Health Assessment for

GEMS LANDFILL NATIONAL PRIORITIES LIST (NPL) SITE

GLOUCESTER TOWNSHIP, CAMDEN COUNTY, NEW JERSEY

CERCLIS No. NJD980529192

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

SUMMARY

The GEMS Landfill, located approximately 20 miles south-southeast of Camden, New Jersey, in Gloucester Township, Camden County, is on the National Priorities List (NPL). The site covers approximately 60 acres. Surrounding land use is best classified as rural-residential, although scattered industrial and recreational areas are adjacent to the site. The closest residences are approximately 300 feet from the landfill. Contaminants at the GEMS Landfill site include volatile organic compounds, polynuclear aromatic hydrocarbons, and inorganic compounds.

The September 30, 1985, Record of Decision (ROD) included provisions for capping the landfill; installing a gas-collection and treatment system, a groundwater-extraction and treatment system, a leachate-collection and treatment system, and surface-water controls; remediating Holly Run and Briar Lake; relocating Holly Run with runoff controls; and connecting affected homes to a municipal water system. A monitoring program will be implemented to assess the effectiveness and reliability of remedial action. The site has recently been enclosed by a perimeter security fence.

BACKGROUND

A. Site Description

The GEMS Landfill consists of 60 acres and is located approximately 20 miles south-southeast of Camden, in Gloucester Township, Camden County, New Jersey (see Figure 1). The site is elevated 80 to 100 feet above the surrounding terrain and has an estimated volume of 6 million cubic yards. It was operated as a landfill from the late 1950's to its closure in 1980. Several parties disposed of municipal and industrial solid and liquid wastes there, including hazardous substances. Although disposal of chemical wastes at the landfill was permitted by the State for a 3-week period in 1970, approval was discontinued after an on-site chemical fire. Records of the New Jersey Department of Environmental Protection (NJDEP) indicate that dumping of chemical wastes at the landfill may have continued intermittently between 1970 and 1976. From 1973 to 1980, on-site inspection reports indicate the presence of leachate emanating from the landfill and flowing into Holly Run. By November 1980, the acceptance of solid waste at the landfill was discontinued. As part of the landfill closure, sludge from the wastewater-treatment plant of the City of Philadelphia was brought in as cover material.

In February 1983, the Environmental Protection Agency (EPA) and NJDEP agreed to conduct studies in the Fox Chase II subdivision and Holly Run. NJDEP concluded that contaminant levels in the Holly Run were sufficiently high to pose a probable direct contact hazard to the public. Readings for ambient air near Holly Run indicated that the levels of organic compounds present would be likely to pose a health hazard to persons entering the

area. Improper drainage of the Briar Lake development resulted in the flooding of residential properties located adjacent to Holly Run.

Remedial actions taken at the GEMS site include correcting the drainage problem by reconstructing culverts upstream from Briar Lake, restricting access to the landfill by installing a perimeter security fence, and restricting access to the local surface water by installing a partial fence along Holly Run and Briar Lake. In response to groundwater contamination, the State has recommended that the Township require residents to connect their homes to the public water system. New wells can be installed around the site only after extensive testing.

The Record of Decision (ROD) signed September 30, 1985 proposes the following remedies 1) construct a landfill cap and regrade existing side slopes, and construct an active gas-collection and treatment system; 2) install surface-water runoff controls and a toe drain; 3) install a groundwater pumping and treatment system and a leachate-collection and treatment system; and 4) reroute Holly Run and excavate contaminated sediments from Holly Run and Briar Lake. Other proposed remedial actions include connecting potentially affected homes with the existing public water-supply system and implementing a monitoring program. The security fence around the landfill perimeter, as proposed by the ROD, has been installed.

B. Public Concerns

Local citizens have complained of several health problems, including nosebleeds and respiratory problems, which they attribute to contaminants from the GEMS Landfill. In 1982, the New Jersey Department of Health (DOH) surveyed residents in the area of the GEMS Landfill site for respiratory symptoms. Although the survey revealed an increase in respiratory-tract symptoms, a subsequent clinical evaluation of lung function did not reveal abnormalities among the study population. Because of complaints about an increased prevalence of nosebleeds within the site area, the Environmental Health Program of DOH conducted a house-to-house survey to assess the incidence of health problems in this area compared with a control population in Gloucester Township. The New Jersey DOH concluded that available data did not suggest any excess risk of chronic health effects as a result of residing near the GEMS Landfill site.

ENVIRONMENTAL CONTAMINATION AND PHYSICAL HAZARDS

A. On-Site and Off-Site Contamination

List of Contaminants

GROUNDWATER, 1983*

On-Site Cohansey-Kirkwood Aquifer

Contaminant	Maximum Concentration (Reported in parts per billion [ppb])
Aroclor-1254	11
Arsenic	120
Barium	3,173
Benzene	2,800
2-Butanone	18,480
Cadmium	1,400
Chromium	102
Chlorobenzene	710
Chloroform	662
1,1-Dichloroethene	33
1,2-Dichloroethane	271
1,2-Dichlorobenzene	1,287
Ethylbenzene	634
Lead	73
Methylene chloride	3,155
Tetrachloroethene	52
Toluene	1,597
1,2-Trans-dichloroethene	816
Trichloroethene	227
Vinyl Chloride	19
Total Xylenes	25,569

*-Samples filtered prior to analysis.

Off-Site Mt. Laurel-Wenonah Aquifer^

Contaminant	Maximum Concentration (Reported in parts per billion)
Benzene	20
Chromium	800
Lead	1,155
Toluene	65
Total Xylenes	34

^Contaminants detected in one of three monitoring wells (917) screened in this aquifer.

Off Site Residential Wells

Contaminant	Maximum Concentration (Reported in parts per billion)
Lead	21~

~-Sample obtained from Shaw Residence.

On-Site Leachate/Soil, 1983

Contaminant	Maximum Concentration (Reported in parts per billion)
Cadmium	917,000
Methylene chloride	804
Lead	1,600,000
Carcinogenic PAHs	70,000

PAHs-polynuclear aromatic hydrocarbons.

Off-Site Surface Soil, 1983

Contaminant	Maximum Concentration (Reported in parts per billion)
Acetone	24,000
Ammonia	23,000
Aniline	1,200
Benzoic acid	1,600
2-Butanone	11,000
Chlorobenzene	360
Lead	542
Methylene Chloride	3,200

Air On-Site, 1983*

Contaminant	Maximum Concentration (Reported in parts per billion)
Benzene	13
Chloroform	3
1,2-Dichloroethane	6
Methylene chloride	49
Tetrachloroethene	2

PHYSICAL HAZARDS

Results of soil-gas monitoring indicated elevated levels of methane at both the landfill and areas adjacent to the FOX Chase II subdivision. The ROD includes provisions for a gas-collection and treatment system that should prevent formation of methane gas pockets.

DEMOGRAPHICS

Approximately 6,000 people live within 1 mile of the site, and approximately 38,000 people live within a 3-mile radius of the site. The nearest residents live in the Fox Chase II subdivision, which is located 300-500 feet northeast of the landfill. Other nearby residential areas are located 1,000 feet south of the site and 1,000 feet northwest of the landfill.

Groundwater is the major source of potable water for residents living around the site. Private and municipal wells supply potable water for local residents. A public water-supply system serves the area.

Although the site lies in an area that is zoned for industrial use, more than half the area supports residential development. Other land uses within the immediate vicinity include a firm with cement-manufacturing and welding operations, located 300 feet southeast of the site, and a motorbike course adjoining the western boundary of landfill. The Gloucester Board of Education owns undeveloped property immediately west of the site.

EVALUATION

A. SITE CHARACTERIZATION (DATA NEEDS AND EVALUATION)

1. Environmental Media

Adequate sampling of surface water, sediment, and air was conducted to determine the nature and extent of contamination for the media associated with the GEMS Landfill site.

Soil sampling was not conducted during site and remedial investigations. Without the results of on-site and off-site soil sampling it is not possible to adequately evaluate the environmental pathways of contaminant migration or the site's potential public health impact.

Groundwater samples from monitoring and residential wells were filtered before analysis for metal contaminants. The analyses should be conducted on unfiltered samples to obtain better information for determining the public health implications of ingested water because EPA drinking water standards are based on total unfiltered concentrations of chemicals. No valid comparison can be made of the filtered samples with these standards.

Preliminary results of groundwater monitoring indicate that the Mt. Laurel-Wenonah Aquifer east of the site is contaminated; however, site documents indicate that the single well in which contaminants were detected may have been improperly installed. The Mt. Laurel-Wenonah Aquifer is the primary source of potable water in the area surrounding the site.

2. Land Use and Demographics

Land use and demographic data were inadequate for ATSDR to assess fully the public health impacts of the GEMS Landfill site. Site documents contained no demographic data other than the general location and use of groundwater wells within the site area and the number of residents within a 1- and 3-mile radii of the site. More detailed demographic information, such as the number of residents within 1,000 feet of the site and the age, sex, ethnic background, and socioeconomic status distribution of nearby residents, would be useful in identifying possible high risk subpopulations and more accurately assessing the site's impact on public health.

3. Quality Control and Quality Assurance

The conclusions contained in this report are based on the data package supplied to ATSDR. The accuracy of these conclusions is based on the reliability and completeness of the data contained in materials reviewed.

ENVIRONMENTAL PATHWAYS

Environmental pathways for migration of site contaminants to off-site areas include groundwater and surface-water flow, the movement of soil contaminants through erosion by surface-water runoff and wind, the transport of volatilized organic contaminants and fugitive dusts, and the bioaccumulation of contaminants in food-chain entities.

In the area surrounding the site, groundwater is the primary source of potable water. Monitoring of groundwater in the area revealed several contaminants, both on-site and off-site. Contaminants were detected primarily in the upper aquifer (Cohansey-Kirkwood) under the site. Contamination was detected downgradient from the northeast corner of the landfill in an area adjacent to a residential subdivision. Several contaminants were detected in a single monitoring well screened in the lower aquifer (Mt. Laurel-Wenonah) and located approximately 2,000 feet east of the landfill. The results from monitoring the lower aquifer are inconclusive, possibly because of improper installation of the well or the existence of an off-site contaminant source. The Mt. Laurel-Wenonah Aquifer is an important source of potable water.

Groundwater contaminants may be dispersed to off-site areas through groundwater movement. Groundwater flow within the upper aquifer is to the

northwest except in areas along Holly Run where the flow is in a more northerly direction. Regional groundwater flow in the deep aquifer is also northwest, but because this aquifer is a local water source and is heavily pumped, the direction of flow in the immediate site vicinity is southeast. Camden County operates a municipal well approximately 4,500 feet east-southeast of the site. Wells or boreholes that penetrate both the upper and lower aquifers and are improperly sealed may be conduits for contaminant movement between the aquifers. Contamination of both aquifers could have a important impact on local residents.

The ROD provides for extracting and treating contaminated groundwater and calls for connecting all potentially affected homes to the existing public water-supply system, and monitoring groundwater. These measures should be adequate to reduce the pathway for migration of groundwater contaminants and to prevent human exposure to these site-related groundwater contaminants.

Two streams, Holly Run and Toms Branch, originate in the vicinity of the site and combine approximately 6,000 feet west of the site to form the South Branch. Although the water quality of the South Branch has not been impacted by the site, surface water within the immediate vicinity of the site has been impacted. Contaminated leachate from the landfill flows into the wetland west of the site and into the Holly Run drainage basin. Holly Run flows into Briar Lake which in turn flows into Holly Lake. Although contaminated leachate from the landfill has had an appreciable impact on the water quality of Holly Run and Briar Lake, the site appears to have had little impact on Holly Lake.

Flooding of Holly Run is an important mechanism for transporting contaminated surface water to adjacent areas, including the Fox Chase II residential subdivision.

Remedial actions proposed in the ROD include constructing a landfill cap, regrading existing side slopes, installing of a toe drain at the base of the landfill and a leachate collection and treatment system, and implementing surface-water runoff controls. These measures should adequately reduce the migration of surface-water contaminants to off-site areas. Remedial measures should also reduce the possibility of human exposure to contaminated surface water.

In 1983, air monitoring was conducted during three separate sampling programs. Sampling points varied during each round and included both on-site and off-site locations. Several volatile organic compounds (VOCs) were detected at levels of possible public health concern. Explosimeter readings taken in conjunction with the analysis for VOCs were negative. Air monitoring for VOCs was also conducted in the basements of several homes, but results did not indicate elevated levels.

Contaminants may be transported off-site through volatilization or through the generation of fugitive dusts. These pathways for contaminant

transport become more likely during activities that disturb soil or wastes.

The ROD proposes several actions, including installing the landfill cap, and measures that will collectively eliminate sources from which contaminants could volatilize. The combination of remedial actions proposed in the ROD should be sufficient to address adequately the airborne pathway for volatilized contaminants and fugitive dusts.

Although soil sampling was not conducted during site investigations, leachate-saturated soil was sampled. Soil contaminants can be transported by surface-water runoff, wind erosion, and the infiltration of precipitation. The ROD proposal of a site cap and a security fence around the site perimeter should adequately address on-site soil contamination.

Monitoring of soil-gas in April 1984, indicated that VOCs are greatest at sampling locations close to the landfill and Holly Run. VOCs in excess of 1,000 ppm were detected outside several residences in the Fox Chase II subdivision. Air samples collected from 6 of the 11 residences with backyards immediately adjacent to the landfill had combustible gas levels exceeding 100 percent of the lower explosive limit. Only one of six air samples taken from the front yards of these residences had levels of VOCs (200 ppm) with an explosimeter reading of 6 percent of the lower explosive limit of combustible gases.

The ROD proposes installing a gas-collection and treatment system that is expected to appreciably reduce the formation of gas pockets and help minimize the potential for health impacts of site-related soil-gas and methane buildup.

Contaminants in surface water and soil may bioaccumulate in on-site and off-site food-chain entities. Wild plants and cultivated vegetables from residential gardens may bioaccumulate site contaminants. Holly Run and Briar Lake are not large enough to support populations of edible fish or other aquatic animals that serve as human food-chain entities. Since the site lies immediately adjacent to residential areas, small game hunting in the area immediately surrounding the site area is unlikely.

Although the ROD does not specifically address the food-chain pathway of contaminant migration, it does propose confining or eliminating the reservoirs of surface-water and sediment contaminants and reducing the amount of on-site contaminants by removing waste and soil. Capping and fencing the site should further reduce its impact on local wildlife. Controls for surface-water runoff should also help minimize the site's impact on local residential gardens.

HUMAN EXPOSURE PATHWAYS

Although several potential routes exist by which humans can be exposed to contaminants from the GEMS Landfill site, proposed site remediation should

reduce, but may not eliminate, these human-exposure pathways. Ingestion of contaminated groundwater, surface water, soil, and food-chain entities are potential routes of human exposure to site-related contaminants. Other possible pathways of human exposure include dermal absorption of contaminants from groundwater, surface water, air, and soil, and the inhalation of fugitive dusts or volatilized contaminants from groundwater during household uses, surface water, soil, sediments, or wastes.

Groundwater

Although the area surrounding the Site has a municipal water system, not all residents are connected to this system. Some residents living around the site also rely on private wells for potable water. Monitoring data from groundwater indicate that off-site residential and municipal supply wells which were sampled have not been impacted by site-related contaminants, but groundwater contaminants at levels of public health concern have been detected in on-and off-site monitoring wells located both upgradient and downgradient from the site. Remedial workers and nearby residents using potable wells may be exposed to appreciable contaminant levels through dermal contact, ingestion of contaminated groundwater, or inhalation of volatilized contaminants released during domestic use of groundwater or groundwater extraction and treatment.

Surface water

Although surface water within the site area is not used as a source of potable water, human exposure to surface-water contaminants is possible because access to the site, Holly Run, and Briar Lake is limited but not restricted. Contaminants in on-site leachate-saturated soil and off-site surface-water bodies, including Holly Run and Briar Lake, are at levels likely to be of public health concern. Ingestion, inhalation, or dermal absorption of leachate or other surface-water contaminants may take place during wading, swimming, and other recreational activities on-site and off-site in Holly Run and Briar Lake.

Soil

Samples of contaminated, leachate-saturated soil collected from on-site areas revealed contaminants at levels likely to be of public health concern. Because soils were not collected from off-site areas, a full evaluation of this potential human-exposure pathway is not possible. Contact with contaminated on-site soil is possible for site trespassers because access to the site is not restricted. Because proposed remedial activities include excavation and site regrading, remedial workers may also be exposed to soil contaminants. Ingestion or dermal contact with contaminated soil may adversely impact human health.

Airborne contamination

Inhalation of VOCs and contaminated fugitive dusts may be a human-exposure pathway. Although air monitoring conducted in 1983 indicated the presence of several contaminants, contaminants were below potentially hazardous levels. On-site remedial activities that disturb soil may generate fugitive dusts or release VOCs and thereby expose on-site remedial workers and area residents to site contaminants.

Food-chain contamination

Ingestion of contaminated food-chain entities, such as wild plants or cultivated vegetables, may be a human exposure pathway. Since off-site soil sampling was not conducted, ATSDR can not assess adequately this potential human exposure pathway.

PUBLIC HEALTH IMPLICATIONS

Currently the GEMS Landfill Site poses a potential health risk. Hazardous contaminants present in groundwater, surface water, and leachate include several VOCs and inorganic chemicals.

ENVIRONMENTAL MEDIA

On-site groundwater

On-site groundwater is contaminated with various VOCs, including methylene chloride, benzene, and vinyl chloride, and several inorganic chemicals such as lead and arsenic. Long-term exposure to the levels of these contaminants present in the on-site groundwater may pose a health hazard. Remedial workers are at risk of exposure to on-site groundwater primarily via inhalation. At present, no other populations are known to be at risk of exposure to on-site groundwater.

On-site leachate and soil

Soil was not sampled during site investigations, but because on-site leachate seeps were reported, on-site soil is likely to be contaminated with at least the contaminants found in the leachate, including cadmium, lead, and carcinogenic PAHs. Long-term exposure to these contaminants, particularly via ingestion, may result in adverse health effects. Until remediation has been completed, trespassers, especially children, may be exposed to the contaminants present in the on-site leachate. Worker engaged in remedial activities are at risk of exposure to contaminants associated with on-site leachate.

On-site air

Although no contaminants were present at levels likely to be hazardous in the ambient air, activities that disturb the soil may increase the ambient air levels of contaminants to concentrations that pose a health concern to remedial workers.

Off-site contamination

Off-site groundwater: Mt. Laurel-Wenonah Aquifer; monitoring well (MW) 917

Long-term exposure to the levels of benzene, chromium, and lead that are present in off-site groundwater obtained from MW 917 may pose a health concern. Although at present no human receptors to groundwater in the area of this well are known, the municipal-water supply system does obtain water from this aquifer.

Off-site residential wells

One of the five residential wells sampled (Shaw) is contaminated with lead at a level that may pose a health concern following long-term ingestion. A provision to connect all affected homes to the municipal water supply is included in the ROD. It is unclear from the available site documents whether affected homes have indeed been connected to the municipal water supply system. Until documentation is available that this connection has been made, ATSDR will assume that exposure to water obtained from the above mentioned well is occurring.

Off-site surface water

Off-site surface water is contaminated with lead and various VOCs including chlorobenzene, methylene chloride and 2-butanone at levels that may pose a health concern. Long-term exposure via ingestion and inhalation to off-site surface water may result in adverse health effects. Until remediation has been completed, children are considered at risk of exposure to off-site surface water. Workers may also be exposed to the above-mentioned contaminants in off-site surface water during remediation.

Site-specific toxicologic discussion

A site-specific toxicologic discussion will be included for the following individual and groups of contaminants of concern at the GEMS site: carcinogenic PAHs, lead, methylene chloride, and benzene. The selection was based on the type and extent of potential adverse health effects expected from these contaminants at the respective levels present in various environmental media, their frequency of occurrence in these media, and the potential for exposure to these contaminants.

Carcinogenic PAHs

Chronic exposure to carcinogenic PAHs present in the on-site leachate and soil at the GEMS site poses a potential health concern. Human exposure to individual PAHs in the environment seldom, if ever, occurs. More commonly, humans are exposed to individual PAHs such as benzo[a]pyrene, as components of complex mixtures of PAHs and other chemicals. Interactions between components are likely to occur, and these interactions may play a large part in the carcinogenesis resulting from exposure to PAHs. The best studied endpoint of intermediate and long-term toxicity induced by this group of PAHs is cancer. Many individual PAH components present in the on-site leachate at the GEMS site have been shown in laboratory bioassays to be mutagenic and carcinogenic, thus supporting the designation of human carcinogenicity (IARC, 1983).

Lead

Long-term exposure to lead, at levels present in on-site groundwater and leachate, in off-site groundwater, in one residential well, and in surface water associated with the GEMS Site, may result in neurobehavioral toxicity, inhibition of heme synthesis and erythropoiesis, and cardiovascular and developmental toxicity.

Neurobehavioral toxicity:

Statistically significant inverse linear associations between cognitive ability and levels of blood-lead have been reported in two different populations of children, with no evident threshold down to the lowest blood-lead level of 6 ug/dl (Hawk et al., 1986; Fulton et al., 1987).

Heme synthesis and erythropoiesis:

Low-level exposure to lead is associated with inhibition of erythrocyte d-aminolevulinic acid dehydrogenase (ALAD) activity. This inverse correlation of blood-lead level with ALAD is seen at very low blood-lead levels and occurs in adults as well as children (Chisolm et al., 1985).

Cardiovascular effect:

Several studies have been conducted in occupational and general populations on possible relationships between blood-lead levels and hypertension. Data from the National Health And Nutritional Examination Survey II, (Harlan et al., 1985; Pirkle et al., 1985) and the British Regional Health Study (Pocock et al., 1984, 1985) indicated small but statistically significant direct associations between blood-lead levels and blood pressure readings in middle-aged men (40 to 59 years old) with no apparent threshold through <10 ug/dl.

Developmental toxicity:

Prenatal exposure to lead may produce toxic effects in the human fetus, including slowed growth, low birth weight, and impaired mental development. These effects may occur at relatively low-blood lead levels. Statistically significant inverse correlations between maternal blood-lead levels and gestational age and birth weight have been reported (Dietrich et al. 1986, 1987a). The effects on birth weight and gestational age have been observed at blood-lead levels as low as 12 ug/dl.

Methylene chloride

Methylene chloride was present at the GEMS site at levels of concern in on-site groundwater and leachate and off-site surface water. Most adverse health effects in humans result from exposure to methylene chloride via inhalation. Methylene chloride may potentially affect the central nervous system (CNS) and the cardiovascular system and may result in respiratory toxicity. Methylene chloride is also considered a probable human carcinogen.

CNS toxicity

In general, most of the toxicologic data available for methylene chloride was derived from occupational exposures. CNS effects reported in workers following long-term exposure to methylene chloride at up to 100 ppm include headaches, dizziness, memory loss, paresthesia, and loss of consciousness (Welch, 1987). These workers were, however, concomitantly exposed to other unspecified solvents. In another study, (Cherry et al. 1983), reported a statistically significant increase in sleepiness and physical and mental tiredness in a worker population following long-term exposure to methylene chloride at up to 173 ppm. In addition to these subjective complaints, a statistically significant correlation was found between a deterioration in performance and an increase in the blood concentration of methylene chloride from the beginning to the end of the shift.

Cardiovascular toxicity

The cardiotoxic effects potentially produced by methylene chloride are most likely mediated by carbon monoxide, a product of methylene chloride metabolism, via carboxyhemoglobin (Co-Hb). The percentage of Co-Hb in the blood is directly proportional to the exposure concentration of methylene chloride and the length of exposure. Although methylene chloride-induced cardiotoxicity would not be expected in healthy individuals exposed to the levels of methylene chloride present at the GEMS Landfill site. This potential adverse health effect may be of concern to certain high risk subpopulations such as those with compromised cardiovascular systems.

Respiratory toxicity

Long-term, low-level exposure to methylene chloride appears to have caused upper respiratory irritation (Welch, 1987). The specific histologic and clinical aspects of this effect of methylene chloride were not available.

Carcinogenicity

When compared with the general population, no statistically significant excess cancer mortality was reported in workers. For workers exposed up to 30 years to methylene chloride in air concentrations of 26-125 ppm no statistically significant excess cancer mortality was reported when compared with the general population (Friedlander et al., 1978; Hearne et al., 1987). Methylene chloride has been reported to cause liver, lung, and mammary- and salivary gland malignancies in animals (NTP, 1986).

Benzene

Exposure to the levels of benzene present in on-site and off-site groundwater at the GEMS Site may pose a health concern. Ingestion and inhalation are the major probable pathways of exposure. Benzene can also be absorbed through the skin, but the rate and extent of absorption are generally lower than for inhalation exposure. Absorption is, therefore, unlikely to be appreciable, particularly under the potential exposure conditions at this site. With long-term exposure, benzene can cause hematotoxicity, immunotoxicity, neurotoxicity, and genotoxic effects. Epidemiologic studies have shown that long-term, low-level inhalation exposure to benzene may cause cancer in humans.

Hematotoxicity

In several case studies, pancytopenia and its variations, and aplastic anemia have been detected after chronic exposure to benzene in a variety of situations, primarily occupational (Aksoy et al., 1972; Goldstein, 1977). Worker exposure occurred primarily via the inhalation route at ambient air levels ranging from 0.06-1100 ppm. Benzene-induced hematotoxicity also involves lymphoid cell lines. Immunotoxic effects manifested in exposed workers include alterations in immune responsiveness.

Genotoxicity

Benzene has proven to be a genotoxicant in worker populations. The association between benzene exposure and the appearance of structural and numerical chromosomal aberrations in human lymphocytes has been found so consistently, that benzene can be considered a human clastogen (IARC 1982; van Raalte and Grasso, 1982).

Carcinogenicity

An association has been established between benzene exposure by inhalation and leukemia in humans (Rinski et al., 1981; Yin et al., 1987a; Aksoy, 1980). Although data are insufficient to validate a carcinogenic potential via the ingestion or dermal route, benzene may be assumed to cause cancer in humans if ingested in sufficient quantities. Since absorption through the skin is low, unless there are compromises in the skin barrier (cuts, dermatological conditions, etc.), the risk of cancer after dermal exposure alone is probably less than by other routes. Epidemiologic studies have shown that benzene is a human carcinogen but have not clearly established what levels or duration of exposure are necessary for this effect. Although establishing cause-and-effect relationships is complicated by exposure to other chemicals in addition to benzene (Casarett L.J. and Doull J., 1986), the current consensus is that a cause-and-effect relationship between benzene and leukemia is sufficiently clear. Potential adverse health effects from exposure via inhalation to benzene at this site cannot be assessed using the information currently available.

Sensitive subpopulations

1. Because children have an increased sensitivity to some of the contaminants found on-site, such as lead, they are an important high risk subpopulation.

2. Fetuses and neonates are also high risk subpopulations because some of the hazardous contaminants cross the placental barrier and are also present in breast milk. This is true for lead.

3. Individuals with hypertension or hepatic or renal disorders are especially at risk because several contaminants associated with this site are hepatic and renal toxicants and possible contributors to hypertension, which in turn may exacerbate renal disorders or be exacerbated by renal or hepatic disorders.

4. Individuals with compromised cardiovascular systems may experience adverse health effects from long-term exposure to the levels of cadmium, lead, and methylene chloride associated with the GEMS site.

CONCLUSIONS AND RECOMMENDATIONS

From the information reviewed, ATSDR concludes that this site is of potential health concern because a potential risk to human health exists from possible exposure to hazardous substances at concentrations that may result in adverse health effects. As noted above in the Public Health Implications Section, human exposure to cadmium, lead, methylene chloride, benzene, and carcinogenic PAHs may occur, be occurring, and have occurred in the past via ingestion, inhalation, and dermal contact.

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended, the GEMS Landfill site, Gloucester Township, Camden County, New Jersey, has been evaluated for appropriate follow-up with respect to health effects studies. Although there are indications that human exposure to on-site and off-site contaminants may be currently occurring and may have occurred in the past, this site is not being considered for follow-up health studies at this time because the potential for exposure is slight and infrequent. However, if data become available suggesting that human exposure to significant levels of hazardous substances is currently occurring or has occurred in the past, ATSDR will reevaluate this site for any indicated follow-up

To help protect public health ATSDR recommends the following.

1. Restrict public access to the GEMS Landfill Site.

2. Conduct additional groundwater monitoring of the Mt. Laurel-Wenonah Aquifer to determine the nature and extent of contamination.

3. Periodically monitor residential wells until use of these wells is discontinued.

4. Sample and analyze on-site and off-site soil to determine the nature and extent of soil contamination. Soil sampling conducted off-site should include those areas used for home gardening and residential yards.

5. If soil sampling results indicate contaminants at levels of public health concern in residential yards or home gardens, actions should be taken to minimize human contact with soil contaminants.

6. Include the following in the remediation workplan if additional site remediation occurs:

Provide adequate personal protective equipment that meets the standards of Occupational Safety and Health Administration (OSHA) for workers conducting remedial activities in and around the site.

Follow appropriate precautionary guidelines, regulations, and advisories from the National Institute for Occupational Safety and Health (NIOSH) and OSHA.

Employ methods of dust suppression if remedial activities will involve ground-disturbing activities. Appropriate real-time, peripheral-air monitoring should be done during working hours in addition to on-site air monitoring. Levels of contaminants in the ambient air at the periphery of the site should not exceed National Ambient Air Quality Standards (NAAQS) or NIOSH recommendations. All actions to prevent exposures to contaminants associated with the GEMS Landfill site during remediation should help protect individuals living and working on these sites.

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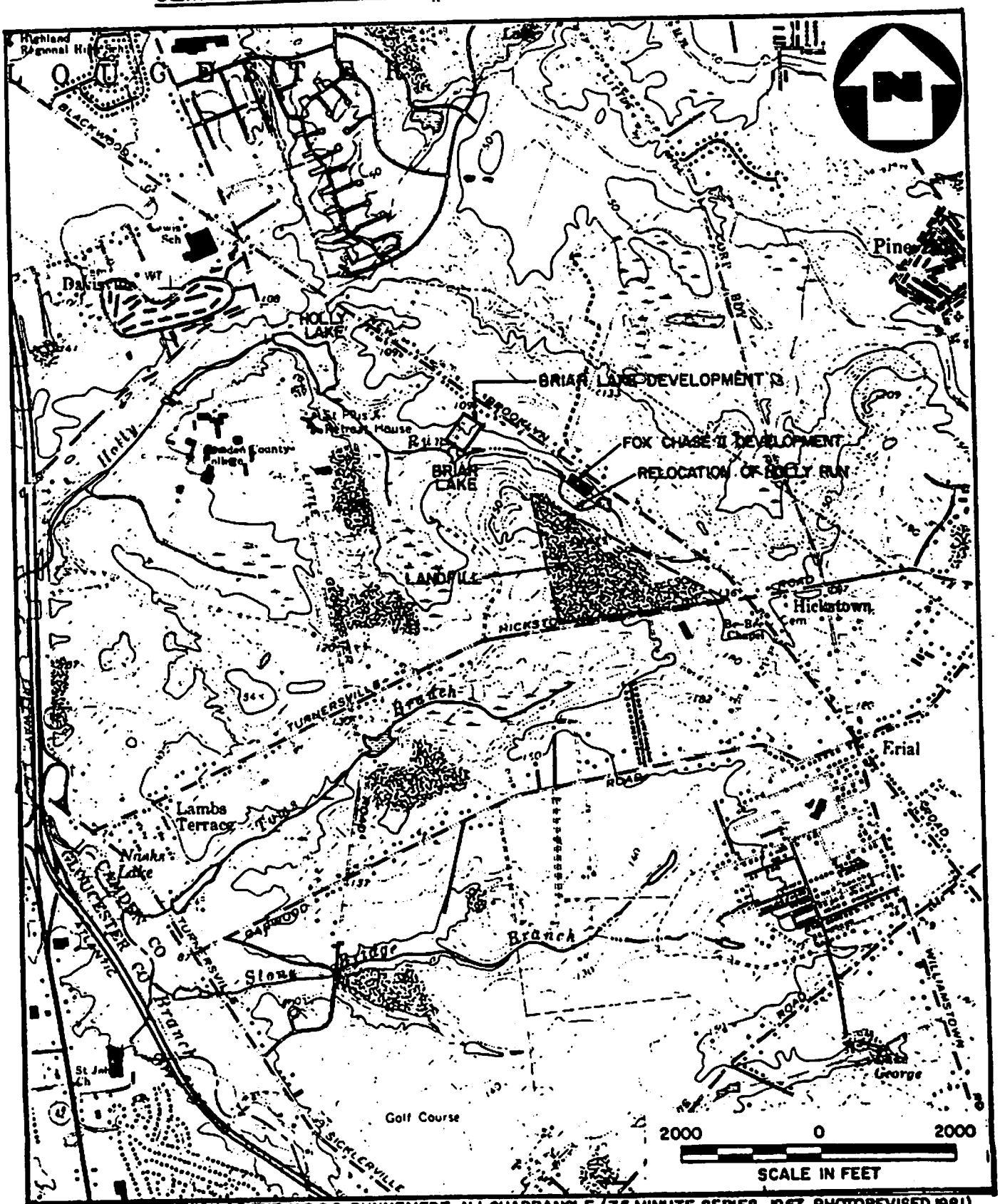
Figure I

GEMS LANDFILL SITE, GLOUCESTER TWP., NJ



BASE MAP IS A PORTION OF THE U.S.G.S. RUNNEMEDE, NJ QUADRANGLE (7.5 MINUTE SERIES, 1967, PHOTOREVISED 1981) CONTOUR INTERVAL 10'.