collect storm water runoff. This storm water may contribute to LFG generation that has caused the elevated methane concentrations observed. It is recommended that the City undertake a site drainage study to determine existing drainage patterns and identify possible improvements.

- *Clean-up illegal waste dumps.* A considerable amount of illegally dumped waste is scattered on the ground surface across the Eubank Landfill and surrounding open lands. Some of the debris should be removed to promote positive drainage, since closely spaced piles of waste on the landfill cover will trap storm water.

- *Control of ongoing dumping.* Illegal dumping of additional waste at the Eubank landfill should be controlled with a combination of access restrictions (fencing, blocked roads), patrols, and enforcement against offenders. Surface cleanup of illegal dump sites often discourages additional dumping.

# References

Analytical Technologies, Inc. 1996. *Analytical results of an air sample collected at Eubank Landfill on 3/26/96.* Prepared for City of Albuquerque. March 26, 1996.

CH2M Hill. 1996. *Preliminary site assessment and soil gas investigation report, south Eubank landfill site.* Eubank Landfill, City of Albuquerque landfill gas investigation. Prepared for New Mexico Land Offices. April 1, 1996.

City of Albuquerque (COA). 2002. Fax from Doug Earp, Environmental Health Department, providing groundwater data. March 25, 2002.

Kelley, V.C. 1977. *Geology of Albuquerque Basin, New Mexico*. New Mexico Bureau of Mines and Mineral Resources Memoir 33. 59 p.

Nelson, T. 1997. *Past and present solid waste landfills in Bernalillo County, New Mexico, 1997.* Prepared for University of New Mexico School of Public Administration. City of Albuquerque landfill gas investigation. June 25, 1997.

Peavy, H.S., D.R. Rowe, and G. Tchobanoglous. 1985. *Environmental engineering.* McGraw Hill, New York. 699 p.

Rhombus, P.A. 1987. *Eubank Landfill, lease compliance report*. Prepared for the City of Albuquerque Solid Waste Department. July 22, 1987.

PNM, 2001. Sandia Switching Station to Four Hill 3-phase distribution line methane soil gas survey. June 6, 2001.

U.S. Environmental Protection Agency (EPA). 1995. *Compilation of air pollutant emission factors*. AP-42, 5th edition. Research Triangle Park, NC. January 1995.

———. 1997. *Characterization of waste in the United States: 1996 update*. EPA Publication Number EPA530-97-R-015 U.S. Environmental Protection Agency, Office of Solid Waste Washington, DC. May 1997.

Vinyard and Associates, Inc. 2001. Letter from Martin D. Vinyard to Bernie Loeffler of Askus New Mexico, Inc. regarding Site evaluation, proposed cell tower equipment storage shed to be located within the Sumitomo-Sitex facility located at 9401 San Mateo Boulevard, Albuquerque, New Mexico. V&A Project no. 01-1-14. January 11, 2001.