Health Consultation

BROOKHAVEN LANDFILL

TOWN OF BROOKHAVEN,
SUFFOLK COUNTY, NEW YORK

EPA FACILITY ID: NYD038150264

NOVEMBER 29, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

New York State Department Health
Center for Environmental Health
Under a Cooperative Agreement with
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia

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TABLE OF CONTENTS

BACKGROUND AND STATEMENT OF ISSUES

A. Introduction

The New York State Environmental Facilities Corporation opened the Brookhaven Landfill in March 1974, and the town of Brookhaven assumed ownership of the landfill in 1976. Throughout the history of this site, area residents have expressed many health concerns, and the Agency for Toxic Substances and Disease Registry (ATSDR) received a petition for a public health consultation to address these concerns. This resulting public health consultation was produced through a cooperative agreement between the New York State Department of Health (NYS DOH) and ATSDR. This document uses existing air and groundwater data to evaluate the potential for humans to be exposed to contaminants surrounding the Brookhaven Landfill.

An ATSDR public health consultation provides advice on specific public health issues that occur as a result of actual or potential human exposure to a hazardous material. People can be exposed to environmental contamination by eating contaminated food, soil, or water (ingestion); breathing contaminated air (inhalation); and directly touching contaminated materials (dermal contact). Public health consultations rely primarily on environmental data, health data, and community concerns to evaluate exposures at a specific site. A public health consultation makes recommendations based on these data and concludes with an outline of site specific public health actions.

B. Site Description and History

The Brookhaven Landfill is at the town of Brookhaven Waste Management Facility, in the town of Brookhaven, Suffolk County, New York (Appendix A, Figure 1). The town of Brookhaven Waste Management Facility Site consists of approximately 534 acres between Horseblock Road and Sunrise Highway. The landfill has six cells. The old landfill (Cells 1 through 4), which has been permanently closed, occupies 90 acres. Cell 5 is active but is near capacity and being brought to final grade in preparation for closure and capping. It occupies an additional 78 acres on the western portion of the site: 56 acres of landfill and 22 acres of other facilities. Cell 6, which is currently active, occupies the area between the old landfill and Cell 5. The total footprint of Cell 6 is about 113 acres, but some of this overlies Cell 5 and the old landfill. Horizon Village, the closest residential area, is 2,400 feet west of the nearest edge of the old landfill and 900 feet west of the nearest edge of Cell 5. The Hampton Avenue School is 5,600 feet west-southwest of the landfill.

The old landfill accepted municipal solid waste and incinerator ash. Landfilling began in Cell 1 in about 1974. As the cell approached its design capacity, new cells were constructed. Cell 2 opened in about 1983, Cell 3 in 1989, and Cell 4 in 1991. Cells 1 through 3 were permanently capped and closed in 1993, and Cell 4 was capped in 1997. Erosion problems occurred with the cap on the old landfill when some of the vegetation planted for stabilization did not grow. The erosion problem has been corrected. Cells 5 and 6 began operating in 1996 and 2003, respectively. They accept construction and demolition debris and incinerator ash, but not municipal solid waste. The landfill has a gas collection system for methane that generators burn to produce electricity. The landfill also has a permanent flare used to burn additional landfill gases.

During 1983-1984, thirty-five abandoned 55-gallon steel drums that were found along town highways were transported to the landfill for temporary storage. Analysis of the drum contents indicated that they contained flammable, non-chlorinated organic liquids. S & W Waste, Inc. removed the drums and transported them to its disposal facility in New Jersey in 1985.

The New York State Department of Environmental Conservation (NYS DEC) listed The town of Brookhaven Landfill on the New York State Registry of Inactive Hazardous Waste Sites when the Registry was first developed (NYS DEC, 1987). NYS DEC reviewed landfill records and leachate and groundwater sampling on and near the town of Brookhaven Landfill. The review did not identify any data indicating past disposal of hazardous waste at the Brookhaven Landfill. The site was removed from the list in May 1992, due to the lack of documentation of hazardous waste as defined in Part 371 of the Title 6 New York Codes, Rules and Regulations (NYS DEC, 1991). ATSDR was petitioned for a health consultation due to off-site odor concerns and groundwater contamination in private drinking wells downgradient of the landfill.

C. Site Visit and Physical Hazards

During the investigation for the draft health consultation in 1994, NYS DOH staff visited the landfill. Representatives of the NYS DEC, the town of Brookhaven Department of Waste Management, and the town of Brookhaven Landfill were also present during the site visit. The flare, which burns landfill gases, was operating. NYS DOH staff did not observe any odor problems or dust problems. There was a large area of wooded land between the nearby houses and the outer edge of the proposed Cell 5 (which began operation in 1996). Staff saw piles of trees and brushes on cleared land north of Cell 4.

NYS DOH and NYS DEC staff toured the site again in 1998. The permanent flare was operating. Staff did not notice any odor problems on-site or in the neighboring residential area. NYS DOH staff noted a five-foot hole in the perimeter fence adjacent to the Horizon Village housing development. The town repaired the fence to prevent access to the active landfill. NYS DEC periodically monitors the landfill to ensure compliance with New York State regulations. The NYS DEC communicates with NYS DOH as necessary to keep NYS DOH informed of activities to ensure ongoing activities do not pose public health issues.

D. Demographics

NYS DOH estimated from the 2000 Census (US Bureau of the Census, 2001) that 5,841 people live within one mile of the Brookhaven Landfill site. The age distribution of the area is somewhat younger than of the rest of Suffolk County as well as New York State excluding New York City (NYC). There were 1,241 females of reproductive age (ages 15-44) within one mile of the site, and the area has greater racial and ethnic diversity than the rest of Suffolk County or the state (excluding NYC). Based on the 2000 Census (US Bureau of the Census, 2002), a higher percentage of the population is living below the poverty level while the median household income is lower than the rest of the county. These comparisons are provided in the following table.

2000 Census Demographics for the Brookhaven Landfill

2000 Census Demographics	New York State excluding NYC	Suffolk County	Area within 1 mile of Brookhaven Landfill
Age Distribution			
<6	8%	9%	10%
6-19	20%	23%	25%
20-64	58%	58%	59%
>64	14%	10%	7%
Race Distribution			
White	85%	85%	61%
Black	8%	7%	26%
Native American	<1%	<1%	<1%
Asian	2%	2%	2%
Pacific Islander	<1%	0%	0%
Other	2%	4%	6%
Multi-Racial	2%	2%	4%
Percent Minority*	18%	21%	49%
Ethnicity Distribution			
Percent Hispanic	6%	11%	19%
1999 Median Income	$47,517	$65,288	$59,941
% Below Poverty Level	10%	6%	18%

* Minority includes Hispanics, African-Americans, Asian-Americans, Pacific Islanders, and Native Americans.

E. Environmental Contamination

Groundwater Contamination

As part of a study on the transport of contaminants in groundwater from 1981 to 1983, the United States Geological Survey (USGS) investigated the hydrogeology and chemical quality of groundwater in a four square-mile area surrounding the landfill (Wexler, 1988a). This study found elevated pH, temperature, specific conductance, chloride, and ammonium concentrations in samples from monitoring wells downgradient of the landfill. The USGS report states "although elevated specific conductance and chloride concentrations might be attributed to sources other than the landfill, the presence of ammonium in groundwater on Long Island is unusual and is considered to be a reliable indicator of contamination by landfill leachates". A leachates plume 3,700 feet long, 2,400 feet wide, and at least 90 feet deep was delineated.

In 1990, the town hired a consulting firm to assess the groundwater quality near the landfill. Early groundwater monitoring data show elevated levels of some metals, including iron, manganese, and arsenic. The report shows that the plume advanced 1,800 - 3,000 feet in the direction of groundwater flow between 1982 and 1990 (Dvirka and Bartilucci, 1990a). Remedial measures, capping, and improved controls in the newer cells should reduce groundwater contamination from the landfill.

Public water was made available beginning in 1983 to those residents downgradient of the landfill affected by, or potentially affected by, the contaminant plume. The town of Brookhaven installed the water mains in cooperation with the Suffolk County Water Authority.

Drinking Water Well Contamination

In 1986 and 1987, thirty-one private wells downgradient of the landfill were tested for volatile organic compounds (VOCs). Four compounds were detected in eight wells. In January 1989, the NYS DOH drinking water guidelines for each of these four compounds in public water supplies were reduced. Only vinyl chloride levels exceeded the previous guideline (prior to 1989), but the concentrations of all four compounds exceed the current NYS DOH drinking water guidelines. In 1991, twenty-six additional private wells downgradient of the landfill were tested for VOCs. Three wells contained contaminants above the NYS DOH drinking water guideline.

Additional private wells were tested in 1996 in response to recommendations made in the draft health consultation. A 1996 town of Brookhaven Landfill private well survey recorded 201 total responses. Private wells were used for drinking water at 64 homes and businesses and an additional 21 were used for other purposes. Respondents reported 116 homes and businesses were connected to public water; 29 had disconnected wells and 87 did not have a well. Of the 64 private wells still in use, NYS DOH identified four that were near the contaminant plume and collected water samples from these wells in October 1996. Trichloroethene (TCE) was detected in one private well above the NYS drinking water guideline. Public drinking water was available to this residence at that time, and they have since connected to the public water supply and discontinued use of their well.

These well surveys are summarized in Table 1 below. The table shows the detected compounds in micrograms per liter (mcg/L), the number of wells in which they were detected, and their respective drinking water guidelines, before and after January 1989:

Table 1: Groundwater Contaminants in Private Wells downgradient of Brookhaven Landfill

Volatile Organic Compound	*Detected Range in mcg/L (# wells above detection limit)*			*Drinking Water Guideline mcg/L*	
	1986-1987	*1991*	*1996*	*Pre Jan 1989*	*Jan 1989*
vinyl chloride	3 - 13 (4)			5	2
1,1-dichloroethane	7 - 28 (5)	6 - 17 (2)		50	5
1,1,1-trichloroethane	6 - 12 (7)			50	5
cis-1,2-dichloroethene	6 - 15 (5)	8 (1)		50	5
Dichlorodifluoromethane		6 (1)		50	5
Trichloroethene			7 (1)	50	5

The source of the VOC contamination was not determined. However, the landfill is a potential source because the contaminated wells are hydraulically downgradient of the landfill.

Air Contamination

Incinerator Ash

The town accepts incinerator ash at the landfill and area residents expressed concerns that they have been exposed to contaminants by breathing airborne incinerator ash dust and that dust control measures are not always properly implemented. The town of Brookhaven takes measures, including wetting incinerator ash before delivery and delivering it to the site in covered trucks, to minimize the potential for the ash to become airborne. Water trucks are on-site to wet the active disposal cell as needed. Cover is placed over areas that will not be used for disposal of fresh ash within 24 hours. Consultants hired by the town of Brookhaven measured dust concentrations in a 1993 ambient air study (Environmental Health Associates, 1993). The town of Brookhaven was required to conduct additional air monitoring before NYS DEC would issue an operating permit for Cell 5. The results of all air monitoring sampling events are discussed in the Air Monitoring section below.

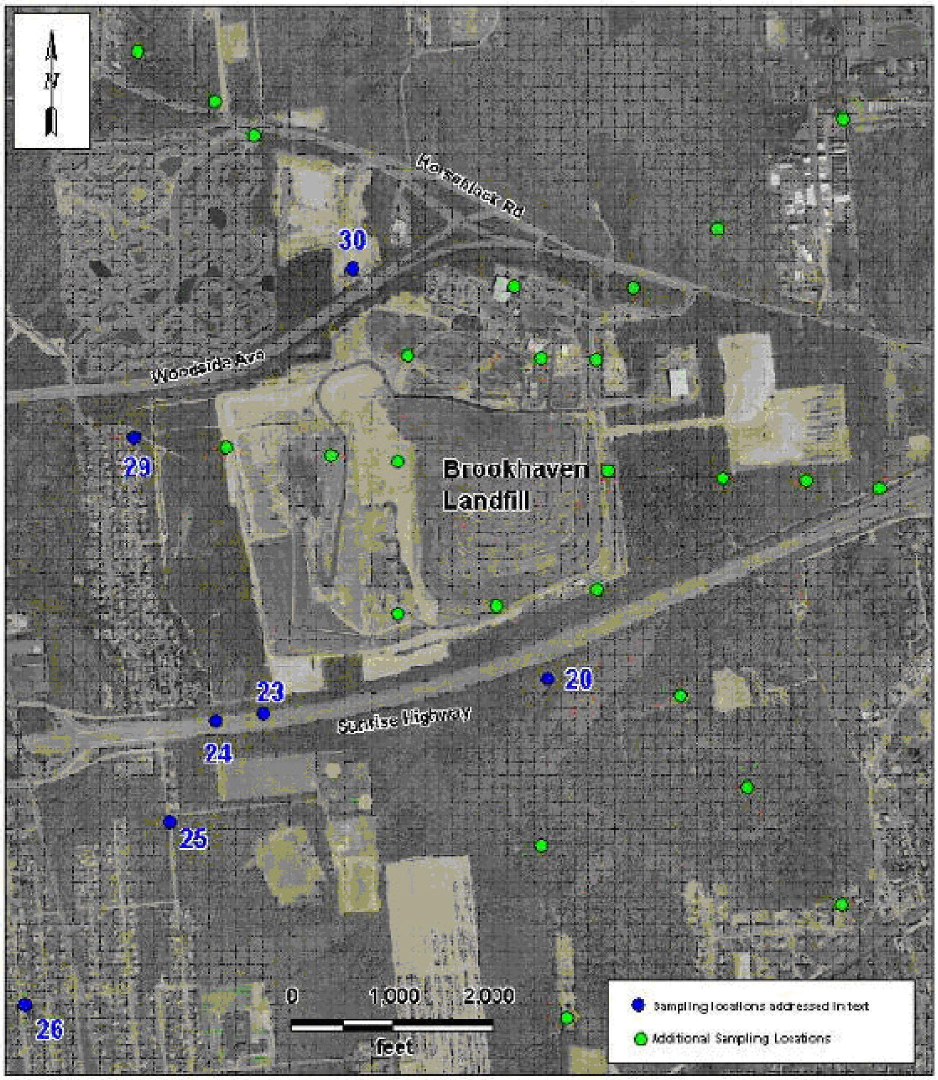
Air Monitoring

The number of odor complaints has decreased since the beginning of 1993 when the town began an odor reduction program. The town installed additional gas recovery wells, placed additional cover at the site, and installed higher capacity generators that burn methane and a gas flare. The interim flare operated from March 1993 until 1995 when the permanent flare was installed. The odors about which citizens have expressed concern, could be caused by general landfill gas or hydrogen sulfide in the ambient air, which is discussed in detail below.

1) NYS DEC Hydrogen Sulfide Sampling (January 1992 to April 1993)

On 110 occasions during 1992 and 1993, the NYS DEC sampled hydrogen sulfide (H_2S), a common landfill gas, in air at and around the Brookhaven Landfill site. A square grid was established radiating out from the landfill's center to approximately 4,800 feet downwind (see Figure 1 below) at and near the Horizon Village Complex (29) and the Hampton Ave School (25, 26). The wind direction, temperature, and barometric pressure were recorded on each sample date. Two or three locations were sampled upwind on each collection date. These served as an unaffected or baseline measure of H_2S in the air. Between 8 and 10 downwind locations were also sampled on each day. Three instantaneous readings (Jerome® meter) were collected and averaged at each location. Any downwind reading (average) that was 10 parts per billion (ppb) or greater than the upwind/baseline average was thought to be impacted by the landfill and considered to be an "elevated sample." Of the roughly 900 downwind samples (approximately 8 collections per day on 110 days) there were only 20 downwind "elevated samples". Air samples collected along Sunrise Highway (sites 20, 23, 24) but not in residential areas had the most elevated levels of H_2S. A sample set (site 30) collected along Woodside Ave, 1,000 feet west of Horseblock Rd. had one elevated sample (10.1 ppb above upwind average). The highest H_2S samples collected in the upwind and downwind air, were 5.5 ppb and 29 ppb respectively. Residences and the school downwind from the landfill (sites 25, 26, 29) had no elevated readings.

Figure 1. 1992-1993 NYS DEC Hydrogen Sulfide Sampling Locations


N
Horseblock Rd
Woodside Ave
Brookhaven
Landfill
Sunrise Highway
30
29
23
24
20
25
26
0
1,000
2,000
feet
Sampling locations addressed in text
Additional Sampling Locations

2) 1993 24-Hour Ambient Air Study

Consultants (Environmental Health Associates) hired by the town of Brookhaven sampled ambient air near the landfill on September 30, 1993 as part of the preparation for a draft environmental impact study. Air samples were collected in the breathing zone for 24 hours from five locations surrounding the landfill and from the flare (BLAA-06) operating at the landfill (Appendix A, Figure 2). A sample (BLAA-01) was collected 1000 feet upwind to the northeast of the landfill at the landfill office. Samples were collected at the Hampton Avenue School (BLAA-02), 5,600 feet southwest and downwind of the landfill, and at Horizon Village (BLAA-03), about 900 feet west of Cell 5, because these locations are of particular interest to the community. Two locations 450 feet (BLAA-04) and 800 feet (BLAA-05) southwest and downwind of the main landfill were also sampled. The air samples were analyzed for 43 volatile organic compounds (VOCs), hydrogen sulfide, and total particulate matter (total dust), including eight metals associated with incinerator ash. The following table shows the September 30, 1993 sample results for volatile organic compounds and metals that were present above the detection limit at the Hampton Avenue School (BLAA-02) and the Horizon Village (BLAA-03), which were the two off-site (downwind) locations of interest. Also included in the table are typical outdoor background ranges and health-based comparison values for short-term exposure. Complete sampling results at all sampling locations for metals and VOC's are included in Tables 2 & 3, respectively, in Appendix C.

Table 2. Brookhaven Landfill Off-Site Ambient Air Sampling Data from the September 30, 1993 24-Hour Ambient Air Study (All values in micrograms per cubic meter [mcg/m^3])[1]

Chemical	BLAA-02 (Hampton Ave School)	BLAA-03 (Horizon Village)	Typical Background Range[2]	Short-term Comparison Values	
				ATSDR MRL[3]	Cal EPA REL[4]
Acetone	68	120	15.4 – 31.7	61,762	NA
Benzene	1.2	0.7	1.2 – 3.7	160	1,300
2-butanone	17	17	2.2 – 5.7	NA	13,000
Toluene	3.5	3.8	5.6 – 16.3	3,769	37,000
Cadmium	0.001	ND	<0.001 (rural) 0.003 – 0.04 (urban)	NA	NA
Chromium (total)	0.007	0.0019	<0.01 (rural) 0.01 – 0.03 (urban)	NA	NA
Mercury	0.0001	ND	0.01 – 0.02	NA	1.8
Nickel	0.01	0.0029	0.006 – 0.02	NA	6
Vanadium	0.0045	0.002	<0.001 – 0.064 (rural) 0.15 – 1.4 (urban)	0.2	NA

[1]The presented data are for detected volatile organic compounds (VOCs) and metals (see text for discussion of lead and particulates). Data for all chemicals and locations included in the 1993 24-hour sampling are found in the

Appendix. A, Tables 2 & 3.
[2]The background ranges for the detected VOCs represent the 25^{th} and 75^{th} percentile air levels from a US EPA background VOC study. From 1994 through 1996, US EPA measured VOCs in indoor and outdoor air at 100 randomly selected public and private office buildings across the United States. The background ranges for the five metals were obtained from their ATSDR Toxicological Profiles (ATSDR 1999b, 2000, 1999a, 1998, 1993).
[3]ATSDR MRL: Minimum Risk Level; short-term (0-14 days) health comparison value derived by ATSDR. MRLs are based on non-cancer health effects only.
[4]Cal EPA REL: California Environmental Protection Agency's Acute (less than 24 hours) Reference Exposure Levels.
NA – Not available
D – Not detected

Volatile Organic Compounds (September 30, 1993)

Four volatile organic compounds (acetone, benzene, 2-butanone and toluene) were detected at both the Hampton Avenue School (BLAA-02) and the Horizon Village (BLAA-03). The remaining 39 volatile organic compounds that were tested for were not detected at these locations. The detected levels of benzene and toluene are below or within typical outdoor background ranges for these contaminants (Hadwen et al. 1997). Acetone and 2-butanone (also known as methyl ethyl ketone) were detected above the typical background range at both locations, but the levels do not exceed their short-term health-based comparison values, which are levels in air that are expected to be without appreciable risks for noncancer health effects for short-term exposure (Table 2).

Metals (September 30, 1993)

Cadmium, chromium, mercury, nickel and vanadium were detected at one or both of the off-site locations (Table 2). None of the detected levels exceeded typical outdoor background levels. Lead was detected at 0.012 micrograms per cubic meter (mcg/m^3) at both the Hampton Avenue School and Horizon Village. The detected level does not exceed the National Ambient Air Quality Standard for lead of 1.5 mcg/m^3, assuming that the levels are representative of a quarterly average, which is the averaging time of the standard (ATSDR 1999c).

Total Particulate Matter (September 30, 1993)

Samples collected at Horizon Village and the Hampton Avenue School had total particulate concentrations (i.e., particulate matter 10 micrometers or less in diameter (PM_{10})) of 56.0 mcg/m^3 and 45.0 mcg/m^3, respectively. Both of these measurements were lower than the 24 – hour National Ambient Air Quality Standard of 150 mcg/m^3 for PM_{10} (US EPA 2004).

Hydrogen Sulfide (September 30, 1993)

Forty-four instantaneous air samples were taken during the 24-hour ambient air study on September 30, 1993, and were analyzed for hydrogen sulfide. Thirty-four of these samples (77%) showed non-detectable concentrations, nine had levels of 3 mcg/m^3 (2 ppb) or less, and one contained 6 mcg/m^3 (4 ppb) hydrogen sulfide. These concentrations are all lower than the New York State Ambient Air Quality Standard of 14 mcg/m^3 (10 ppb), and also do not exceed the available short-term health comparison values for hydrogen sulfide of 42 mcg/m^3 and 97 mcg/m^3 established by the California Environmental Protection Agency (Cal EPA, 1999) and ATSDR (ATSDR, 1999d), respectively. This comparison assumes that the instantaneous air concentrations are representative of the average concentrations over the time period on which the standards (one hour) and comparison values (one hour and up to 14 days for the Cal EPA and ATSDR values, respectively) are based.

3) 1996 – 1999 Air Sampling for VOCs, Methane, Particulates, Lead and Hydrogen Sulfide

Off-site monitoring for volatile organic compounds (VOCs), methane, total suspended particulates (TSP), PM_{10} and hydrogen sulfide was conducted by RTP Environmental Associates on a 12-day schedule at locations along the boundary of the landfill (RTP Environmental Associates, 1997-1999). The monitoring locations are shown in Appendix A, Figure 2. Table 3 below summarizes the sampling events during this period.

Table 3 - Air Monitoring Near the Brookhaven Landfill, 1996 - 1998.

Contaminant	Dates of Air Monitoring	Location of Monitors	Sampling Schedule
TSP, PM_{10}, lead	September 30, 1996 to March 24, 1998	Western boundary of landfill, east of Horizon Village; Southern boundary of landfill, in area of maximum predicted TSP impact (RTP Env. Assoc. (1997-98))	24 hour samples (midnight to midnight), every 12th day
VOCs, methane	September 1, 1997 to December 20, 1999	Western boundary of landfill, east of Horizon Village	24 hour samples (midnight to midnight), every 12th day
hydrogen sulfide	August 8, 1997 to December 20, 1999	Western boundary of landfill, east of Horizon Village; Southern boundary of landfill, in area of maximum predicted TSP impact (RTP Env. Assoc. (1997-99))	3 rounds of instantaneous samples taken at morning, noon, and mid-afternoon (9 total samples per day), every 12th day*

*One-hour bag samples were taken on days the instantaneous samples exceeded the State's hydrogen sulfide standard.

Total Suspended Particulates (TSP), Particulate Matter (PM_{10}) and Lead (1996 – 1998)

The primary purpose for measuring TSP and PM_{10} at the landfill border was to evaluate dust-control measures that had been initiated on-site. None of the measured levels of PM_{10} taken every 12th day for almost 18 months exceeded the 24-hour National Ambient Air Quality Standard for particulates greater than 10 microns (150 mcg/m^3) at either sampling location. For TSP, the measured levels slightly exceeded the State's 24-hour standard for total suspended particulates (250 mcg/m^3) on only one day (February 4, 1998). These measurements (289 mcg/m^3 and 264 mcg/m^3), were taken by two systems at the same southern location on a day when (according to the consultant's report) strong northeasterly winds prevailed during the test period and the trucks that are used to water the road near Cell 5 and suppress the on-site dust were not in operation. This single day of exceedance of the TSP standard is not indicative of long-term dust levels. The overall TSP and PM_{10} data suggest that the dust control measures have been largely effective in reducing residential exposure to dust generated from the landfill since regular sampling in the residential areas over 18 months indicates that under typical conditions, the standards for particulates are being met.

The maximum 24-hour average lead concentrations for the two systems at the southern location were 0.15 mcg/m^3 and 0.14 mcg/m^3. The maximum 24-hour average lead concentration at the western location was 0.02 mcg/m^3. The highest 24-hour average measured during the 18-month monitoring period was approximately ten times below the National Ambient Air Quality Standard for lead (1.5 mcg/m^3, as a quarterly average).

VOCs and Methane (1997 – 1999)

Seventy one samples, each averaged over 24 hours, were taken every 12th day from September 1, 1997 to December 20, 1999 at the western boundary of the landfill (Appendix A, Figure 2) and analyzed for volatile organic compounds (VOCs) and methane. Table 4 below, shows the average of the 24-hour samples compared to available typical outdoor background ranges for each chemical. When the chemical was not detected, we assumed that it was present at one-half of the analytical detection limit (the lowest concentration of a chemical that can reliably be distinguished from a zero concentration).

None of the averaged 24-hour values exceeded the typical outdoor background ranges. For some chemicals, information on typical background levels was not available. For those chemicals lacking background ranges, the average of the 24-hour samples were compared to available public health assessment inhalation comparison values for noncancer and cancer effects. The public health comparison values represent a long-term exposure level in air that is unlikely to result in cancer or noncancer health effects. None of the chemicals for which background data were unavailable exceeded their health-based comparison values, except acrolein. In the analysis of these samples, acrolein was designated as a tentatively identified compound, meaning that it was thought to be present even though it was not one of the targeted chemicals for the particular analytical method used. The estimated levels of acrolein were at the lower limits of detection for the analytical instrument, but they also exceeded its health comparison value for noncancer effects. Thus acrolein is selected for further discussion (see Discussion).

Table 4. Brookhaven Landfill Ambient Air Sampling Data from the 1997-1999 Study of Volatile Organic Compounds in Ambient Air (All values in micrograms per cubic meter [mcg/m^3])

Compound	Average[1]	Background Range[2]
Acetaldehyde	1.70	1.6 - 4.2
Acetone	9.30	15.4 - 31.7
Acrolein	0.55	NA
Benzaldehyde	0.21	NA
Benzene	2.14	1.2 - 3.7
Bromodichloromethane	0.075	<0.6 - <10
Bromoform	0.125	<1 - <10
Bromomethane	0.115	<0.8 - <1
Butanal	0.01	NA
Butane	4.83	NA
t-butanol	0.17	NA
2-butanone	1.34	2.2 - 5.7
Camphor	0.04	NA
Carbon disulfide	0.43	<0.8 - 2.2
Carbon tetrachloride	0.68	<0.8 - 1.0
Carbonyl sulfide	0.01	NA
Chlorobenzene	0.39	<0.6 - <0.8
Chloroethane	0.12	<0.8 - <1
Chloroform	0.12	<0.4 - <0.6
Chloromethane	1.91	2 - 3
o-chlorotoluene	0.08	NA
Cumene	0.135	<10
Decane	0.01	NA
Dibromochloromethane	0.165	<0.5 - <10
1,2-dibromoethane	0.17	<1.2 - <1.4
1,2-dichlorobenzene	0.115	<0.8 - <1
1,3-dichlorobenzene	0.11	<1.5 - <8
1,4-dichlorobenzene	0.118	<1.5 - <6
Dichlorodifluoromethane	2.03	3.8 - 5.8
1,1-dichloroethane	0.06	<0.4 - <0.6
1,2-dichloroethane	0.075	<0.6
1,1-dichloroethene	0.14	<1 - <1.2
cis-1,2-dichloroethene	0.125	<0.8 - <1.2
trans-1,2-dichloroethene	0.105	<7 - <10
1,2-dichloropropane	0.2	<1.2 - <1.6
1,3-dichloropropane, cis & trans isomers	0.405	NA
Dichlorotoluene	0.28	NA
Dimethyl disulfide	0.534	<2 - <2.8
Ethanol	30.44	13 - 47
2-ethyl-1-hexanal	0.10	NA
2-ethyl-1-hexanol	7.25	NA
Ethylbenzene	0.439	<1.4 - 1.6
2-ethylhexanal	0.06	NA
3-heptanone	0.13	NA
Hexamethylcyclo- trisiloxane	2.18	NA
2-hexanone	0.145	NA
Isobutane	1.11	NA
Isopentane	0.77	NA
Isopropanol	0.03	NA
Isopropyl alcohol	0.35	NA
Methane	4.04	1,050 - 1,410
2-methyl-1,3-butadiene	1.68	NA
4-methyl-2-pentanone	0.173	NA
Methyl tert-butyl ether	2.662	<1.4 - <5.4
2-methylbutane	9.39	NA
Methylene chloride	0.707	<1.8 - 3.0
2-methylpentane	0.30	NA
b-myrcene	0.10	NA
Octamethylcyclo- tetrasiloxane	0.15	NA
Pentane	1.45	NA
a-pinene	0.66	<1 - <1.4
b-pinene	1.06	NA
Propane	0.17	NA
Propene	0.56	NA
Sabinene	0.10	NA
Styrene	0.223	<1.4 - <2.0
sulfur dioxide	0.42	NA
1,1,2,2-tetrachloroethane	0.1	<1 - <7
Tetrachloroethene	0.82	<1.4 - 3.0
Toluene	5.19	5.9 - 16.3
1,1,1-trichloroethane	0.44	<0.6 - 1.7
1,1,2-trichloroethane	0.185	<1 - <1.4
Trichloroethene	0.18	<1 - <1.6
Trichlorofluoromethane	2.72	<2.8
Trichlorotrifluoroethane	0.77	<1.6 - <2.0
Tridecane	0.14	NA
Trimethylbenzene isomers (total)	0.83	<1 - <10
vinyl acetone	0.135	NA
vinyl chloride	0.115	<0.8 - <1
Xylenes (total)	2.04	3.6 - 7.3

[1]Arithmetic average of 71 samples where non-detected values were estimated to be one-half the value of the detection limit (if available) for the specific chemical.

[2]The listed background range represents the 25th and 75th percentile air levels for the individual chemical obtained from either a US EPA or NYSDOH background volatile organic compound (VOC) study. From 1994 through 1996, US EPA measured VOCs in indoor and outdoor air at 100 randomly selected public and private office buildings across the US. From 1989 through 1996, the NYSDOH sampled indoor and outdoor air at 53 residences across New York State that were expected to contain levels of VOCs typically found in homes.

NA – Not Available

Hydrogen Sulfide (1997-1999)

Instantaneous samples measuring hydrogen sulfide were taken at the western and southern boundaries of the landfill in areas that were intended to be reasonably representative of residential exposure (Appendix A, Figure 2). The samples were taken every 12th day from August 8, 1997 to December 20, 1999. Nine instantaneous samples were taken on each designated sampling day (three in the morning, at noon, and in the afternoon). If the average of any of the morning, noon, or afternoon rounds exceeded the one-hour New York State standard for hydrogen sulfide (14 mcg/m^3 or 10 ppb), a one-hour bag sample was taken so that the results could be directly compared to the one-hour standard.

Overall, the hydrogen sulfide levels at the southern location were higher than levels at the western location. The average of all the instantaneous samples at the southern location was 8.4 mcg/m^3 (6 ppb), while at the western location, which is just east of the Horizon Village, the average of all the instantaneous samples was 4.2 mcg/m^3 (3 ppb). On 12 of the 73 sampling dates (16%) at the southern location, the average of either the morning, noon or afternoon round of instantaneous samples exceeded the one-hour hydrogen sulfide standard (14 mcg/m^3 or 10 ppb). The one-hour bag samples at this location ranged from 4.2 mcg/m^3 to 70 mcg/m^3 (3 ppb to 50 ppb) and the average level was 25 mcg/m^3 (18 ppb). At the western location, the average of either the morning, noon or afternoon rounds of instantaneous samples exceeded the one-hour hydrogen sulfide standard on only one of the 73 sampling dates. The one-hour bag sample taken on this date (June 23, 1999) showed hydrogen sulfide at a level of 8.4 mcg/m^3 (6 ppb), which did not exceed the one-hour standard of 14 mcg/m^3 (10 ppb). Since the hydrogen sulfide standard was exceeded in several of the one-hour samples taken at the southern location, this contaminant is further discussed (see Discussion).

Exposure Pathways

Overview

The health consultation identifies potential and completed exposure pathways associated with past, present, and future use of the site. Exposures to contaminants in air and groundwater, which have migrated off-site of the landfill, are the exposure pathways evaluated for this health consultation. The landfill is a known past source of air contamination. It was never determined whether the landfill was the source of the volatile organic compounds detected in private wells, although the landfill leachate is known to have affected groundwater quality in the area. Public access to the landfill is restricted by a fence and by security personnel. Therefore, the potential for the public to have direct contact to contaminants in on-site air, water, and soils is limited.

Introduction to Pathways Analysis

An exposure pathway consists of five elements: a source of contamination, a transport mechanism, a point of exposure, a route of exposure, and a receptor population. All five of these elements must be present for an exposure to a contaminant to occur.

The source of contamination is the origin of the release to the environment (any waste disposal area or point of discharge); if the original source is unknown, it is the environmental media (soil, air, biota, water), which are contaminated at the point of exposure, that is considered to be the source. Environmental media and transport mechanisms "carry" contaminants from the source to points where human exposure may occur. The exposure point is a location where actual or potential human contact with a contaminated medium may occur. The route of exposure is the manner in which a contaminant actually enters or contacts the body (i.e., ingestion, inhalation, and dermal absorption). The receptor population is the person or people who are exposed or may be exposed to contaminants at a point of exposure.

Human exposure in this document is classified as either a completed or potential exposure pathway. A completed exposure pathway exists when the criteria for all five elements of an exposure pathway are documented. A potential exposure pathway exists when the criteria for any one of the five elements comprising an exposure pathway is not met, but has the potential to be met. An exposure pathway is considered to be eliminated when any one of the five elements comprising an exposure pathway has not existed in the past, does not exist in the present, or will never exist in the future.

Groundwater Exposure Pathways

1. Completed Groundwater Exposure Pathways

The groundwater exposure pathways of concern are the ingestion, inhalation, and dermal absorption of VOCs through the use of contaminated private wells. Six volatile organic compounds have been identified in private wells in the area of the Brookhaven Landfill site (Table 1). A groundwater plume downgradient of the landfill was identified around 1982 and VOCs in private wells were first detected in 1986. Use of the contaminated private wells probably resulted in residents ingesting low levels of VOCs in the past. Water main installation began in 1983 and residents were responsible for hooking up to the public water and discontinuing use of their private wells. The data are insufficient to accurately define how long exposures occurred, although any exposures due to the landfill started sometime after the landfill opened in 1974, and ended when each resident connected to the public water supply.

2. Potential Groundwater Related Exposure Pathways

The Suffolk County Department of Health Services and NYS DOH have ensured that public water is available to all residences that have wells potentially contaminated by VOCs. A small potential still exists for present and future exposures to VOCs via contaminated groundwater, if private wells are used. The landfill-related contamination in groundwater has decreased due to remedial measures (e.g. leachate control) being implemented at the landfill.

Air Related Exposure Pathways

1. Completed Air Related Exposure Pathway

Ambient air was monitored for VOCs, methane, and hydrogen sulfide on several occasions between 1992 and 1999. Measurements of hydrogen sulfide monitored during 1992-1993, during a 24-hour ambient air study in September 1993, and during routine monitoring from 1996-1999 indicates that hydrogen sulfide in ambient air was generally less than the one-hour ambient air standard, 14 mcg/m^3 (10 ppb), but nearby residents were exposed intermittently to low levels (less than 25 ppb) of hydrogen sulfide. Based on odor concerns, these exposures began in 1992 and were not continuous during 1992-1993. Remedial activities in 1993 have decreased the frequency of odor complaints, although sampling indicates H_2S may still be elevated in ambient air occasionally.

Acrolein was the only VOC detected in off-site ambient air samples, collected from 1997-1999, at levels above background or health-based comparison values. Exposure to low levels has occurred intermittently for an unknown amount of time, perhaps as early as 1992 when odor complaints from H_2S began.

2. Potential Air Related Exposure Pathway

Although soil vapor intrusion from landfill-related contamination is not expected, the low-level VOC contamination that has affected private wells should be evaluated for possible soil vapor-intrusion concerns. This will be accomplished through the existing NYS DEC policy on evaluation of possible soil vapor intrusion at legacy sites.

Given landfill operations there is still a chance for exposure to H_2S, VOCs, or particulate matter in air. The potential for exposure should be minimal as long as Brookhaven landfill continues proper operation of remedial measures including flares to burn landfill gases, and wetting of ash on-site.

F. Health Outcome Data

NYS DOH maintains several health outcome databases, which can be used to generate site-specific data, when appropriate. These databases include the Cancer Registry, the Congenital Malformations Registry, the Heavy Metals Registry, vital records (birth and death certificates), and hospital discharge information.

NYS DOH staff were asked by the South Central School District to assess ongoing health problems at the school. Since the health symptoms reported by staff and students (e.g., headache, eye irritation, and nausea) are common and have many causes, a record-keeping system was developed to try to relate the symptoms to odors from the landfill. Several logs were developed for use by school personnel to record odors from the landfill, absenteeism, visits to the nurse's office, visits to the nurse for use of asthma medication, and health complaints from staff. Health symptom logs were kept for two periods, one in the winter and one in the spring, to try to minimize the effects of winter viral infections. The logs were kept from January 18 to February 10, 1994, and from April 11 to May 6, 1994.

The presence of odors was reported more frequently during the winter period than during the spring period. Overall for the winter and spring periods, the presence of odors was not consistently associated with higher numbers of daily visits to the nurse's office for complaints of illness or irritation, or for asthma medication. In summary, the records kept by the nursing staff during two periods in 1994 did not show a pattern of increased health symptoms on days when an odor from the Brookhaven Landfill was recorded. It should be noted, however, that by 1994 the odors from the landfill had decreased because of the odor reduction plan implemented at the landfill in 1993. Persons interested in obtaining a copy of the Summary of Evaluation of Records Kept by Nursing Staff at the Frank P. Long Elementary School (NYS DOH 2005a) may contact the NYS DOH at 1-800-458-1158, extension 27950.

NYS DOH also conducted a study of cancer incidence for the area near the Brookhaven Landfill. The study examined data from the New York State Department of Health Cancer Registry for the years 1982-1996 and included census tracts 1591.06, 1591.03, 1592.03, 1592.04, and 1593.00 in the town of Brookhaven. The number of cases of cancer observed in the study area was compared to the number of cases that would be expected in similar areas in the state, accounting for population size, age and sex distribution, and population density. Comparison of observed and expected cases was performed for all cancers combined and for individual cancer sites. Results of the cancer incidence study found that overall the numbers of cancers diagnosed during the years 1983-1992 among males, females, children and young adults were not statistically significantly different from the numbers expected. No specific cancer site exhibited a statistically significant excess or deficit in numbers of cases observed compared with the numbers expected.

Calculations of observed and expected numbers of cancer cases in the area surrounding the Brookhaven Landfill were also updated through the year 1996. In the later period, 1993-1996, the actual numbers of total cancers among males and females, children and young adults were not significantly different from the numbers expected. Among specific cancer sites, bladder cancer and malignant melanoma of the skin among males and uterine cancer among females exhibited significant excesses in numbers of cases observed compared with the numbers expected. No other individual cancer site among males or females showed a statistically significant difference from the expected number of cases. Additional review of male bladder and female uterine cancers showed no obvious clustering near the landfill.

When the combined time period (1983-1996) was examined, a statistically significant excess in total cancers was found among females. The excess in total number of female cancer cases is accounted for by a statistically significant excess in uterine cancer, as well as nonsignificant excesses in cancers of the lung and breast. In the later time period (1993-1996) and the combined time period (1983-1996), the uterine cancers were generally diagnosed among women 45 years of age and older, as would be expected. Uterine cancer has no known environmental risk factors. All known risk factors for uterine cancer are related to individual characteristics or lifestyle choices, including never having given birth or having few children, late age at menopause, obesity, use of hormone replacement therapy without progesterone during and after menopause, and possibly dietary factors. Persons interested in obtaining a copy of the Cancer Incidence Near the Brookhaven Landfill report (NYS DOH 2005b) may contact the NYS DOH at 1-800-458-1158, extension 27950.

G. Community Health Concerns and Current Issues

Area residents expressed health concerns about exposure to air and water contaminants. They voiced their concerns about the effects of the existing landfill and the proposed expansion at the November 10, 1992 Draft Environmental Impact Statement Public Hearing on the Brookhaven Landfill Expansion (Wehran-NY, 1992a,b,c). The town responded to the oral comments made at the hearing and also to written comments in the Final Environmental Impact Statement for the town of Brookhaven Landfill Expansion, August 1993 (Wehran-NY, 1993). In November 1993, a representative of ATSDR met with the petitioner of this public health consultation, representing the South Sungate Homeowners Association, and other members of the community to discuss their concerns.

Water Quality Issues

Community water quality concerns focus on whether the landfill has affected the drinking water. Members of the community have been concerned in the past that private potable wells south of Sunrise Highway were active, (Appendix A, Figure 1) despite the availability of public drinking water. A private well survey was conducted in 1996 and only one contaminated well was identified (see "Groundwater Contamination" section).

The town of Brookhaven has taken remedial measures to prevent further contamination of the groundwater from landfill leachate. Initially, the landfill was lined but there was no disposal system for the leachate. Today, each cell is lined and has its own leachate collection system. Cell 1 has a single layer liner of PVC. Cell 2 is double lined with PVC overlain by chlorinated polyethylene (CPE). Cell 3 is lined with a high-density polyethylene (HDPE) and with a PVC liner. Cell 4 has three liners: a polyvinyl chloride (PVC) underliner and two high density polyethylene (HDPE) overliners. Cells 5 and 6 have a double composite liner.

The leachate collects on the liner and drains into leachate manholes. When the levels are high, pumps become activated and transfer the leachate to on-site storage tanks. Tank trucks then transport the leachate to the Suffolk County sewage treatment plant at Bergen Point, Babylon, New York for disposal.

Air Quality Issues

A resident in a neighborhood near the landfill conducted an informal survey of health concerns. Many residents expressed concern that they had experienced headaches, allergies, asthma, respiratory infections, rashes, ear infections, and sinus problems. The residents expressed concern that the town was composting yard waste at the site and that *Aspergillus fumigatus*, a fungus commonly found in compost, was causing these health problems. The town of Brookhaven Landfill is not a licensed composting facility. However, at the time of the survey, it was a leaf transfer facility, and the transfer of leaves was a registered activity. Leaves were brought to the site and temporarily stored there for the maximum time allowed by law, up to one week. Leaf stockpiles of less than 3,000 cubic yards are exempt from composting regulations. NYS DEC monitored the site to ensure that the leaves were removed within one week and that the stockpiles did not exceed the 3,000 cubic yard limit. NYS DEC could take appropriate action if nuisance conditions, such as off-site odors, were caused by this operation.

NYS DEC reported that the town completed leaf transfer operations during 1993 without any significant problems or complaints. However, NYS DOH found the documentation of the leaf transfer activities to be unclear. Therefore, NYS DOH and NYS DEC conducted a more thorough investigation of the leaf transfer activities in late 1994. NYS DEC officials inspected the town of Brookhaven Landfill site in November 1994 and determined that the leaf stockpiles were in excess of the 3,000 cubic yard exemption limit. To alleviate this problem the town was asked to transfer the excess leaves to the permitted Manorville Compost Facility. The town stopped accepting leaves and grass at the landfill.

The town also chips wood at the site and therefore stores trees and wood chips at the site. Again, NYS DEC takes appropriate action if nuisance conditions, such as odors, occur off-site. The town employs the wood chipping operation to reduce landfilling of recyclable material and uses the wood chips for municipal landscape projects. After the November 1994 NYS DEC inspection, the town agreed to minimize potential storage problems, such as odors or fires, by reducing the pile size from one large pile to several smaller piles.

The area residents have also expressed concerns about gaseous emissions and odors from the landfill. In November 1992, staff members of the Hampton Avenue School conducted an informal survey of the teachers and parents of children attending this school. During this time period, teachers and students reported intermittent odor problems and the following health problems: headaches, eye irritation, allergies, asthma, and nausea.

DISCUSSION

A. Description of the Evaluation of Health Risks

To evaluate the potential health risks from contaminants of concern associated with the Brookhaven Landfill site, the NYS DOH has assessed the risks for cancer and noncancer health effects. The risk for health effects is related to contaminant concentration, exposure pathway, exposure frequency, and duration (discussed in depth in the environmental pathways and exposure pathways sections). For additional information on how the NYS DOH uses these parameters to determine and qualify health risks, refer to Appendix C.

B. Exposures to Volatile Organic Chemicals (VOCs) in Drinking Water

Exposures to contaminants in drinking water supplies can occur via ingestion, dermal contact, and/or inhalation from water uses such as showering, bathing, or other household activities. Although exposure varies depending on an individual's lifestyle, each of these exposure routes can contribute to the overall daily intake of contaminants and may potentially increase the risk for long-term health effects. Accordingly, for the purpose of estimating potential exposures, the NYS DOH doubled the concentration of chlorinated VOCs detected in the drinking water to account for possible additional exposure via inhalation and dermal routes.

<u>Past Ingestion, Dermal Contact, and Inhalation Exposure</u>

For an undetermined period of time, private residential water supply wells downgradient of the Brookhaven Landfill site have been contaminated with chlorinated VOCs. The landfill was never demonstrated to be the source of the VOCs. However, if the landfill is the source of VOC contamination in groundwater, it could have occurred as early as 1974, when the landfill opened, until the use of contaminated wells stopped (i.e. residents connected to public drinking water). Testing of private wells began in 1986. Before that time, contaminant levels in the private wells are not known. The highest levels of vinyl chloride, 1,1-dichloroethane, 1,1,1-trichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, and trichloroethene, to which private well users are known to have been exposed, exceed the NYS public drinking water standards and/or public health comparison values (Table 1). Therefore, these chemicals have been selected for further evaluation.

Several studies of workers exposed to elevated levels of vinyl chloride in air reported an increased risk for angiosarcoma, a relatively rare type of liver cancer (ATSDR, 2004b). Other human cancers associated with vinyl chloride exposure include cancer of the brain, central nervous system, lung, respiratory tract, and lymphatic and hematopoietic systems.

Based on the increased risk for liver angiosarcomas found among vinyl chloride workers, vinyl chloride is considered a known human carcinogen (ATSDR, 2004b). Vinyl chloride was found in four private wells with concentrations ranging from 3 mcg/L to 13 mcg/L. Only one well contained 13 mcg/L. People exposed to vinyl chloride in drinking water, over a period of up to 30 years, at the highest level detected (13 mcg/L) are estimated to have a moderately increased risk of developing cancer.

Some studies of people exposed for long periods of time to high levels of trichloroethene in workplace air, or elevated levels of trichloroethene in drinking water, show an association between exposure to trichloroethene and increased risks for certain types of cancer, including cancers of the kidney, liver and esophagus, and non-Hodgkin's lymphoma. Since all of these studies have limitations, and we do not know if the cancers observed in these studies are due to trichloroethene or other factors, they only suggest, but do not prove, that exposure to trichloroethene can cause cancer in humans. Trichloroethene causes cancer in laboratory animals exposed to high levels over their lifetimes (ATSDR, 1997). 1,1-Dichloroethane also causes cancer in animals exposed to high levels over their lifetimes (ATSDR, 1990a). Chemicals that cause cancer in laboratory animals after high levels of exposure may also increase the risk for cancer in humans who are exposed to lower levels over long periods of time.

Whether 1,1-dichloroethane causes cancer in humans is not known. The increased cancer risks for people exposed for up to 30 years to the highest reported levels of 1,1-dichloroethane (28 mcg/L) and trichloroethene (7 mcg/L) are estimated to be low and very low respectively. The actual cancer risk for these chemicals in drinking water cannot be estimated because of the lack of information on past exposures. There are no sampling data prior to 1986 and the amount of time the contaminants have been present is unknown. Toxicological data are inadequate to assess the carcinogenic effects of 1,1,1-trichloroethane, cis-1,2-dichloroethene, and dichlorodifluoromethane (ATSDR 2004a, 1996; US EPA IRIS, 2004).

The six chlorinated VOCs (vinyl chloride, trichloroethene, 1-1-dichloroethene, *cis*-1,2-dichloroethene, dichlorodifluoromethane and 1,1,1-trichloroethane) detected in private drinking water wells near the Brookhaven Landfill site also produce a variety of noncarcinogenic effects, primarily to the liver, kidneys, and nervous system (ATSDR, 1990a, 1996, 1997, 2004a, 2004b). Chemicals that cause effects in humans and/or animals after high levels of exposure may also pose a risk to humans whom are exposed to lower levels over long periods of time. Although the risks of noncarcinogenic effects from past chronic exposures to the highest measured levels of these chlorinated VOCs in private drinking water supply wells are not completely understood, the existing data suggest that the risks are minimal.

C. Inhalation Exposures to Air Contaminants

Acrolein (1997 – 1999)

Exposure to acrolein at high concentrations can cause irritation of the eyes, nose, throat and lungs (ATSDR, 1990b). Information on the levels of acrolein we would typically expect to find in outdoor air are not available. Acrolein can be formed from the breakdown of many products in air. Small amounts of acrolein can be formed and enter the air when organic matter, such as trees and other plants, including tobacco, is burned and also when fuels, such as oil and gasoline are burned. Acrolein was detected in only 13 of the 71 samples (18%) taken at the western boundary of the landfill. The average of the 24-hour samples of acrolein (0.55 mcg/m^3) taken every 12th day exceeds the long term public health assessment comparison value of 0.02 mcg/m^3, which is a reference concentration derived by the US EPA (US EPA, 2005). The reference concentration is an air concentration for the chemical that is estimated to be without appreciable risk of adverse noncancer health effects during a lifetime. The average of the 24-hour samples is highly influenced by using one-half the method detection limit (0.5 mcg/m^3) for the samples in which acrolein was not detected. Using zero for the non-detect samples rather than one-half the detection limit, the average becomes 0.14 mcg/m^3. The actual average of the 24-hour samples is probably somewhere in the range of 0.14 mcg/m^3 to 0.55 mcg/m^3.

The US EPA reference concentration is based on mild microscopic changes in the nasal cells of rats exposed to elevated levels of acrolein for 13 weeks. The reference concentration is set 50 times lower than the analytical detection limit, and 1000 times lower than the level at which these health effects occurred in the animals (20 mcg/m^3). The average of the 24-hour samples detected at the western boundary of the landfill (depending on whether zero or one-half the detection limited is used) is about 40 to 140 times lower than the exposure level that causes mild changes in the nasal cells of rats.

Hydrogen Sulfide (1997-1999)

Hydrogen sulfide was detected 12 times on six separate days above the one-hour standard of 14 mcg/m^3 (10 ppb) at the southern boundary of the landfill when measured in one-hour bag samples. The basis of the hydrogen sulfide standard is the prevention of disagreeable odors. The highest of the one-hour bag samples, ranging from 52 mcg/m^3 to 70 mcg/m^3 (37 ppb to 50 ppb), were taken on April 5, 1998, while the town was in the process of installing a landfill gas collection system at Cell 5, which was completed before the end of April, 1998 (RTP Environmental Associates, 1997-1999). The next highest level from the one-hour bag samples was 39 mcg/m^3 (28 ppb) on September 8, 1998. The average of the one-hour bag samples at the southern location was 25 mcg/m^3 (18 ppb).

Hydrogen sulfide is a colorless gas with a rotten-egg odor. Some people can smell hydrogen sulfide at very low levels, as low as 0.7 mcg/m^3 (0.5 ppb) in air (NYS DOH, 1999). Short-term exposure to moderate amounts of hydrogen sulfide in the workplace produces eye, nose and throat irritation, nausea, dizziness, breathing difficulties, headaches, and loss of appetite and sleep. Continued exposure can irritate the respiratory passages and can lead to a buildup of fluid in the lungs. There is limited information on the effects of long-term exposure to low levels of hydrogen sulfide. People working in industries where hydrogen sulfide exposure is common, but is usually below the OSHA 8-hour standard (14, 000 mcg/m^3 or 10,000 ppb), may have decreased lung function, increased risk of spontaneous abortion, and impaired neurological functions (including reaction time, balance, color discrimination, short-term memory, and mood) compared to unexposed workers. People living near industries that emit hydrogen sulfide have an increased risk of eye irritation, cough, headache, nasal blockage, and impaired neurological function (same measures as above) compared to unexposed residents. Limited information is available about exposure levels in studies of people working in or living near industries emitting hydrogen sulfide. In these studies hydrogen sulfide exposure is assumed based on job title, work history, or living near facilities emitting hydrogen sulfide. In all cases, the people with presumed hydrogen sulfide exposure had or likely had exposures to other chemicals that could have contributed to some of the health effects.

Overall, the data from the instantaneous hydrogen sulfide sampling (taken every 12th day) suggest the levels at the western and southern boundaries of the landfill are generally low, and generally below the one-hour hydrogen sulfide standard. Hydrogen sulfide in the instantaneous samples was detected at levels exceeding the one hour standard infrequently (1% and 16% of the sampling days for the western and southern location, respectively). The available data on hydrogen sulfide levels at the western and southern locations are limited for estimating long-term exposure levels and potential health risks. The average and median of all the instantaneous hydrogen sulfide samples (nine samples taken every 12th day for over 2 years) at the southern location were 8.4 mcg/m^3 (6 ppb) and 5.6 mcg/m^3 (4 ppb), respectively. The corresponding average and median hydrogen sulfide levels at the western location, which likely better represent residential exposure due to the close proximity to the homes in the Horizon Village, were both 4.2 mcg/m^3 (3 ppb). In general, the instantaneous sample results were higher than the corresponding results for one-hour bag samples, and therefore they probably overestimate the exposure to hydrogen sulfide. If we assume that the average and mean levels of all the instantaneous hydrogen sulfide samples at the western location is representative of potential long term residential exposure, the risk for long-term hydrogen sulfide-related health effects is estimated to be low (US EPA, 2004).

Based on the overall data, exceedances of the one-hour standard appear unlikely to have lasted for long periods of time. However, on the limited number of days the standard was exceeded, the one-hour bag samples showed that the hydrogen sulfide concentrations (4.2 mcg/m^3 to 70 mcg/m^3 (3 ppb to 50 ppb)) were above the odor threshold and within the range associated with increased health complaints in communities near hydrogen sulfide sources. Thus it is possible that on these days, the elevated hydrogen sulfide concentrations could cause short-term health effects such as those described among residents near the landfill (e.g., headaches, nausea, eye irritation and breathing difficulties). Remedial measures taken by the town of Brookhaven, which include a gas collection system for methane that generators burn to produce electricity and a permanent flare for additional landfill gases, have reduced hydrogen sulfide levels to levels typically less than 14 mcg/m^3 (less than 10 ppb), and the number of odor complaints has decreased. However, since the landfill is still a source of hydrogen sulfide, a temporary interruption in remedial measures (e.g., use of gas flares) could result in release of the gas and increased exposure and risk for short-term health effects.

CONCLUSIONS

The Brookhaven Landfill is classified as no apparent public health hazard (see Appendix D) since the risk of long-term adverse health effects from site related air contaminants is low. Exceedances of the hydrogen sulfide standard appear unlikely to have lasted for long periods of time, and the hydrogen sulfide concentrations have reduced as have the number of odor complaints since 1993 when remedial activities were implemented. Public health actions were needed in the past at the Brookhaven Landfill site because people have been exposed to low level VOCs in private wells, prior to being supplied by public water, and exposed intermittently to hydrogen sulfide in ambient air, at levels above the one-hour standard.

A contaminant plume exists and may be advancing in the direction of regional groundwater flow. Many residents downgradient of the landfill switched from private well water to public water in the early to mid-1980's. Private well sampling was conducted on three occasions (1989-1990, 1993, 1996) to evaluate if private wells downgradient of the landfill were contaminated and in use. By 1996, the well survey identified only one private well in use with contamination above the New York State drinking water guideline. The public supply was available to the residence, which has since been hooked up to public water.

Residents in the community surrounding the town of Brookhaven Landfill have been exposed intermittently to low levels of hydrogen sulfide in the ambient air since 1991. Hydrogen sulfide in ambient air has been sampled on three occasions (1992-93, September 1993, and 1997-1999). Remedial measures, including a permanent flare and generators that burn methane, implemented at the landfill in 1993, reduced the hydrogen sulfide levels and odor complaints since 1993. The most recent ambient air monitoring was conducted for 18 months, from 1997 through 1999, at the southern and western boundaries of the landfill. Hydrogen sulfide concentrations in ambient air (one-hour bag samples) were occasionally above the odor threshold and within the range that could be associated with short-term health effects.

Acrolein was the only contaminant of concern, other than hydrogen sulfide, identified during the ambient air monitoring from 1997 to 1999. Acrolein was detected infrequently at low levels along the western boundary of the Brookhaven Landfill site. The relatively infrequent detection (13 of 71 samples) of acrolein suggests that the long-term air levels to which residents may be exposed are probably much lower than the air levels represented by the average of the 24-hour samples (because they are skewed high due to detection limitations).

RECOMMENDATIONS

NYS DEC should continue to monitor activities at the Brookhaven Landfill to ensure that the landfill complies with all NYS DEC permits and regulations.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Brookhaven Landfill site contains a description of actions to be taken by ATSDR and/or NYS DOH at and near the site subsequent to the completion of this health consultation. For those actions already taken at the site, please see the Background and Statement of Issues section of this health consultation (note that PHAPs discussed in the draft health consultation are now accomplished and discussed elsewhere in the document). The purpose of the PHAP is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NYS DOH to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented are as follows:

A. NYS DOH will work with NYS DEC to respond to future community concerns if any are identified.

ATSDR will reevaluate and expand the PHAP as needed. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions may determine the need for additional actions at this site.

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CERTIFICATION

The health consultation for the Brookhaven Landfill site was prepared by the New York State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial reviews were completed by the Cooperative Agreement Partner.

Technical Project Officer, CAT, SPAB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation, and concurs with its findings.

Team Leader, CAT, SPAB, DHAC, ATSDR