Public Health Assessment

Final Release

Former Penick Corporation/Penco of Lyndhurst Facility
Bergen County, New Jersey

NJDEP Facility IDs: 84090 and 93651

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Prepared by:

New Jersey Department of Health
Environmental and Occupational Health Surveillance Program

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Summary

Introduction

The New Jersey Department of Health (NJDOH) has reviewed recent data to provide interpretation and a public health evaluation concerning potential exposures from site-related contamination detected in groundwater, soil, and air for the former Penick Corporation and Penco of Lyndhurst site located at 540 New York Avenue in Lyndhurst Township, Bergen County.

NJDOH's top priority is to ensure that the community around the site has the best information possible to safeguard its health.

Conclusions

NJDOH has reached four conclusions regarding potential health implications to exposures related to the former Penick Corporation/Penco of Lyndhurst site.

Conclusion 1

NJDOH conclude that past exposures to lead from contaminated surface soil present within the south drainage ditch may have harmed people's health in the past.

Basis for Conclusion

Past exposures to lead in surface soil at the south drainage ditch may have resulted in unnecessary exposures to lead for children who may have frequently visited this area prior to its remediation in 1993. In addition, surface soil from the south drainage ditch was also contaminated mainly with several PAH compounds, and, on a very limited basis, aroclor 1254, a mixure of polychlorinated biphenyls (PCB). Past exposures to these chemicals of concern may have occurred to residents, specifically children, who may have possibly used this area or the immediate vicinity as a walking path to and from school. However, repetitive exposures at the former drainage ditch are unlikely as, historically, it was heavily overgrown with vegetation and not readily accessible. Based on the concentrations of the chemicals, other than lead, found prior to remediation, adverse non-cancer health effects from past exposures are not expected for children or adults. The cumulative lifetime excess cancer risk from ingestion and dermal exposures to COCs are considered a no apparent increase in risk when compared to the background risk of cancer.

Next Steps

Contaminated soils and sediments in the south drainage ditch area are considered by the New Jersey Department of Environmental Protection to have been addressed by remedial actions completed by 1993. The area is no longer considered contaminated.

Conclusion 2

NJDOH conclude that present and future exposures to benzene, 1,3-butadiene, chloroform, 1,2-dichloroethane and methylene chloride detected in indoor air at four residences during April 2009 investigations are not expected to harm people's health.

Basis for Conclusion

As no health-based comparison values were exceeded, adverse non-cancer health effects are not expected to occur for present and future exposures to these contaminants in indoor air to adults and children occupying the four tested residences. Based on the levels of contaminants detected in indoor air, there is a low increase in risk of cancer for one residence and no apparent increase in risk of cancer for occupants of three residences, in comparison to the background risk of cancer. Contaminants detected in indoor air during the April 2009 investigation are likely present from consumer-related and background ambient air sources, since the chemicals were not detected in soil gas below tested homes.

In addition, average concentrations of benzene in groundwater samples for monitoring wells within a 100 foot radius of the residential area did not exceed NJDEP screening levels for vapor intrusion since 2002. Toluene concentrations in groundwater for monitoring wells within a 100 foot radius have been far below the NJDEP screening levels for vapor intrusion since routine monitoring began in 1987. Groundwater data further supports evidence that the benzene and toluene groundwater plumes have likely not extended into the residential investigation area since 2002.

The potential for present and future exposures to site-related contamination via vapor intrusion is considered interrupted as the NJDEP is actively monitoring groundwater and the operation of mitigation measures to capture and treat contaminated groundwater.

Next Steps

The NJDEP should continue monitoring the operation and effectiveness of the groundwater remediation system to ensure the contaminated groundwater plume is under hydraulic control and not migrating towards nearby residential areas. Additionally, the NJDEP

	should continue to oversee the remediation of all contamination on or emanating from the Penick/Penco site, including monitoring the effectiveness of institutional and/or engineering controls in place to address site-related contamination.
Conclusion 3	*NJDOH conclude that past exposures to benzene in indoor air at six of the seventeen residences tested in 1989 may have harmed people's health.*
Basis for Conclusion	Based on the 1989 indoor air investigations, non-cancer adverse health effects from long-term inhalation exposures to benzene to residents living at six residences along New York Avenue could have occurred from past exposures. Estimates of lifetime excess cancer risk due to exposure to benzene for 30 years resulted in a low increase in risk of cancer at four tested residences and no apparent or no increase in cancer risk for occupants of the remaining residences. The assessment of indoor air data is limited due to the lack of soil gas data to verify a benzene source was present at the time of the 1989 investigations, and the presence of consumer products which could have contributed, in whole or in part, to indoor air concentrations. However, groundwater data from 1987 investigations indicate that the benzene groundwater plume extended into the residential area, supporting the plausibility that benzene present in indoor air at the time may have originated in part from site-related contamination. Groundwater data from 2002 show that the benzene and toluene plumes have likely not extended into the residential area since this period.
Conclusion 4	*NJDOH conclude that number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated in Lyndhurst in the period 1990-2008.*
Basis for Conclusion	NJDOH Cancer Epidemiology Services (CES) conducted standardized incidence ratio (SIR) analyses for all cancers combined and for multiple myeloma for the period 1990 through 2008 in Lyndhurst. The results of the Lyndhurst SIR analyses indicate that the number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated.

For More Information

Copies of this public health assessment will be provided to concerned residents in the vicinity of the site via the township libraries and the Internet. NJDOH will notify area residents that this report is available for their review and provide a copy upon request. Questions about this Public Health Assessment should be directed to the NJDOH at:

Environmental and Occupational Health Surveillance Program
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Consumer, Environmental and Occupational Health Service
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Statement of Issues

In August 2008, the Lyndhurst Township Health Department requested assistance from the New Jersey Department of Health (NJDOH) to conduct a public health evaluation to assess community exposures to site-related contamination associated with the former Penick Corporation/Penco of Lyndhurst site located at 540 New York Avenue in Lyndhurst Township, Bergen County. Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), the NJDOH reviewed environmental data and prepared this public health assessment (PHA) to determine the public health implications associated with potential exposures to site-related contamination for area residents. This includes obtaining the most recent data related to the ongoing vapor intrusion investigation conducted for the site in 2009.

Background and Site History

Figure 1: Location of former Penick/Penco Site

The former Penick/Penco facility was situated on an approximate 17 acre parcel at 540 New York Avenue in Lyndhurst Township, Bergen County (see Figure 1). The property is bordered between Ridge Road to the east, Delafield Avenue to the west and the Erie Lackawanna Railroad and commercial properties to the south. St. Joseph’s Cemetery is located on the eastern adjacent property. Residential properties are located to the immediate north, south and west of the site. The surrounding area consists of mixed residential, commercial and industrial settings.

Current land use at the site consists of a large multi-building shopping center with approximately 60 to 80% of the ground surface covered by asphalt pavement and building structures (Langan 2011).

Regarding environmental compliance history, the site falls under NJDEP ISRA case numbers 84090 for Penick Corporation operations and 93651 for Penco of Lyndhurst, Inc. operations.

Property Operational History

The property was initially owned and operated by United Cork Works Company circa 1900 to 1941. Operations during the United Cork Works Company ownership period are unknown (NJDEP 1984, Cole 1997). A review of the earliest aerial photographs available indicate the site property was developed in the period between 1940 and 1953 while the residential area along New York Avenue existed as a wooded area. The residential area is visible as its current developed state by the 1971 photograph (Cole 1997).

Penick Corporation - Operational History

The property was acquired in 1941 by the Penick Corporation (Penick) with facility operations running from 1941 through 1986, although there is conflicting information indicating operations may have started as early as 1938 (Penick 1984, NJDEP 1984; Kozel 1991). In general, operations consisted of the manufacture of numerous specialty organics, botanicals, pharmaceuticals (acetaminophen), and pesticides, including synthetic pyrethroid (Kozel 1991; Cole 1997). During the Penick operational period, the property contained 43 buildings, open storage area, and two parking lots. Details of the building operations were described in background documents as follows:

Penick Corporation Operations		
Building No.	Operation	Materials Stored or Processed
2	Extraction, milling of botanicals	cascara, quassia, mate, guarana
3	Milling, sifting, blending	rotenone
4A, 4C, 30, 44	Administration, quality control	waste lab, chemicals (small quantities)
6, 7	Pesticide formulations	resmethrin, 4,4'- DDT, 4,4'- DDE, lindane, chlordane
9	Tagetes extract blending	tagetes
11, 38, 39	Warehousing	unspecified
12	Manufacture of piperidine ester	piperidine ester
13	Purification of quassia; Storage of quillaia and henna	quassia, quillaia, henna
14	Extraction of henna leaves	henna leaves
16	Processing of soap bark	soap bark
18 complex, 21	Quality control	small quantities of radioactive material used in quality control process (Building 18).
19	Solvent recovery	solvents from botanical extractions (ethyl alcohol)
22	Rotenone extraction	rotenone
27	Power plant	fuel sources

Penick Corporation Operations cont.		
28	Warehousing	benzyl cyanide; ethylene gylcol; methylene chloride; sulfuric acid; para toluene sulfonic acid; kerosene deodorized Bayol 90; dimethyl succinate; hydrochloric acid; formaldehyde; calcium oxide
41 complex	Acetaminophen (N-(hydroxyphenyl)-acetamide) production	acetic anhydride; anhydrous ammonia; sulfuric acid; para nitro phenol
43 complex	Pesticide production	resmethrin, carbon monoxide (gas), materials listed in Building 28
Carboys Building	Materials storage	sulfuric acid
Remaining Buildings	Administration, technical departments	none specified in documents

Source: Penick 1984; Cole 1997

Manufacturing operations involved three departments identified as Pesticides, Botanicals and Acetaminophen. The manufacture of acetaminophen involved the hazardous materials stored in the Building 41 complex listed above. Documents indicate that only non-hazardous waste products were generated during acetaminophen production which included acetaminophen (N-(hydroxyphenyl)-acetamide), acetic acid and ammonium acetate. This production effluent was directed to the facility's on-site treatment plant before permitted discharge to the publicly operated treatment works (POTW) operated by the Passaic Valley Sewer Commission (Penick 1984).

The pesticide resmethrin (tradename SBP-1382) was manufactured in the Building 43 complex. Documentation indicates resmethrin was the only bulk pesticide compound produced by the Pesticides Department. The manufacture of this product involved benzyl cyanide, ethylene gylcol, methylene chloride, sulfuric acid, para toluene sulfonic acid, kerosene deodorized Bayol 90, dimethyl succinate, n-heptane, toluol 1 nitration, isopropyl alcohol, methanol ACS, and carbon monoxide (gas). The manufacture of resmethrin involved a 5 stage process which included the production of carbinol, valerate and furoate as precursors and intermediates to the final product. Two waste streams generated from this process included spent toluene and "polymerized process tars." Spent toluene was stored in vessel #66 and polymerized process tars were drummed before being disposed as hazardous waste through approved disposal firms (Penick 1984).

Pesticide formulations were conducted in Buildings 6 and 7. These operations involved blending of various grades and concentrations of active ingredients to produce bulk resmethrin. Bulk resmethrin is documented as a mixture of rotenone, a naturally occurring pesticide from the roots of several South American plants, pyrethrum, a naturally occurring insecticide found in plants of the genus Chrysanthemum; dursban;

and chlorpyrifos. Deodorized kerosene and water were used as the mixing agent. Building 22 was utilized for the extraction of rotenone (Penick 1984).

Botanicals consisted of several product lines and were manufactured for their use in pharmaceuticals, cosmetics, flavors, fragrances, industrial photographic emulsions, and pesticides. Botanicals were isolated by extraction, direct milling, or a combination of both. The final product was either packaged or further processed (e.g., spray drying, formulation, air drying, etc.). The production of botanicals involved the following compounds: ethyl alcohol, toluene, methanol, acetone, heptane, isopropyl alcohol, hydrochloric acid, sulfuric acid, caustic, calcium oxide and formaldehyde. Building 2 was used for the extraction and milling of various botanicals such as cascara, quassia, mate and guarana. Building 16 was utilized for processing soap bark. Buildings 12, 13 and 14 were used for the manufacture of piperidine ester, the purification of quassia, and the extraction of henna leaves. Hazardous wastes associated with the manufacture and processing of botanicals were unspecified waste solvents which were stored in underground storage tank (UST) #66, which also received other unspecified plant wastes (Penick 1984).

As of the 1984 Initial ECRA Notice of Requirements, the remaining buildings on the property housed administrative and technical departments or were dormant. There was no additional information provided for the historical use of the dormant buildings under the Penick operational period. Background information indicates there were no surface impoundments or secured landfills used to contain hazardous wastes at the site (Penick 1984.) Locations of buildings and some areas of concern identified in this report are depicted in historical background information (see Figures 2 and 8).

In February 1986, Penco of Lyndhurst, Inc. (Penco) purchased the Penick property including its botanical and pharmaceutical operations. Prior to this sale, Penick sold its pesticides operations to Rousell-Uclaf (Cole 1997).

Penco of Lyndhurst - Operational History

The property was acquired in 1986 by Penco of Lyndhurst with facility operations running from 1986 through 1993 (Cole 1997). Operations during the Penco ownership period are identified as the manufacture of botanicals and acetaminophen (Cole 1997).

A list of annual hazardous materials storage under Penick Corporation and Penco of Lyndhurst operations is presented in Table 1. A summary of materials storage within above ground storage tanks under Penco operations is provided in Table 2. A summary of regulatory permits issued for Penco of Lyndhurst operations is provided in Table 3.

In April 1993, Penco filed for bankruptcy and terminated operations subjecting the company and property to ISRA requirements (Langan 1995; Cole 1997). Background files indicate that in June 1996, building No. 11 was damaged by fire and building No. 28 had burned to the ground (NJDEP 2011).

There are currently three responsible parties associated with the site: Railroad Junction Associates, LLC (RJA) of Edgewater, New Jersey and North Atlantic Properties, LLC of Edgewater, New Jersey associated with Penco ownership; and Unilever United States, Inc. (aka CPC International) of Englewood Cliffs, New Jersey associated with Penick ownership (ESI 2007).

Present Operations

The entire site was razed in early 1999 and re-developed to its current state as a shopping mall containing multiple buildings and several commercial businesses, some of which include ShopRite, GNC, Staples, Supercuts, Blockbuster and Washington Mutual Bank.

Site and Remedial Investigation/Action History

Documented Spills Under Penick Corporation Operations: 1977 to 1983

Several discharges in liquid and solid form were documented under former Penick operations from May 1977 through August 1983. Specific details of these discharges were limited and are summarized in Table 4.

Groundwater Investigation and Remedial Actions: 1980 to 1982

A large toluene release occurred on May 9, 1980 due to the rupture of a 10,000 gallon underground storage tank (UST #24); however, other documents report UST #24 having a 6,000 gallon capacity (Langan 1990). The spill was reported to the NJDEP, but the quantity of the spill was not determined. The following year, evidence of the discharge was documented as trees dying in the immediate area of the spill, deteriorating asphalt and toluene odors in the basement of a nearby Penick building. Based on this information, a "Notification of Hazardous Waste Site" report was filed with the US EPA requiring the subsequent installation of 8 groundwater monitoring wells to delineate the extent of toluene contamination in groundwater (Penick 1984, Langan 1990, 1995). A second discharge from UST#24 in 1981 led to its removal in 1982 (Versar, 1985).

Under NJDEP oversight, placement and installation of groundwater wells began in December 1981 and was completed by April 1982 (Penick 1984, Langan 1990). As of February 1982, it was reported that the extent of the toluene plume "had migrated to the plant's northern property line but had not reached adjacent properties" (Penick 1984; Langan 1995). On June 2, 1982 a meeting was held with Penick, NJDEP, and Township of Lyndhurst officials who agreed to Penick's proposal to install a groundwater interceptor trench to capture the toluene plume and prevent off-site contaminant migration. A letter agreement was executed between Penick and the Township of Lyndhurst for the construction, operation and monitoring of this system with the system being completed and operational by October 1982 (NEPCC 1982; Penick 1984).

To address toluene contamination, a groundwater recovery system was installed (August 1982 to October 1982) in the form of two interceptor trenches approved by the NJDEP and the Township of Lyndhurst. Trench A was installed at the northern property line along New York Avenue to help prevent off-site contaminant migration. Trench B was installed at the central area of the toluene plume within the property near Building 28 to minimize contaminant migration and expansion of the contaminant plume (see Figures 2 and 3). This system was put into operation in October 1982 (Langan 1995).

Air test results were conducted on February 23 and April 2, 1982 showing toluene was present in air to the property line; however, it was reported that toluene did not reach the neighboring properties (Penick 1984).

Initial Site Investigations: 1984 to 1985

On April 30, 1984, Penick notified the NJDEP of its intent to sell the site property and operations triggering NJDEP Environmental Cleanup Responsibility Act (ECRA) requirements. Environmental investigations conducted by the Penick consultant, Versar, Incorporated (Versar) of Springfield, Virginia, indicated the presence of pesticides, metals, PAHs and volatile organic compounds in property soils and groundwater. However, the NJDEP rejected the analytical data from this investigation as Versar failed to properly document quality assurance/quality control procedures (Langan 1990, 1995). It was noted that an inspection reported in the 1984 ECRA Notification indicated Buildings 6 and 7 were contaminated with the following pesticides: 4,4’- DDT, 4,4’-DDE, lindane, and chlordane. The second floor of Building 7 contained chlordane at 11,300 milligrams per kilogram (mg/kg) with the other three pesticides found at lower unspecified concentrations (Penick 1984).

Subsequent Site Investigations: 1986 to 1991

A second investigation of the site was completed in 1987 by Dames & Moore of Cranford, New Jersey. This investigation included the collection of 113 soil and 24 ground water samples. Details of this investigation indicate that soil was contaminated with VOCs, SVOCs, metals, PCBs, petroleum hydrocarbons (PHCs) and pesticides above NJDEP cleanup criteria. Ground water analysis indicated the presence of VOCs (specifically benzene and toluene), SVOCs, PHCs, and metals above NJDEP groundwater quality criteria (Langan 1995).

Groundwater investigations were expanded in March and August 1989 to delineate potential off-site migration of contaminants to the residential area along New York Avenue, down-gradient from Interceptor Trench A (Langan 1990). This investigation included the installation of an additional 13 monitoring wells to those existing from previous investigations (Langan 1990, 1995). Results of this investigation indicated the groundwater intercept system was effectively capturing the groundwater toluene plume and preventing off-site migration. The investigation also identified the migration of VOC contamination into the underlying bedrock aquifer and further delineated the presence of two smaller distinct benzene groundwater plumes near the intersection New York Avenue and Lafayette Place (Langan 1995).

Additional soil investigations were conducted in 1991 with the collection of 92 soil samples in various site areas which were known to exceed NJDEP soil cleanup criteria. Based on the results of this investigation, three site-specific areas known as OPA-46, OPA-53 and the leach tank area (near Building No. 19) were identified for remedial action (Langan 1995).

South Drainage Ditch Investigation

This drainage ditch is located along the southern property boundary between the site and the adjacent New Jersey Transit Railroad right-of-way. This ditch was within a freshwater wetlands area and consisted of a man-made unlined channel, approximately two to four feet wide, designed to receive waste water and storm water run-off from the site (NJDEP, undated). The ditch flowed along the transit right-of-way for approximately 1,500 feet. The ditch is characterized as fill material consisting of sand and cinders overlying glacial till. Groundwater depth in the ditch area varied from being present at the surface near its beginning to approximately 4.25 feet over 400 feet downstream (Langan 1993).

In 1981, there was a reported discharge of 3,000 to 5,000 gallons of acetaminophen (N-(hydroxyphenyl)-acetamide) to the ditch area (NJDEP, undated). This drainage ditch was evaluated several times in 1987 through 1993 which determined soil/sediments, groundwater and standing water within and in the vicinity of the ditch were impacted with contaminants which included VOCs, SVOCs, PAHs, pesticides, and metals (Langan 1990, 1993a, 1995). In June 1991, the South Drainage Ditch Area was remediated through the removal and off-site disposal of approximately 1,000 cubic yards of contaminated soil/sediment (Langan 1991a). Full remediation and restoration of the area was completed by 1993 (Langan 1993a).

Asbestos Remediation: 1991

In February 1991, an investigation of insulation material on piping and ground surfaces at the site’s Equipment Storage Area verified the presence of asbestos. Asbestos was present in five out of twelve samples of insulation material sampled. During the same month, approximately one cubic yard of asbestos-containing material was bagged, removed from the Equipment Storage Area and disposed under NJDEP oversight.

Phase I, II, & III On-Site Soil Remediation: 1991

From February through November 1991, a total of approximately 1,606 cubic yards of contaminated site soil was excavated and disposed of at an off-site facility as part of the site’s initial soil cleanup actions. Remediation detailing quantity of soil removed by area and date is summarized in Table 5a (Langan 1991a,b, 1992, 1993b).

Concerning OPA No. 53, soils contaminated with base/neutral organic compounds were not remediated from this area as it is located in one of the main transportation and utility corridors below the site. Therefore, remedial actions were addressed through the draft deed notice submitted in April 2008 to address remaining soil contamination at the property (Langan 1992, 2008).

Former UST No. 95 (T95) Area

In June 2002, the NJDEP required RJA to conduct further investigation on the site property in an area where the former UST No. 95 (T95) was located (see Figure 4). T95 was previously located approximately 75 feet west of the current Washington Mutual Bank. Investigations performed in the area in 2003 indicated the presence of benzene and toluene exceeding the state soil and groundwater cleanup standards. Soil samples were collected in May and June 2007 at depths ranging from 5.5 to 10 feet below ground surface. Soil samples collected from the T95 area during removal activities indicated benzene was detected at concentrations ranging from non-detect to 719 mg/kg exceeding the NJDEP's Impact to Groundwater Soil Cleanup Criteria (IGWSCC - most stringent criteria) of 1 mg/kg. Soil samples collected from the T95 area indicated toluene was detected at concentrations ranging from non-detect to 9,340 mg/kg exceeding the NJDEP's IGWSCC of 500 mg/kg. Additionally, 1,2-dichloroethane was detected in soil concentrations ranging from non-detect to 11.4 mg/kg exceeding the NJDEP's IGWSCC of 1 mg/kg. Groundwater samples collected in March 2007 during remedial activities indicated benzene was detected at 62.5 parts per billion (ppb) exceeding the NJDEP Groundwater Quality Standards (GWQS) of 1 ppb. Toluene was not detected above the GWQS (ESI 2007). Based on these findings, NJDEP required remedial actions to address benzene contamination in soil acting as a source for groundwater contamination. Approximately 3,100 cubic yards of contaminated soil was excavated from May through August 2007 which included the collection and disposal of 38,350 gallons of benzene and toluene contaminated groundwater as part of the removal activities. Follow-up groundwater sampling conducted in May 2008 indicated there were no detections of the above contaminants present (ESI 2008).

Additionally, during remedial activities an unknown UST was encountered in the area of T95 requiring its removal in July 2007. RJA is listed as the owner of this UST, with a documented capacity of 1,000 gallons and noted to be filled with sludge and groundwater. The UST was located approximately 45 feet to the west of the Washington Mutual Bank. Soil samples collected from this UST area in July 2007 indicated benzene was detected at concentrations ranging from 0.259 to 17.3 mg/kg, exceeding the NJDEP IGWSCC of 1 mg/kg. Benzo(a)pyrene was also detected at a maximum concentration of 0.762 mg/kg, marginally above the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC) of 0.66 mg/kg (ESI 2007). The UST and its contents were disposed of at approved facilities in July, August and September 2007 (ESI 2007).

Former UST No. 111 Area

UST No. 111 had a capacity of 10,000 gallons and was used to store waste oil produced by facility operations. This tank was no longer in service by the time of site investigations conducted in 1990 during which time it had failed a tank integrity test (Langan 1990; see Table 5b). Remedial investigation of this tank in May 1987 indicated subsurface soils were impacted with several metals, SVOCs, and pesticides (Langan 1990).

In March 2007, NJDEP requested this area be further investigated as part of site remedial activities. Investigation of this area was conducted in March 2007 and June 2007 where benzene and toluene were detected below state soil cleanup criteria of 1 ppb and 1,000 ppb, respectively (ESI 2007).

Groundwater Treatment and Bioremediation System

The present groundwater treatment system consists of pumping toluene-contaminated groundwater from three on-site sumps located within two groundwater intercept trenches. Treatment of recovered contaminated groundwater is performed by using a clarifier to remove solids, bag filters to remove iron and a shallow tray air stripper to remove toluene from recovered water. Air stripping of toluene occurs in two phases. The first phase is within the clarifier where an air sparging blower aerates recovered groundwater to aid in both volatilization of toluene and precipitation of iron. The second phase of air stripping occurs within the air stripping unit to further volatilize toluene from recovered groundwater. Once toluene is volatilized to its gaseous state it is recovered through a set of vapor phase carbon units. This air stripping system is reported to have a toluene removal efficiency of 99.9 percent. A bioventing system was installed in March 2000 and consists of injecting air at 69 points located across the toluene plume area to provide oxygen to aid in facilitating active bioremediation. This system is capable of delivering at least 1,380 pounds of atmospheric oxygen to the subsurface per day (NJDEP 2008; Langan 2011).

Beginning August 15, 2000, a nutrient injection program was initiated where nitrogen, phosphorous, and potassium are periodically injected into three infiltration galleries located within the shallow groundwater to enhance bioremediation activities (NJDEP 2008; Langan 2009, 2011). Monitoring wells MW-51, MW-52, P-3A, P-5, P-8 and P-9 are sampled on a quarterly basis to monitor levels of nitrate, nitrite, phosphorous and potassium to ensure they are within NJDEP permit guidelines. It is noted that high concentrations of potassium were observed in groundwater following the start of the nutrient injection program with the highest levels observed in January 2004. The cause of these high levels was found to be from the addition of nutrients high in potassium. As potassium is not consumed during biological activity, an alternate potassium-free nutrient supply, diammonium phosphate anhydrous (DAP), has been used since February 2002. Potassium levels have been on a decreasing trend following the recorded high in January 2004. A recent Permit-By-Rule application was submitted to the NJDEP on January 3, 2011 for the continued operation of this treatment system.

The current state of the toluene plume extends from the north and west of the original spill area. Historically, the toluene plume was approximately 3.5 acres in size; however, active containment and recovery through the groundwater intercept trenches (Trenches A and B) has significantly reduced the size of the plume. Presently, the toluene removal rate by the on-site treatment system is estimated to be approximately 613 to 1,227 pounds per year. This system is monitored on a monthly basis to ensure it is operating in accordance with NJDEP permit requirements (Langan 2011).

Current Site Status

In response to a Notice of Deficiency issued by the NJDEP in November 2007, a draft deed notice was submitted in April 2008 to address remaining soil contamination at the property (Langan 2008). The deed notice encompasses the entire site property consisting of Block 79, Lots 1 and 2 and Block 73, Lots 1 and 3 (see Figure 5). Details of remaining site contamination for the deed notice areas are detailed in the *Environmental Contamination* section of this report. This draft deed notice remains under review with the NJDEP at the time of this report preparation.

Geology and Hydrogeology

According to the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey for Bergen County, New Jersey, soils in the vicinity of the site area are described as Boonton-Urban land soils. Boonton soils are described as an unsorted glacial till originating from red sandstone, basalt, shale, and diabase. Urban land soils are described as soils which have been disturbed and covered by an impermeable surface (ESI 2007/2008).

The general vicinity of the site is located within the Piedmont physiographic province on glacio-fluvial Pleistocene deposits overlying Pleistocene glacial till deposits. The glacio-fluvial deposits range from 15 to 25 feet in thickness. Underlying the Pleistocene glacial till deposits is the red shale and sandstone of the Passaic Formation of the Newark Group. The bedrock aquifer for the area is situated within the Triassic Age Passaic Shale Formation (ESI 2007/2008).

Regarding the site-specific area, below the property, fill material is present ranging in depths of 0 to 6 feet, with the thickest portions present on the southern side of the property. The fill has been characterized as red-brown-to-black, fine-to-medium-grained sand with trace-to-some amounts of gravel. On the eastern side of the property, the fill material is underlain by alluvium ranging in thickness from 4 to 10 feet. The alluvium deposits make up the uppermost unconfined water-bearing zone flowing in a west-northwesterly direction (ESI 2008; Langan 2009, 2011).

On the western side of the property, the fill material is underlain by glacial till ranging in thickness from 17 to 30 feet. This glacial till unit consists of clay, sand, gravel and cobbles and is considered the uppermost water-bearing zone for this area.

Groundwater within this unit and the alluvium unit are considered to represent the overburden (uppermost) aquifer (William Carp, NJDEP, personal communication, July 2010). Groundwater within the overburden aquifer flows in a west-northwesterly direction towards the Passaic River, located between ½ to 1 mile from the site (ESI 2008; Langan 2009, 2011).

Bedrock occurs below the glacial and alluvial till units and is composed of shale and siltstone of the Passaic Formation. Groundwater within this unit also flows in a west-northwesterly direction (Langan 2009, 2011).

Groundwater beneath the site is not used as source for potable water. Residents of Lyndhurst are supplied drinking water by United Water-Jersey City which obtains its water from the Boonton Reservoir (ESI 2007/2008). A preliminary assessment completed for the site in 1984 indicates that during this period the Jersey City Water Supply Company supplied potable water to residents (NJDEP 1984). This preliminary assessment also indicates that a community well was located in Lyndhurst and made available to residents to supplement their public water supply (NJDEP 1984). It is noted this community well was impacted with VOC contamination, including benzene, however, NJDEP has determined this well lies up-gradient to and has not been impacted from contamination associated with the former Penick/Penco site (H. Dudar, NJDEP, personal communication, November 25, 2008).

Demographics

Using 2000 United States Census data, the ATSDR estimates that there are about 25,241 individuals residing within a one-mile radius of the former Penick/Penco Lyndhurst facility (see Figure 6).

Community Health Concerns

In the past, area residents have expressed concern over exposures to site-related contaminants from the former Penick/Penco facility. On August 4, 2008, Cancer Epidemiology Services (CES) of NJDOH participated in a conference call with Ms. Joyce Jacobson, Lyndhurst Health Administrator, in response to continued concerns relayed to her from area residents about cancer rates in Lyndhurst, New Jersey.

The main concerns to residents are the long-term health effects and cancer rates within Lyndhurst for individuals who may have been exposed to contaminants associated with the former Penick/Penco site. In response to these concerns, CES completed standard incidence ratio (SIR) analysis reports in 2008, 2010 and 2011 looking at cancer rates in Lyndhurst. The findings of these assessments are provided in the Health Outcome Data section of this report and also in Appendix A.

Past ATSDR/NJDOH Involvement

ATSDR and NJDOH had toured the former site on August 20, 2008 and began gathering environmental data from the NJDEP, and Lyndhurst Township records. We held two Availability Sessions on October 30, 2008, to meet with residents and to further learn about community concerns.

Of primary importance to residents was to ensure that there are no on-going exposures to site-related contaminants. Our initial plan of action was to develop a health consultation to identify health risks from the site, and determine how they may affect public health in the past, present and future.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two tiered approach: 1) a screening analysis; and 2) a more in-depth analysis to determine public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media-specific environmental guideline comparison values (CVs). If concentrations exceed the environmental guideline CV, these substances, referred to as Contaminants of Concern (COC), are selected for further evaluation. Contaminant levels above environmental guideline CVs do not mean that adverse health effects are likely, but that further evaluation is necessary. Once exposure doses are estimated, they are compared with health guideline CVs to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

There are a number of CVs available for the screening environmental contaminants to identify COCs. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) are also considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million persons exposed during their lifetimes (70 years). In the absence of an ATSDR CV, other comparison values may be used to evaluate contaminant levels in environmental media. These include the US EPA Maximum Contaminant Levels (MCLs), Lifetime Health Advisory (LTHA) and the NJDEP GWQC for drinking water and the US EPA Region 6 Human Health Media-Specific Screening Levels (SLs) for air. These health-based benchmarks are derived from the evaluation of cancer and non-cancer effects using current toxicity criteria.

Substances exceeding applicable environmental guideline CVs are identified as COCs and evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed receptor populations. If environmental guideline CVs are unavailable, these contaminants are selected for further evaluation.

Groundwater

Overburden (Uppermost) Aquifer: Penick/Penco Property

Data was reviewed from over 1,000 groundwater samples collected from 71 groundwater monitoring wells during the period of June 1987 through January 2010. Based on recent sampling efforts in 2009, the depth of collection for groundwater samples for the overburden aquifer was approximately from 3 to 13 feet below ground surface. The monitoring wells were placed within the overburden aquifer at depths of approximately 6 to 20 feet below ground surface. The wells were installed between December 1981 through May 2007 (Langan 2004b, 2009). Groundwater sampling was conducted as part of the RI activities overseen by the NJDEP.

Based on maximum concentrations, the following contaminants were detected above their respective environmental CVs (see Table 6): benzene, bromodichloromethane, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, 1,2-dichloroethane (1,2-DCA), cis 1,2-dichloroethene (cis 1,2-DCE), 1,2-dichloropropane, tetrachloroethylene (PCE), toluene, trichloroethylene (TCE), vinyl chloride, bis(2-ethylhexyl)phthalate, nitrobenzene, phenol, dichlorodiphenyldichloroethane (4,4'- DDD), dichlorodiphenyldichloroethylene (4,4'-DDE), dichlorodiphenyltrichloroethane (4,4'- DDT), chlordane, hexachlorocyclohexane (alpha, beta, and delta), dieldrin, aluminum, antimony, arsenic, beryllium, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel, potassium, selenium, sodium, thallium, zinc, and total dissolved solids. Based on these data, the above identified contaminants are considered COCs in groundwater for the overburden aquifer. The main COCs within this aquifer are benzene and toluene as depicted in the July 2009 isopleth map (see Figure 7). It is noted that the toluene plume is under active remediation via the groundwater intercept (recovery) trenches and infiltration galleries (see Figure 7). Natural attenuation has been approved by the NJDEP to address the benzene groundwater plume (Langan 2004a).

Under the current semi-annual and quarterly groundwater monitoring sampling program, 25 monitoring wells within the overburden aquifer are sampled. The number of active monitoring wells within this aquifer total 37 which are all used to gauge groundwater depth and flow direction. The remaining wells were closed at various dates between 1994 through 2001 as part of property development (Langan 2004b, 2009).

Shallow Bedrock Aquifer: Penick/Penco Property

Data was reviewed from 66 groundwater samples collected from four groundwater monitoring wells during the period of June 1987 through January 2010. The monitoring wells were placed within this bedrock aquifer which is approximately between 53 to 70 feet below ground surface within the Brunswick Formation. The wells were installed between 1981 through 1991 (Langan 2004b, 2009).

Based on maximum concentrations, the following contaminants were detected above their respective environmental CVs (see Table 7): benzene, 1,2-DCA, cis 1,2-DCE, PCE, toluene, TCE, vinyl chloride, 4,4'- DDD, 4,4'- DDE, arsenic, mercury, thallium, and total dissolved solids. Based on these data, the above identified contaminants are considered COCs in groundwater for the bedrock aquifer. The main COCs within this aquifer are benzene and toluene.

Under the current semi-annual and quarterly groundwater monitoring sampling program, two bedrock wells remain. The other two bedrock wells were closed under NJDEP approval as part of the development of the property (Langan 2004c, 2009).

Deep Bedrock Aquifer: Penick/Penco Facility Process Wells

Data was reviewed from five groundwater samples collected from four groundwater site process wells (PW-1, PW-3, PW-4, and PW-5) during the period of June 1987 through January 1998. The wells were placed within the deep bedrock aquifer between 267 to 410 feet below ground surface. The wells were installed in October 1938, February 1942, January 1958, and August 1968 (Langan 2004c, 2009). An additional process well, PW-2, was installed in March 1941; however, no sampling data was available for this well.

Based on maximum concentrations, the following contaminants were detected above their respective environmental CVs: methylene chloride, PCE, TCE, 4,4'- DDE, arsenic, iron, lead, mercury, nickel, thallium, and zinc (see Table 8). Based on these data, the above identified contaminants are considered COCs in groundwater for the deep bedrock aquifer.

Under the current semi-annual and quarterly groundwater monitoring sampling program, former process well PW-4 remains and is used as an injection well for the groundwater remediation system. The remaining four wells were closed under NJDEP approval as part of the development of the property (Langan 2004b, 2009).

Soil

Current Site Conditions - Penick/Penco Property

Remaining site contamination is being addressed for the property in an April 2008 draft deed notice currently under review by the NJDEP. Regarding surface soils (0-0.5 feet), organochlorine pesticides, metals, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) remain present at concentrations above the NJDEP Non-Residential Soil Cleanup Criteria (NRDCSCC) and the applicable environmental guideline comparison values. Regarding subsurface soil (0.5-10 feet), contaminants remaining include the analytical groups listed above and additionally include volatile organic compounds (VOCs). Under the conditions of the deed notice, future site use will be restricted to non-residential use (William Carp, personal communication December 10, 2010).

Based on maximum concentrations detected, COCs remaining in surface soil exceeding the NJDEP NRDCSCC and the applicable environmental guideline comparison values include chlordane, dichlorodiphenyltrichloroethane (4,4'-DDT), dichlorodiphenyldichloroethane (4,4'- DDD), dichlorodiphenyldichloroethylene (4,4'-DDE), beryllium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene (see Table 9). The areas of concern associated with former site operations where these COCs are present include Former Foam Basin Area, Former OPA-53 Area, Former UST No. 78, and non-specific site areas (see Figures 8 and 9).

Based on maximum concentrations detected, COCs remaining in subsurface soil include chlordane, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, heptachlor, arsenic, beryllium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, dibenzo(1,2,3-cd)pyrene, benzene, toluene, tetrachloroethylene (PCE) and total petroleum hydrocarbons (TPHCs) (see Table 10). The areas of concern associated with former site operations where these COCs are present include Former Building 19, Former Foam Basin Area, Former OPA-53 Area, Former UST No. 78, Former UST No. 111, Former Railroad Siding Area, Former Vent Overflow Area, Former Tank No. 4, I6-3 Area, Boring 27-1, Former Wastewater Treatment Pit and non-specific site areas (see Figures 8 and 9).

Historic Site Conditions - Penick/Penco Property

South Drainage Ditch (includes Soil, Groundwater, Sediment, and Surface Water)

This drainage ditch is located off-site on the adjacent New Jersey Transit Railroad right-of-way within a freshwater wetlands area. This drainage ditch was evaluated several times in 1987 through 1993 to determine whether soil/sediments, groundwater and ditch surface water within and in the vicinity of the ditch was impacted with contaminants from site operations (Langan 1990, 1993).

Surface and subsurface soil was collected from the drainage ditch area in April 1987 and March 1989. Based on maximum concentrations detected from 18 surface soil (0 – 0.5 feet) samples collected, COCs include arsenic, cadmium, copper, lead, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, aroclor 1254, chlordane, 4-4'- DDD, 4-4'- DDE, 4-4'-DDT, and phenol (see Table 11). Based on maximum concentrations detected from 11 subsurface soil (1 - 8.5 feet) samples collected, COCs include arsenic and benzene (see Table 12). Contaminated soil was removed from the area of monitoring wells MW-36 and MW- 37 during remedial actions which included the replacement of 480 feet of sanitary sewer line (between June and August 1991) believed to be the source of the 4-nitrophenol (Langan 1991a; NJDEP Track Sheet). Conclusions from the assessment indicated the source of SVOC in this area likely originated from leakage of the underground sanitary line. A dye test performed in June 1993 indicated that a storm sewer line between Penco Building Nos. 41 and 43 discharged to the drainage ditch (Langan 1993). The source of VOC contamination for this area was not identified (Langan 1990, 1993).

Groundwater samples from six on-site monitoring wells (MW-10, MW-11, MW-16, MW-36A, MW-37A, MW-38 and MW-43) and three off-site monitoring wells (MW-44, MW-45 and MW-46) were collected to evaluate impacts to the ditch area (Langan 1990, 1993). Groundwater was sampled in April and June 1993 from a total of 10 monitoring wells and was found to be impacted with several VOCs and SVOCs, including several non-targeted compounds. Based on maximum concentrations detected in 14 groundwater samples collected, COCs in groundwater near and within the ditch area include benzene, chlorobenzene, toluene, xylene, benzo(a)anthracene, 4-nitrophenol, phenol, a-ethylhexanoic acid, acetaminophen (N-(hydroxyphenyl) acetamide isomer), N-phenylacetamide, arsenic, beryllium, chromium, copper, lead, nickel and thallium (see Table 13). The non-targeted compounds N-(hydroxyphenyl)-acetamide and N-phenylacetamide are associated with acetaminophen-related operations conducted in Building Nos. 41A and 43 (Langan 1993).

Sediments within the drainage ditch area running along the south side of the property, where it adjoins the New Jersey Transit Railroad right-of-way, were found to be impacted with several contaminants, including toluene, phenol and 4-nitrophenol (Langan 1991a). Phenol and 4-nitrophenol are associated with acetaminophen manufacturing conducted in Building No. 41A (Langan 1993). These impacts were noted to occur near the location of monitoring wells MW-36 and MW-37 (see Figure 10).

Standing water samples from seven locations within the ditch were collected during April and June 1993 to determine if past discharges and contaminated groundwater had impacted the area. Based on maximum concentrations detected in 9 standing water samples collected, COCs in standing water within the ditch include benzene, toluene, 4-nitrophenol, aldrin, hepachlor, arsenic and lead (see Table 14). Additionally, several library search compounds were detected at concentrations exceeding 1,000 micrograms per liter (ug/L) including several ester-based compounds where, according to background information, ester products were manufactured in Building Nos. 41B and 43 under Penco operations (Langan 1993). In June 1993, four additional surface water samples from within the ditch were analyzed and found to have no contaminants above the NJDEP GWQS or Class FW-2 surface water quality standards (NJDEP Track sheet; Langan 1993). It is further noted that the NJDEP has not classified the standing water within this ditch and there are no known surface water bodies on the subject property (Langan 2003, 2004a). Standing water within this ditch was likely present due in part to both the shallow groundwater table in the area and also a result of run-off from site and nearby areas (Langan 1993). The closest surface water body is the Passaic River located approximately one mile west of the site (Langan 2004a).

Documentation indicates contamination within the former ditch area had not migrated off-site based upon groundwater data from down-gradient monitoring wells MW-45 and MW-46 (Langan 1993). Further, based on groundwater and surface water data, the NJDEP indicated contamination within the ditch was the result of surface discharges and not from groundwater (NJDEP, undated). In 1991, approximately 1,000 cubic yards of contaminated soil and sediment were removed from this area as part of site remedial activities (Langan 1991a). Additionally, remedial activities included raising the elevation of the ditch to prevent groundwater from entering this area (Langan 1993).

Waste Water Treatment Plant

The facility maintained an industrial sewer pre-treatment pit located on the western portion of the property. Observations of the pit in August 1997 indicated the likely presence of oil, as globules. In April 1999, as part of remedial and facility decommissioning activities, approximately 47 tons of sludge was removed from the settling pit of the facility's waste water treatment plant. Analysis of the sludge indicated lead was present at hazardous levels (7.3 mg/kg) requiring off-site transport and disposal at an approved treatment facility. The integrity of the settling pit was inspected and found not to have been compromised according to NJDEP documentation. Further, NJDEP documents indicate this pit was demolished and backfilled with non-hazardous masonry material from the demolition of other facility structures (NJDEP, undated).

Building 18

Radioactive material (uranium and thorium) was used in this building for approximately 30 operational years as laboratory chemicals in quality control processes. Annual use is documented at less than 100 milliliters per year. Approximately 10 pounds of radioactive waste material was disposed off-site following site cleanup operations in November 1997 according to NJDEP information. The NJDEP approved a No Further Action in May 1998 for the investigation and closure of the radioactive hazardous wastes associated with this building (NJDEP 2011).

Former UST Locations

Site and remedial investigations were conducted in April through September 1987 at 12 UST locations on the property. Subsurface soil samples were collected at various depths ranging from 0.74 to 3.75 feet below ground surface. Analytical results from 28 samples collected indicate several metals, PAHs, and pesticides were detected above their respective environmental CVs at 11 of the identified USTs. Contaminants detected included arsenic, beryllium, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, chlordane, 4,4'- DDD, 4,4'- DDE, and 4,4'- DDT, heptachlor epoxide, 1,1,2,2 – tetrachloroethane, and total petroleum hydrocarbons (see Table 15).

Former Toluene Spill Area

Site and remedial investigations were conducted in April 1987 at the former toluene spill area located near Building 28 on the property. Seven surface soil samples were collected from 0 to 0.25 feet and eight subsurface soil samples were collected at various depths ranging from 1.75 to 4.17 feet below ground surface. Analytical results indicate arsenic was detected above the respective environmental guideline comparison value in both surface and subsurface samples. Analytical data for soil samples collected from this area are presented in Table 16.

Additional On-Site Areas

Site investigations conducted in April 1987 for several other areas of concern on the property including the catch basin, equipment storage area, drum storage area, foam basin area, soil stained area and a vent overflow area. Surface soil samples within 0 to 0.5 feet from these areas indicate arsenic, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, phenanthrene, indeno (1,2,3-cd) pyrene, beta–hexachlorocyclohexane, chlordane, 4,4'- DDD, 4,4'- DDE, and 4,4'- DDT were detected above their respective environmental guideline comparison values. Subsurface soil (1.08 to 4.08 feet) collected in the vent overflow area indicated one of the five samples exceeded the NJDEP soil cleanup criteria for total petroleum hydrocarbons. Analytical data for soil samples collected from these areas are presented in Tables 17 through 23.

Random Site-Wide Sampling Areas

Site and remedial investigations were conducted in April through August 1987 at random areas on the property. Up to 51 soil samples were collected, however, the sampling depth was denoted as 0 to 2 feet. Therefore, to be conservative, as ATSDR considered the top three inches of soil as the direct contact layer, all data from these sampling events are considered to have been accessible for direct contact. Analytical results indicate arsenic, cadmium, copper, lead, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, aroclor 1254, chlordane, 4,4'- DDD, 4,4'- DDE, 4,4'- DDT, dieldrin, and heptachlor epoxide were detected above their respective environmental guideline comparison values. Analytical data for soil samples collected from this area are presented in Table 24.

Indoor Air

Vapor Intrusion Investigation – NJDEP, April 2009

A vapor intrusion investigation was conducted at four residential properties (Residences A through D) to determine whether vapors from site-related contaminants in groundwater were entering the homes and contaminating indoor air (see Figure 11). These residences were selected by the NJDEP as they are located within 100 feet of a monitoring well in which site-related contaminants have been shown to exceed their respective Generic Vapor Intrusion Screening Levels for Groundwater (GVISLG) prompting requirements for a vapor intrusion assessment to be conducted. Based on the most recent data, contaminants exceeding the GVISLG included 1,2-dichloropropane and 1,2-dichloroethane for MW-23 and carbon tetrachloride and tetrachloroethylene for MW-27. Benzene and toluene were below the NJDEP GVISLG for both the above monitoring wells. In order to expedite this investigation, the NJDEP initiated these investigation efforts in April 2009 in lieu of waiting for the responsible party to fulfill this requirement by June 2009.

In addition to indoor air, soil gas samples were collected by NJDEP to determine whether site-related contaminants posed a threat of vapor intrusion to the four residences investigated, one of which included a daycare operation within the basement of the residence. Soil gas data was used to identify if a vapor intrusion source was located below the structures. A summary of site-related contaminants detected in soil gas and indoor air for the investigated properties has been evaluated for the April 2009 investigation event.

Sub-slab/Soil Gas

One soil gas sample was collected from below the basement floor for each of the four residences, including the Lyndhurst Day-care Center. Sub-slab and soil gas samples were analyzed for targeted VOCs, using US EPA Method TO-15 methods, including the compounds present in MW-23 and MW-27 as previously indicated.

There were no contaminants detected which exceeded their respective NJDEP Generic Vapor Intrusion Screening Levels (GVISL) for indoor residential air. There were a total of four contaminants detected including cyclohexane (range non-detect to 13 micrograms per cubic meter (µg/m^3)), n-heptane (range non-detect to 25µg/m^3), and toluene (range non-detect to 13 µg/m^3). Isopropanol (isopropyl alcohol: range estimated 1,900 to 4,700 µg/m^3) was also present in sample results as this compound is used as a tracer gas for leak detection purposes during sampling. Isopropanol was detected at approximately 0.0002 percent or less which is within NJDEP sampling requirements. There are no soil gas standards for n-heptane. The NJDEP GVISL for cyclohexane and toluene are 310,000 µg/m^3 and 260,000 µg/m^3, respectively. Based on these results, there is no direct evidence that a vapor intrusion source exists below these four evaluated residences. A summary of contaminants detected in sub-slab/soil gas samples are presented in Table 25.

Nearby Residential Area – April 2009 Investigation

Indoor air samples were collected over a 24-hour period using SUMMA® canisters and analyzed for the same targeted VOCs for sub-slab/soil gas samples for the four residences (identified as Residences A through D) which includes the Lyndhurst Day-Care Center. Analysis was performed using US EPA Method TO-15 methods for samples collected during the April 2009 sampling event.

COCs detected in indoor air exceeding the environmental CVs include benzene (non-detect to 5 $\mu g/m^3$), 1,3-butadiene (non-detect to 1 $\mu g/m^3$), chloroform (non-detect to 9 $\mu g/m^3$), 1,2-DCA (non-detect to 5 $\mu g/m^3$) and methylene chloride (non-detect to 29 $\mu g/m^3$). Exceedances of one or more of the above site-related contaminants were observed at all four residences; however, it is noted that none of these contaminants were detected in all soil gas samples (see Tables 26 through 29). Additionally, groundwater monitoring data since 2001 does not indicate the benzene nor toluene groundwater contaminant plumes likely extend into the residential area (ESI 2008; Langan 2004b, 2009). Therefore, there is no evidence that contaminants detected in indoor air originate from a vapor intrusion source and are likely present from background emission and consumer sources. Regardless, as these contaminants exceeded environmental CVs, they have been included in this evaluation.

Ambient air concentrations of contaminants detected for each sampled location were within typical background concentrations observed for urban areas (see Tables 26 through 29). A list of consumer sources and typical ambient background concentrations of compounds present within investigated residences are provided in Appendix B. A list of published information sources for homeowners on how to reduce sources of indoor air contaminants, and measures to improve indoor air quality are also included in Appendix B.

Based on the review of data described above, benzene, 1,3-butadiene, chloroform, 1,2-DCA, and methylene chloride are considered COCs in indoor air for the evaluated residences.

Nearby Residential Area - Past Indoor Air Investigations May, June and October 1989

Over concerns of vapor intrusion from past discharges of toluene and benzene to groundwater, in February 1989 the NJDEP directed Penick (via CPC International) to conduct indoor air sampling of residential basements located along New York Avenue. In May and June 1989, indoor air samples were collected and analyzed for toluene and benzene from 17 study homes (identified as Residences A through Q) to assess if indoor air was impacted from site-related contamination. Study homes were located along New York Avenue and Lafayette Avenue, to the northeast of the Penick/Penco site. In addition, 16 homes (control) located in the Lyndhurst area were included in this investigation as a sample match to observe indoor air quality for area homes not impacted from the site. Seven ambient air samples were also collected to assess possible contributions from industrial sources of benzene and toluene to residential indoor air quality. Indoor air samples were collected in the basement area of both study and control homes (Dames 1989). The assessment report concluded that there was “no statistical significant difference” between the air quality in the residences of concern and the control homes (Moore 1989; Langan 1995).

Based on a review of this data, benzene is considered a COC in indoor air for 16 of the 17 study homes evaluated during this period with concentrations ranging from non-detect to 80.8 µg/m^3. Additionally, benzene was detected in all control homes sampled with concentrations ranging from 0.32 to 50.8 µg/m^3; however, it is noted that one control home had two unusually elevated concentrations of benzene. After excluding these observations, the range of benzene concentrations for the remaining 15 control homes was 0.32 to 14.1 µg/m^3. Toluene was not detected in any of the study homes nor the control homes at concentrations exceeding its environmental CV and is, therefore, not considered a COC for the study homes evaluated during this period. The average concentrations in ambient air were consistent between the study home area and the control home area for benzene (3.6 µg/m^3 vs. 2.7 µg/m^3) and for toluene (18.3 µg/m^3 vs. 13.3 µg/m^3). Data for the above indoor air investigations are presented in Tables 30 and 31.

While benzene was detected at concentrations exceeding the environmental CVs at the control homes, as these homes are not located within close proximity to the site, these detections are likely present from contributions from ambient air and possibly from consumer-related sources or products. Although similar benzene concentrations were detected in the study homes compared to the control homes and that the contaminant's presence can be associated with contributions from ambient air and possibly from consumer-related sources or products, contributions from vapor intrusion via contaminated groundwater cannot be ruled out. Therefore, based on the review of data described above, benzene is considered a COC in indoor air for 16 of the 17 evaluated residences in proximity to the former Penick/Penco site.

Overburden Aquifer – Wells within a 100 Foot Radius of Residences

Historical and current groundwater data was reviewed for monitoring wells located in close proximity to residences along New York Avenue and Lafayette Place to assess the likelihood of contaminated groundwater acting as a source for vapor intrusion. Data was reviewed from over 200 groundwater samples collected from 9 groundwater monitoring wells during the period of June 1987 through July 2010. Groundwater sampling was conducted as part of the RI activities overseen by the NJDEP.

Based on maximum concentrations, the following contaminants were detected above the NJDEP's GVISLG (see Table 32): benzene, carbon tetrachloride, chloroform, 1,2-DCA, 1,2-dichloropropane, PCE, and TCE. Based on these data, the above identified contaminants are considered COCs in groundwater for the overburden aquifer. The main COCs within this aquifer are benzene and toluene as depicted in the most recent July 2009 isopleth map (see Figure 7). It is noted that the toluene plume has been under active remediation via the groundwater intercept (recovery) trenches and infiltration galleries with operations beginning in October 1982 (see Figure 7). Additionally, based on review of groundwater monitoring data and discussion with NJDEP, monitoring wells TMW-2 and MW-24, located near the residential area, were lost due to street paving and construction activities.

Ambient Air

Former Toluene Spill Area – February 1982

At the request of the former Lyndhurst Township Chemical Engineer, ambient air samples were collected at three unpaved ground surface locations above the toluene spill area on February 1, 1982. A fourth control sample was collected at an upwind location on the site property. Samples were collected by National Institute of Occupational Safety and Health (NIOSH) recommended methods using toluene charcoal tube samplers. However, the specific method was not cited in the available documentation. The limit of detection for the method used was noted to be 0.0001 µg for toluene. Samples were documented as analyzed by the Penick plant quality control laboratory. The results of this sampling event are provided in the summary below.

Summary of Toluene Ambient Air Concentrations – Former Toluene Spill Area

Sample No. [(a)]	**Toluene Concentration µg/m^3**	**Environmental CV µg/m^3**	**Contaminant of Concern**
1	70	300 (EMEG) [(b)]	No
2	30		
3	ND		
4	40		

(a) Upwind control sample not identified in data information provided.
(b) Agency for Toxic Substances and Disease Registry – Environmental Media Evaluation Guideline (chronic exposures: more than 365 days/year)
ND – Not Detected

Summary of Contaminants of Concern for Evaluated Locations

Groundwater: Overburden (Uppermost) Aquifer			
VOCs	**SVOCs (PAHs)**	**Organochlorine Pesticides**	**Metals**
benzene, bromodichloromethane, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, 1,2-DCA, cis 1,2-DCE, 1,2-dichloropropane, PCE, toluene, TCE, vinyl chloride	bis(2-ethylhexyl)phthalate, nitrobenzene, phenol	chlordane, dieldrin, 4,4'- DDT, 4,4'- DDD, 4,4'- DDE, hexachlorocyclohexane (alpha, beta, and delta)	aluminum, antimony, arsenic, beryllium, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel, potassium, selenium, sodium, thallium, zinc, total dissolved solids

Groundwater: Shallow Bedrock Aquifer

VOCs	Organochlorine Pesticides	Metals
benzene, 1,2-DCA, cis 1,2-DCE, PCE, toluene, TCE, vinyl chloride	4,4’- DDD, 4,4’- DDE	aluminum, antimony, arsenic, beryllium, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel, potassium, selenium, sodium, thallium, zinc, total dissolved solids

Groundwater: Deep Bedrock Aquifer

VOCs	Organochlorine Pesticides	Metals
methylene chloride, PCE, TCE	4,4’- DDE	arsenic, iron, lead, mercury, nickel, thallium, zinc

Current Site Conditions – Deed Notice

Surface Soil (0-0.5 feet)

PCBs/SVOCs (PAHs)	Organochlorine Pesticides	Metals
benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene	chlordane, 4,4’-DDT, 4,4’-DDD, 4,4’-DDE	beryllium,

Subsurface Soil (0.5-10 feet)

VOCs/TPHCs	SVOCs (PAHs)	Organochlorine Pesticides	Metals
benzene, toluene, PCE, TPHCs	benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, dibenzo(1,2,3-cd)pyrene	chlordane, 4,4’- DDT, 4,4’- DDD, 4,4’- DDE, heptachlor	arsenic, beryllium

Historic Site Conditions – Pre-Remediation

Surface Soil (0-0.5 feet)

VOCs/TPHCs	SVOCs (PAHs)	Organochlorine Pesticides	Metals
benzene, TPHCs	benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, aroclor 1254 (PCB), phenols	chlordane, dieldrin, 4,4’- DDT, 4,4’- DDD, 4,4’- DDE, heptachlor epoxide	arsenic, cadmium, copper, lead, mercury

<table>
<tr><th colspan="4">Historic Site Conditions – Pre-Remediation</th></tr>
<tr><th colspan="4">Subsurface Soil (> 0.5 feet)</th></tr>
<tr><th>VOCs/TPHCs</th><th>SVOCs (PAHs)</th><th>Organochlorine Pesticides</th><th>Metals</th></tr>
<tr><td>benzene, TPHCs, 1,1,2,2-tetrachloroethane</td><td>benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, dibenzo (a,h) anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, aroclor 1254 (PCB)</td><td>chlordane,
4,4’-DDT,
4,4’- DDD,
4,4’- DDE,
β-BHC, heptachlor epoxide</td><td>arsenic, beryllium, cadmium, copper, lead, mercury,</td></tr>
<tr><th colspan="4">Nearby Residential Sampling Locations</th></tr>
<tr><th colspan="4">Current Conditions - Indoor Air</th></tr>
<tr><th colspan="2"></th><th colspan="2">VOCs</th></tr>
<tr><td colspan="2">Residence A; Residence C</td><td colspan="2">benzene, chloroform</td></tr>
<tr><td colspan="2">Residence B</td><td colspan="2">benzene, chloroform, 1,2-DCA, methylene chloride</td></tr>
<tr><td colspan="2">Residence D</td><td colspan="2">benzene, 1,3-butadiene, methylene chloride</td></tr>
<tr><th colspan="4">Historic Site Conditions - Indoor Air</th></tr>
<tr><th colspan="2"></th><th colspan="2">VOCs</th></tr>
<tr><td colspan="2">Residences A through N, P, Q: circa 1989 investigations</td><td colspan="2">benzene</td></tr>
</table>

Toxicological summaries for identified COCs are provided in Appendix C.

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to a receptor population and whether exposures to contamination are high enough to be of health concern. Site-specific exposure doses can be calculated and compared with health guideline CVs.

Assessment Methodology

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. receptor population.

Generally, the ATSDR considers three exposure categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

When assessing an exposure risk to a COC, the US EPA recommends the 95 percent upper confidence limit (95% UCL) of the arithmetic mean should be used to determine the exposure point concentrations (EPC) for site-related contaminants (US EPA 1992). An EPC is considered to be the concentration of a contaminant at the point of human exposure. The 95% UCL is considered a 'conservative estimate' of average contaminant concentrations in an environmental medium to represent the EPC. To determine EPCs, site data were analyzed using ProUCL® 4.0 (US EPA 2007) developed by the US EPA to calculate the 95% UCL.

The exposed populations for identified areas of concern include children and adults within the Lyndhurst community who live within the vicinity of the former Penick/Penco site.

The evaluated exposure pathways for site-related contaminants are presented in Table 33.

Completed Exposure Pathways

<u>Ingestion of and dermal contact with contaminated surface soils outside the site property boundary (past).</u> For the past, there is a completed exposure pathway regarding ingestion of and dermal contact with contaminated off-site surface soil (0 - 0.5 foot) for the former area described as the "south drainage ditch" which ran along the southern property boundary. This ditch received surface run-off from the property while under Penick and Penco operations. Exposed individuals include children and adults within the Lyndhurst community who may have frequented this area as access is believed to have not been restricted. Exposures at this area are considered eliminated with the remedial and restoration activities completed by 1993 (Langan 1993).

<u>Inhalation of COCs in indoor air (past).</u> For the past, an exposure pathway may have existed via vapor intrusion from site-contaminated groundwater resulting in the inhalation of air contaminated with benzene to adults and children for residences based on investigations conducted in 1989. Based on groundwater data, specifically during early groundwater investigations in the late 1980s to early 1990s, concentrations of benzene in monitoring wells within a 100-foot radius of homes located along New York Avenue and Lafayette Avenue were as high as 88,700 µg/L (see Figures 12a and 12c; Table 32). Further review of historic groundwater investigations from June 1987 show the benzene groundwater plume leading into the area at the intersection of New York

Avenue and Lafayette Avenue, specifically in the vicinity where Residences A through D are located (see Figure 13).

Based on this information and the presence of elevated levels of benzene in indoor air results collected during 1989 investigations at Residences B and D, vapor intrusion from the site-related benzene groundwater plume can neither be confirmed nor ruled out. Therefore, for the past, there is a recognized potential that resident exposures to benzene present in indoor air may have been attributable, in part, from site-related groundwater contamination. There are several issues which both support and oppose this assumption. Supporting this assumption is the indication that the boundary of the benzene groundwater plume was within the residential area where benzene was detected at elevated concentrations. In addition there were complaints by some residents to the township of solvent-like odors in their home both following the 1980 toluene spill and in survey information from the 1989 indoor air investigation.

Limitations to the assumption of vapor intrusion are the lack of soil gas data for this sampling period to verify the presence of a vapor intrusion source, contributions to indoor air from ambient and consumer-related sources and information provided in resident questionnaires indicating the storage of petroleum-based products (specifically gasoline) within the home/attached garage for some residences. Indoor storage of gasoline includes Residence B which is noted to have the highest detected concentration of benzene in indoor air for this sampling period. As there are data gaps which limit any conclusive evidence that benzene concentrations detected in indoor air for 16 of the 17 residences investigated in 1989 could be attributed whole or in part from site-related groundwater contamination, a health assessment was performed for these 16 residences.

Potential Exposure Pathways

<u>Inhalation of COCs in indoor air (present, future).</u> For the present, there does not appear to be an exposure pathway originating from site-related groundwater contamination for Residences A through D investigated by the NJDEP in April 2009. NJDEP soil gas investigation data indicate there is no source material present below these residences which were within a 100 foot radius of groundwater monitoring wells impacted by site-related contaminants. Regarding average concentrations of benzene in groundwater from monitoring wells within a 100 foot radius of the residential area, the NJDEP GVISLG of 15 was not exceeded since 2002 (see Figure 12a). Concentrations of toluene in groundwater from monitoring wells within a 100 foot radius of the residential area have never exceeded the NJDEP GVISLG of 310,000 µg/L (see Figure 12b). In addition, regarding monitoring wells closest to the residential area, benzene concentrations have been shown to be near or below the NJDEP Groundwater Quality Standard – Class IIa (GWQS) of 1 µg/L since 2002 while toluene concentrations have been near or below 1 µg/L (far below the NJDEP GWQS of 600 µg/L) since 2002 (see Figures 12c and 12d). This supports evidence that the benzene and toluene groundwater plumes have not likely extended into the residential investigation area since 2002.

Present and future exposures are considered interrupted as the NJDEP is actively monitoring groundwater contaminant levels in wells including those in close proximity to the residential area to determine if and when additional vapor intrusion investigation may be required. Therefore, the presence of benzene, 1,3-butadiene, chloroform and methylene chloride present in 2009 indoor air samples are not considered to originate from site-related groundwater contamination based on NJDEP soil gas data. These contaminants are likely present in indoor air from background and /or consumer-related sources commonly seen in indoor air sampling. A list of consumer and background related contaminant sources within homes has been included in Appendix B.

Eliminated Pathways

Ingestion of and dermal exposure to contaminated surface and subsurface soils within property boundary (past, present and future). Exposure to contaminated surface and subsurface soils within the site property boundary during the Penick/Penco operational period up to the development of the property to its current state are considered eliminated. Past exposures to surface soils within the site boundary are considered eliminated as the property maintained a security fence to prevent unauthorized access from area residents. Exposure to subsurface soils are considered eliminated as ATSDR considers the top three inches of soil as the direct contact layer for incidental ingestion and dermal contact to soil. It is noted that some historical investigation presented data for soil indicates the sample interval was taken from a 0 to 2 feet range; therefore, these samples were considered as surface soil for conservative evaluation.

At present, exposure to surface soils within the site boundary are considered eliminated as the property is covered with an asphalt/concrete cap as part of the Deed Notice for the site. This cap is an approved NJDEP remedial action to prevent exposure to remaining contaminants in underlying soil within the concentration criteria outlined in the Deed Notice.

Ingestion of groundwater (past, present, future). According to information obtained from the NJDEP, the Township of Lyndhurst is supplied with drinking water from the public water supply which does not own or maintain supply wells within the groundwater impact area of the former Penick/Penco site. As such, there were no completed exposure pathways associated with the site concerning ingestion of contaminated groundwater.

Public Health Implications of Completed Exposure Pathways

Once it has been determined that individuals have or are likely to come in contact with site-related contaminants (i.e., a completed exposure pathway), the next step in the public health assessment process is the calculation of site-specific exposure doses. This is called a health guideline comparison which involves looking more closely at site-specific exposure conditions, the estimation of exposure doses, and comparison to health guideline CVs. Health guideline CVs are based on data drawn from the epidemiologic and toxicologic literature and often include uncertainty or safety factors to ensure that they are amply protective of human health.

Non-Cancer Health Effects

To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15-364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. In order to provide additional perspective on these health effects, the calculated exposure doses were then compared to observed effect levels (e.g., NOAEL, LOAEL). As the exposure dose increases beyond the MRL to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

If the NOAEL or LOAEL is not available, the BMDL (benchmark dose level) or BMCL (benchmark concentration level) can be used. The BMD or BMC is a dose or concentration that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background. The BMD or BMC can be used as an alternative to the NOAEL/LOAEL in dose-response assessment. The lower limit of the BMDL or BMCL is a characterization of the dose or concentration corresponding to a specified increase in the probability of a specified response. For example, a BMDL_{10} or BMCL_{10} is the lower confidence limit of the estimated dose corresponding to an increase of 0.10 in the probability of the specified response relative to the probability of that same response at dose zero (ATSDR 2008).

When MRLs for specific contaminants are unavailable, other health based comparison values such as the US EPA's Reference Dose (RfD) and Reference Concentrations (RfC) are used. The RfD is an estimate of a daily oral exposure and the RfC is an estimate of a daily inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure.

Incidental Ingestion of and Dermal Contact with Soil – South Drainage Ditch Area

Contaminated surface soil for the off-site south drainage ditch area along the southern property line area of the site has been identified. Exposures are based on incidental ingestion of contaminated soil for children and adults who may have frequented this off-site area prior to remedial and restoration activities completed by 1993 (Langan 1993). However, repetitive exposures at the former drainage ditch are unlikely as, historically, it was heavily overgrown with vegetation and not readily accessible. Non-cancer exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing the site-specific exposure scenario; and,
BW = body weight (kg)

The following site-specific exposure assumptions (USEPA 1997, 2008) were used to calculate past contaminant doses to area residents (children and adults). The exposure assumptions for the population are based, in part, on discussions held during the October 2008 availability session where residents indicated this non-descript area was used as a walk-through for students to travel to and from school. The exposure period is conservatively estimated to include daily exposure for the entire school year for area children. The same exposure frequency was used as a conservative estimate for adults.

Former South Drainage Ditch Area

Exposed Population	Body Weight	Ingestion Rate	Exposure Assumptions
Child [(a)] (6 through 18 years old)	45 kg	100 mg/day	5 days per week 36 weeks per year
Adult	70 kg		3 days per week 26 weeks per year

(a) Typical school age walking to school is considered to be 6 through 18 years of age.

PCBs. The chronic oral MRL for PCBs (0.00002 mg/kg/day) is based on a 55 month chronic study of female Rhesus monkeys which self-ingested capsules containing aroclor 1254 in a glycerol/corn oil mixture. An uncertainty factor of 300 and a LOAEL of 0.005 mg/kg/day were used to calculate the MRL (ATSDR 2000). The lowest dose level tested, 0.005 mg/kg/day, is a LOAEL for decreased antibody response. Further support for the 0.005 mg/kg/day LOAEL is provided by mild clinical manifestations of toxicity at the same dose regarding eyelid and toe/finger nail changes observed in some monkeys at this dose level (ATSDR 2000).

The intermediate oral MRL for PCBs (0.00003 mg/kg/day) is based on a study of postnatal exposure effects to a PCB congener mixture, representing 80% of the congeners present in breast milk in Canadian women, on learning in monkeys. The tested dose level, 0.0075 mg/kg/day, produced a less serious LOAEL for neurobehavioral toxicity. Support for the LOAEL is provided by the occurrence of minimal immunological alterations in the same monkeys at 0.0075 mg/kg/day. An uncertainty factor of 300 and a LOAEL of 0.0075 mg/kg/day were used to calculate the intermediate MRL of 0.00003 mg/kg/day (ATSDR 2000).

Based on the EPC concentration of the PCB, aroclor 1254 detected in surface soil for the former South Drainage Ditch area, the chronic exposure dose calculated for children and adults (i.e., 0.00006 and 0.00003 mg/kg/day, respectively) exceeded the chronic ATSDR MRL of 0.00002 mg/kg/day and equaled or exceeded the intermediate MRL of 0.00003 mg/kg/day (see Table 34). For children, the exposure dose was approximately 83 times lower than the chronic LOAEL of 0.005 mg/kg/day and approximately 125 times lower than the intermediate LOAEL of 0.0075 mg/kg/day. It is noted that this exposure dose assumes daily contact and ingestion of contaminated soil from this area during the school year.

It is important to note that only one of six samples collected from the south ditch drainage area had a positive detection of the PCB, aroclor 1254 which suggests PCB contamination in this area was likely very limited and not widespread. Further, there were very low and very limited detections of aroclor 1254 present in on-site soils within the data provided for this assessment. Thus, it is plausible that the higher detection within the South Drainage Ditch area is present from an off-site source as it cannot be confirmed with any degree of certainty this contaminant originates from Penick/Penco site operations.

Non-cancer adverse health effects for children regarding past exposures to PCBs detected in the soil for this area are not likely as the exposure dose was less than the chronic and intermediate LOAEL and additionally, this exposure assessment was based on extremely conservative assumptions.

As the chronic exposure dose for adults was marginally above the chronic MRL and equaled the intermediate MRL, the uncertainty factors incorporated into these values are considered protective of public health where past adult exposures to PCBs detected in the soil for this area are not expected to cause non-cancer adverse health effects to adults.

Polycyclic Aromatic Hydrocarbons (PAHs). Benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, indeno(1,2,3-c,d)pyrene and phenanthrene have been detected in soils within the former South Drainage Ditch area. These contaminants are a fraction of compounds termed PAHs and fall within the broad spectrum of SVOCs. PAHs are in a class of over 100 compounds and are formed as a result of incomplete combustion of coal, oil, wood and other organic materials. More commonly they are found in petroleum-based products such as coal tar, asphalt, creosote, and roofing tar. In the environment, PAHs are found as complex mixtures of compounds, and many have similar toxicological effects and environmental fate. Because they are produced by combustion processes, PAHs are widespread in the environment. Benzo[a]pyrene and dibenzo(a,h)anthracene are considered the most toxic forms of PAH to humans (ATSDR 1995). Reference doses have been developed by EPA for anthracene (0.3 mg/kg/day), acenaphthene (0.06 mg/kg/day), fluoranthene (0.04 mg/kg/day), fluorene (0.04 mg/kg/day), and pyrene (0.03 mg/kg/day) (ATSDR 1995).

Based on the maximum concentration of all PAH compounds detected in soil within the former South Drainage Ditch area, the highest exposure dose was calculated at 0.000196 mg/kg/day for phenanthrene for child exposures which is below the most stringent RfD for pyrene at 0.03 mg/kg/day (see Table 34). As such, non-cancer adverse health effects for children or adults associated with potential past exposure to PAH compounds detected in the soil for this area are not expected.

Remaining COCs. With the exception of lead, the calculated exposure doses for adults and children for the remaining COCs present in this area did not exceed their respective health CVs. Therefore, non-cancer adverse health effects are not expected to occur to adults and children for past exposures to these contaminants. It is noted that the maximum arsenic concentration in soil for this area was detected at the NJDEP non-residential direct contact soil remediation standard (NRDCSRS) of 19 mg/kg and may be present from site operations, adjacent railway operations and/or from natural background conditions. The NJDEP NRDCSRS for arsenic is based on natural background concentrations.

Lead. The EPC of lead in surface soil for this area at 604 mg/kg exceed the NJDEP soil remediation standard of 400 mg/kg. Lead exposures associated with the intermittent use of this area was evaluated using the USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) model (USEPA 1994b). The IEUBK model estimates a plausible distribution of blood lead levels for children aged 0 to 84 months (0 to 7 years) centered on the geometric mean blood lead levels from available exposure information. Blood lead levels are indicators of exposure, and are also the most widely used index of internal lead body burdens associated with potential health effects. The model also calculates the probability that children's blood lead levels will exceed a level of concern. The IEUBK model takes into account lead exposures from background sources in it default parameter settings. The EPA's default parameters for background sources include those from air, drinking water, soil, dust, air, dietary intake and maternal blood lead levels.

Based on recommendation by the CDC's Advisory Committee for Childhood Lead Poisoning Prevention (ACCLPP), in June 2012 the CDC had revised their blood lead level of concern from 10 µg/dL to 5 µg/dL for children aged 1 through 5 years [CDC 2012]. Therefore, potential lead exposures to children aged 6 to 7 years from the south drainage ditch area for the former Penick/Penco site were evaluated based on the CDC's revised blood lead level of concern for children for the IEUBK model. In using the

IEUBK model, the lead concentration in soil should not result in a 5% probability of exceeding the revised blood lead level of concern for children at 5 µg/dL.

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 5 µg/dL (P_5) for children are shown in the following table:

Exposure Scenario		
Age[d] (months)	**Five Visits/Week; 36 Weeks/Year[a]**	
	Blood Lead Level[b] (µg/dL)	**P_5 (%)[c]**
72 - 84	2.5	6.8

[a]weighted dust lead concentration -
(604 mg/kg x 5/7 day/week x 36/52 weeks/year) = 299 mg/kg (USEPA 2003a);
[b]Geometric mean lead levels in blood;
[c]probability of blood lead level > 5 µg/dL;
[d]the exposure pathway is mainly surface soil for 6 to 7 year old children.

For the incidental lead ingestion exposure scenario, the model predicted that the geometric mean blood lead levels for children ages 72- 84 months were below the level of concern (5 µg/dL); the probabilities of blood lead levels exceeding 5 µg/dL for children ages 72 - 84 months were at 6.8%, slightly above the recommended 5% probability of exceeding a blood lead concentration of 5 µg/dL. Therefore, there was a risk to 6.8% of the children who frequently accessed the south drainage ditch area prior to its remediation in 1993 where exposures could have resulted in a blood lead level exceeding 5 µg/dL.

As children are considered the most susceptible population based on body weight, daily soil intake estimates, and frequency of hand to mouth contact, an adult lead exposure under the same scenario will typically be much lower than that of a child. Therefore, prior to remediation of the area in 1993, adverse health effects associated with past lead exposures at the South Ditch Drainage area for adults are not expected.

<u>Inhalation of VOCs in Indoor Air</u>

Nearby Residential Area: Present and Future Exposures - April 2009 Investigation

There were no detected concentrations of contaminants exceeding the chronic MRLs or RfC for benzene (10 µg/m^3), 1,3-butadiene (2 µg/m^3), chloroform (100 µg/m^3), 1,2-DCA (2,000 µg/m^3), or methylene chloride (1,000 µg/m^3) at Residences A through D targeted by the NJDEP for evaluation based on proximity to contaminated groundwater wells (see Table 35). As no health-based comparison values were exceeded, adverse non-cancer health effects are not expected to occur for present and future exposures to these contaminants in indoor air to adults and children occupying the residences. Adverse non-cancer health effects are not expected to occur for present and future exposures to these contaminants in indoor air to these populations as the residential area and groundwater are being actively monitored for the threat of vapor intrusion by the

NJDEP which includes mitigation measures for the capture and treatment of contaminated groundwater to prevent groundwater migration into residential areas.

Nearby Residential Area: Past Exposures May, June and October 1989 Investigations

Historical groundwater investigations indicate benzene was present in groundwater above the NJDEP's 2006 vapor intrusion groundwater screening level of 1 µg/L in the area of residences near the corner of New York Avenue and Lafayette Place as depicted in the 1987 isopleth map (see Figure 13). There was no indication in background information when a release occurred resulting in this contamination, as opposed to the toluene groundwater plume resulting from the May 1980 spill. Post-1987 groundwater data suggests that the benzene plume remained in close proximity to the residences until approximately 2001, when data suggests the benzene groundwater isopleth contour at 1 µg/L was not intruding into the residential area (see Figure 7). As there is a lack of additional investigation data (i.e. soil gas investigation), it cannot be confirmed whether the source of benzene in indoor air originates, in whole or part, from vapor intrusion due to site-related contamination.

Based on recent data, benzene concentrations in groundwater for monitoring wells closest to the residences has shown to have been reduced to below the NJDEP GVISLG of 15 µg/L since July 2001 (Langan 2009; NJDEP 2006). However, due to limitations concerning lack of information concerning soil gas data, when benzene was discharged to groundwater, and when the benzene plume was within the boundary of the residential area, it is difficult to determine the potential exposure period. Therefore, while initial groundwater data suggests the benzene plume was within the area of residences near the corner of New York Avenue and Lafayette Place in 1987, exposures have been conservatively estimated using the US EPA default assumption for a 30 year residential period with exposures likely ceasing by 2001 based on available groundwater data. As such, the following conclusions have been made for the assessment of non-cancer health effects for past inhalation exposure to benzene.

Regarding benzene concentrations in indoor air for the 1989 investigations, the acute MRL at 30 µg/m^3 was exceeded at Residences B, D, F, and L (range 36.7 – 80.8 µg/m^3). The intermediate MRL at 20 µg/m^3 was exceeded at Residences B, D, F, K, and L (range 29.1 – 80.8 µg/m^3). The chronic MRL/RfC at 10 µg/m^3 was exceeded at Residences A, B, D, F, K, and L (range 10.2 – 80.8 µg/m^3). The above results are summarized in Table 36. It is also noted that one residence had a detection of benzene at 9.9 µg/m^3 which is marginally below the chronic MRL.

The acute inhalation MRL for benzene (30 µg/m^3) is based on a study of male mice exposed to benzene concentrations of 0, 10.2, 31, 100, or 301 parts per million (ppm) in whole-body dynamic inhalation chambers for 6 hours/day for 6 consecutive days. The MRL is based on a 10.2 ppm (32,600 µg/m^3) exposure level resulting in a less serious LOAEL causing significant depression of femoral lipopolysaccharide-induced B-colony-forming ability in the absence of a significant depression of total numbers of B-cells. The concentration was adjusted for intermittent exposure by multiplying the LOAEL (10.2 ppm) by 6/24 to correct for less than a full day of exposure resulting in the $\mathrm{LOAEL_{ADJ}}$ at 2.55 ppm. An uncertainty factor of 300 and the $\mathrm{LOAEL_{ADJ}}$ at 2.55 ppm were used to calculate the acute MRL of 0.009 ppm which converts to 30 µg/m^3 (ATSDR 2007). The highest benzene concentration in indoor air at 80.8 µg/m^3 was approximately 403 times lower than the reported LOAEL of 32,600 µg/m^3 (10.2 ppm). Therefore, acute non-cancer adverse health effects from past inhalation exposures to benzene to residents at all tested homes along New York Avenue and Lafayette Place are not likely to have occurred.

The intermediate inhalation MRL for benzene (20 µg/m^3) is based on a study of male mice exposed to 10, 30, or 100 ppm of benzene by inhalation for 6 hours/day, 5 days/week for 20 exposure days. The MRL is based on a 10 ppm (32,000 µg/m^3) exposure level resulted in a less serious LOAEL causing significantly delayed splenic lymphocyte reaction to foreign antigens evaluated in in vitro mixed lymphocyte reaction. The concentration was adjusted for intermittent exposure by multiplying the LOAEL (10 ppm) by 6 hours/24 hours to correct for less than a full day of exposure and 5 days/7 days to correct for less than a full week of exposure. The resulting $\mathrm{LOAEL_{ADJ}}$ is 1.8 ppm. An uncertainty factor of 300 and the $\mathrm{LOAEL_{ADJ}}$ is 1.8 ppm were used to calculate the intermittent MRL of 0.006 ppm which converts to the MRL of 20 µg/m^3 (ATSDR 2007). The highest benzene concentration in indoor air at 80.8 µg/m^3 was approximately 396 times lower than the reported LOAEL of 32,000 µg/m^3 (10 ppm). Therefore, intermediate non-cancer adverse health effects from past inhalation exposures to benzene to residents at all tested homes along New York Avenue and Lafayette Place are not likely to have occurred.

The chronic inhalation MRL for benzene (10 µg/m^3) is based on a cross-sectional study of 250 workers (approximately two-thirds female) exposed to benzene at two shoe manufacturing facilities in Tianjin, China, who were employed for an average of 6.1±2.9 years. US EPA benchmark dose modeling software was performed on data where a benchmark response (BMR) of 0.25 sd below the control mean B cell count was selected because it resulted in a $\mathrm{BMC_{0.25sd}}$ of 0.42 ppm and its lower 95% confidence limit ($\mathrm{BMCL_{0.25sd}}$) of 0.10 ppm (320 µg/m^3). A $\mathrm{BMCL_{0.25sd}}$ of 0.10 ppm causing benzene-induced decreased B cell count was selected as the critical effect to derive the MRL. The $\mathrm{BMCL_{0.25sd}}$ of 0.10 ppm was adjusted from the 8-hour time weighted average for worker exposure to a continuous exposure concentration (24 hours/day) to derive a $\mathrm{BMCL_{0.25sdADJ}}$ of 0.03 ppm which converts to the MRL of 10 µg/m^3 (ATSDR 2007). The range of benzene concentrations in indoor air exceeding the chronic MRL of 10 µg/m^3 was 10.2 to 80.8 µg/m^3 which was approximately 4 to 32 times lower than the reported LOAEL of 320 µg/m^3 (10 ppm). Therefore, chronic non-cancer adverse health effects from inhalation exposures to benzene to residents living at Residences A, B, D, F, K, and L along New York Avenue could have occurred from past exposures prior to 2001.

Adverse non-cancer health effects are not expected to occur for future exposures to these contaminants in indoor air to these populations as groundwater data indicates benzene concentrations were near or below the NJDEP GVISLG of 1 µg/L for benzene since 2001. Additionally, the NJDEP is actively monitoring continued groundwater investigations and mitigation measures to capture and treat contaminated groundwater to eliminate the threat of vapor intrusion and prevent exposures.

Cancer Health Effects

The site-specific lifetime excess cancer risk (LECR) indicates the cancer potential of contaminants. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population in addition to the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 44 per 100 individuals for males, and 38 per 100 for females; the lifetime risk of being diagnosed with any of several common types of cancer ranges approximately between 1 in 10 and 1 in 100 (ACS 2011). Typically, health guideline CVs developed for carcinogens are based on one excess cancer case per 1,000,000 individuals. The NJDOH considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk (expressed exponentially as 10^{-6}).

According to the United States Department of Health and Human Services (USDHHS), the cancer class of contaminants detected at a site is as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

The risk of cancer was evaluated for contaminated soil based on the site-specific exposure scenario and exposure location. Cancer exposure doses were calculated using the following formula:

$$\text{Cancer Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW}$$

where C = concentration of contaminant in soil (mg/kg);
IR = intake rate of contaminated soil (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg); and
BW = body weight (kg).

Several COCs are identified for the Pennick/Penco site; however, only COCs having CSFs are used to estimate the LECR to exposed individuals.

Incidental Ingestion of Soil – Former South Drainage Ditch Area

Based on the EPC of COCs detected in surface soil from the former South Drainage Ditch Area, the LECRs for past ingestion exposures for children and adults are 9 in 100,000 and 3 in 100,000 (see Table 37). As previously stated, exposure assumptions were very conservative as aroclor 1254 was detected in only one of six samples in this area. Additionally, it is likely present from an off-site source as aroclor 1254 was not detected in high concentrations or on a frequent basis on the former Penick/Penco site.

Inhalation of VOCs in Indoor Air

The site-specific assumptions and recommended exposure factors (EPA 2002) used to calculate the LECR are the same as those used to assess non-cancer health effects. The LECR for adults was calculated by multiplying the cancer exposure dose by the cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(\text{mg/kg/day})^{-1}$. LECRs for soil exposures were calculated using the following formula (US EPA 2009):

$$LECR = Cancer\ Exposure\ Dose \times CSF$$

where CSF = Cancer Slope Factor $(\text{mg/kg/day})^{-1}$

Exposure concentrations to indoor air contaminants and LECRs were calculated using the following formulas (US EPA 2009):

$$EC = \frac{EPC \times ET \times EF \times ED}{AT}$$

where EC = exposure concentration ($\mu g/m^3$);
EPC = exposure point concentration of contaminant in air ($\mu g/m^3$);
ET = exposure time (hours/day);
EF = exposure frequency (days/year);
ED = exposure duration (years); and
AT = averaging time (years).

$$LECR = EC \times IUR$$

where EC = exposure concentration ($\mu g/m^3$); and
IUR = inhalation unit risk of contaminant in air $(\mu g/m^3)^{-1}$

The LECR for residents was calculated by multiplying the cancer exposure concentration in indoor air by the inhalation unit risk (IUR). The IUR is defined by the US EPA as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air (US EPA 2008b).

Nearby Residential Area: Present and Future Exposures - April 2009 Investigation

The risk of cancer for present and future exposures regarding the inhalation of indoor air contaminated with benzene, 1,3-butadiene, chloroform, 1,2-DCA, and methylene chloride was evaluated for adults and children occupying the Residences A through D identified from the April 2009 indoor air investigation.

The LECR was estimated using EPCs in indoor air using data from the April 2009 investigation. Site-specific assumptions and recommended exposure factors (US EPA 2002, 2009) were used to calculate the exposure concentration based on the exposure period as described in the *Non-Cancer Health Effects Section* and in Table 38.

<u>Residence/Daycare Facility A (present, future).</u> Based on the EPC of benzene, 1,3-butadiene, chloroform, 1,2-DCA, and methylene chloride in the indoor air, LECRs were estimated to be approximately 4 in 100,000 for adults and 3 in 1,000,000 for daycare children, which is considered to pose no apparent increase in risk when compared to the excess background risk of all or specific cancers (see Table 38).

<u>Residence B (past, present).</u> Based on the EPC of benzene, chloroform, 1,2-DCA, and methylene chloride in the indoor air, LECRs were estimated to be less than 2 in 10,000 for adults and children which is considered to pose a low increase in risk when compared to the excess background risk of all or specific cancers (see Table 38).

<u>Residences C, and D (past, present).</u> Based on the EPC of benzene, 1,3-butadiene, chloroform, 1,2-DCA, and methylene chloride in the indoor air, LECRs were estimated to be less than 2 in 100,000 for adults and children which is considered to pose no apparent increase in risk when compared to the excess background risk of all or specific cancers (see Table 38).

Nearby Residential Area: Past Exposures - May, June and October 1989 Investigations

The risk of cancer for past exposures regarding the inhalation of indoor air contaminated with benzene was evaluated for adults and children occupying the Residences A through N, P and Q identified from the 1989 indoor air investigations.

The LECR was estimated using EPCs in indoor air using data from the May, June and October 1989 investigations. Site-specific assumptions and recommended exposure factors (US EPA 2002, 2009) were used to calculate the exposure concentration based on the exposure period as described in Table 39. As initial groundwater data suggests the benzene plume was within the area of residences near the corner of New York Avenue and Lafayette Place in 1987, exposures have been conservatively estimated using the US EPA default assumption for a 30 year residential period with exposures likely ceasing by 2001 based on available groundwater data. As such, the following conclusions have been made for the LECR assessment for past inhalation exposure to benzene.

<u>Residences B, D, F, K and L (past).</u> Based on the EPC of benzene in indoor air, LECRs were estimated for the above residences to be approximately 1 to 3 in 10,000 for adults and children, which is considered to pose a low increase in risk when compared to the excess background risk of all or specific cancers (see Table 39). For children under

past daycare at Residence K, the LECR was estimated for the above residences to be approximately 7 in 1,000,000 which is considered to pose no apparent increase in risk when compared to the excess background risk of all or specific cancers (see Table 39)

Residences – All Remaining (past). Based on the EPC of benzene in indoor air, LECRs were estimated for the remaining residences to be less than 4 in 100,000 for adults and children which is considered to pose no apparent increase in risk when compared to the excess background risk of all or specific cancers (see Table 39).

Health Outcome Data

Based on expressed community concern, NJDOH Cancer Epidemiology Services (CES) has released three standardized incidence ratio (SIR) analyses for multiple myeloma in 2008, 2010, and 2011. Based on the most recent SIR analysis (2011), CES has reviewed the age and gender distribution of multiple myeloma cases in Lyndhurst from 1990 to 2008 which included analysis of two consecutive time periods (1990-1999 and 2000-2008) to examine trends in cancer occurrence. In addition, this SIR analysis included the age-sex-specific population determined from the 1990, 2000 and 2010 U.S. Census data. The primary source of cancer cases used in the development of an SIR comes from the New Jersey State Cancer Registry (NJSCR). Additionally the CES were able to verify all multiple myeloma cases reported by the community with the NJSCR. Some of these cases were either 1) not residents of Lyndhurst at the time of diagnosis; 2) diagnosed outside of the analysis period (1990-2005); or 3) diagnosed with cancer other than multiple myeloma and, therefore, could not be included as a case within the SIR analysis for multiple myeloma in Lyndhurst.

One of the concerns raised was that the ages of individuals diagnosed with multiple myeloma in Lyndhurst were younger than expected. According to the American Cancer Society, 34% of all multiple myelomas are diagnosed in individuals aged 65 or younger while 66% are diagnosed among individuals 65 or older. The SIR analysis released in 2008 for Lyndhurst indicates 19% of the cases were younger than 65 years indicating a lower proportion of younger individuals affected with multiple myeloma in Lyndhurst.

As a separate issue, for the SIR analysis released in 2008, CES reviewed a single case of a rare cancer (neurilemoma or epithelium schwanoma) in a former Lyndhurst resident diagnosed in her early thirties in the late 1990s. The concern raised was this was a rare cancer not typically diagnosed at this young age. CES review of neurilemoma data indicated approximately 130 cases were diagnosed in New Jersey for the 1990-2005 period. Approximately 21% of neurilemomas were diagnosed in individuals under 35 years old with slightly over 50% occurring in females.

The results of for all Lyndhurst SIR analyses conducted indicated that the number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated. Copies of the NJDOH cancer incidence responses for 2008 through 2011 are provided in Appendix A.

Child Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults. They also play outdoors and often bring food into contaminated areas. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The NJDOH evaluated the potential risk for resident children residing near the Penick/Penco site who may have been exposed to contaminants in soil and indoor air possibly originating from the site. Based on the exposure point contaminant concentrations in contaminated soil within the former south drainage ditch area and a 30-year exposure duration, a "no apparent increase" in risk of cancer effects for area residents, including children, was determined. Based on the 1989 indoor air investigations, the exposure point concentrations of benzene in indoor air and a 30-year exposure duration up to 2001 resulted in a "low increase" in risk of cancer effects for four tested residences and "no apparent increase" in cancer risk for occupants of the remaining twelve residences, including children. Limitations in the indoor air assessment exist due to the lack of data (i.e. soil gas data) to verify a benzene source was present at the time of the 1989 investigations and the presence of consumer products which could have contributed, in whole or in part, to indoor air concentrations. However, groundwater data from 1987 investigations indicate the benzene groundwater plume was estimated to extend into the residential area which supports the plausibility that benzene present in indoor air of tested homes could have originated from site-related contamination.

Present indoor air investigations conducted by the NJDEP in April 2009 indicate a soil gas source was not present below tested homes. In addition, groundwater sampling data for monitoring wells within a 100 foot radius of the residential area did not exceed NJDEP GVISLG since 2002 regarding average concentrations of benzene in groundwater. Toluene concentrations in groundwater for monitoring wells within a 100 foot radius have been far below the NJDEP GVISLG since routine monitoring began in 1987. Groundwater data further supports evidence that the benzene and toluene groundwater plumes have not likely extended into the residential investigation area since 2002 (see Figures 12c and d). Therefore, benzene concentrations detected in indoor air during the April 2009 investigation are likely present from consumer-related sources and background concentrations present in ambient air.

Regarding possible exposures at the southern drainage ditch area, children who may have frequently visited this area prior to its remediation in 1993 may have been at risk for lead exposures which could have resulted in a blood lead level exceeding the CDC's current blood lead level of concern of 5 µg/dL. Exposures from this area are based on repeated access to this area where soil ingestion on a daily basis for over 8 months would have been necessary to put approximately 6.8% of the children at risk for developing a blood lead level in excess of 5 µg/dL.

Background sources of lead exposures from air, water, dietary intake, soil, dust and maternal blood lead levels have been taken into account in determining the risk of lead exposures from site-related soil exposures. Recent scientific research had clearly shown that blood lead levels below 10 µg/dL have been shown to cause neurological, behavioral, immunological, and developmental effects in young children. Specifically, lead causes or is associated with decreases in intelligence quotient, attention deficit hyperactivity disorder, deficits in reaction time, problems with visual motor integration and fine motor skills, withdrawn behavior, lack of concentration, issues with sociability, decreased height, and delays in puberty [CDC 2012].

Conclusions

In August 2008, the Lyndhurst Township Health Department requested assistance from the NJDOH to conduct a public health evaluation to assess community exposures to site-related contamination associated with the former Penick Corporation/Penco of Lyndhurst site located at 540 New York Avenue in Lyndhurst Township, Bergen County. The Penick Corporation operated at the site from approximately 1938 to 1986 and manufactured numerous specialty organics, botanicals, pharmaceuticals (acetaminophen), and pesticides, including synthetic pyrethroid. The property was acquired in 1986 by Penco of Lyndhurst with facility operations running from 1986 through 1993. Operations during the Penco ownership period are identified as the manufacture of botanicals and acetaminophen. Several discharges were documented under Penick and Penco operations resulting in contamination of soil and groundwater which had impacted both on-site and off-site areas, including the possibility of impacting indoor air for several nearby residences. The entire site underwent remediation in the 1990s; buildings were razed in early 1999, then the site was re-developed to its current state as a shopping mall containing multiple buildings and several commercial businesses. Following review and assessment of environmental data, the NJDOH have reached the following conclusions regarding exposures to residents for the former Penick/Penco site.

The NJDOH conclude that past exposures to contaminated surface soil present within the south drainage ditch may have harmed people's health in the past. Past exposures to lead in surface soil at the south drainage ditch may have resulted in unnecessary exposures to lead for children who may have frequently visited this area prior to its remediation in 1993. Past exposures to lead may have occurred to residents , specifically children, who may have possibly used this area or the immediate vicinity as a walking path to and from school. However, repetitive exposures at the former drainage ditch are unlikely as, historically, it was heavily overgrown with vegetation and not readily accessible. Exposures from incidental ingestion of contaminated soil from this area may have put children at risk for lead exposures which could have resulted in a blood lead level exceeding the CDC's current blood lead level of concern of 5 µg/dL. Exposures from this area are based on repeated access to this area where soil ingestion on a daily basis for over 8 months would have been necessary to put approximately 6.8% of the children at risk for developing a blood lead level in excess of 5 µg/dL.

In addition to lead, surface soil from the south drainage ditch was contaminated mainly with several PAH compounds and, on a very limited basis, aroclor 1254 (PCB). Aroclor 1254 was limited to one sample detection in this area and, therefore, is not considered a widespread contaminant. Further, aroclor 1254 was not shown to be a significant contaminant for on-site soils, with detections being extremely low in concentration. Thus, it is plausible that the higher detection within the South Drainage Ditch area is present from an off-site source as it cannot be confirmed with any degree of certainty this contaminant originated from Penick/Penco site operations. Based on the concentrations of COCs, other than lead, observed in this area, adverse non-cancer health effects from past ingestion and dermal exposures are not expected for children or adults exposed prior to the remediation of this area by 1993. The cumulative lifetime excess cancer risk from ingestion and dermal exposures to COCs are considered to pose no apparent increase in risk when compared to the background risk of cancer.

The NJDOH conclude that present and future exposures to benzene, 1,3-butadiene, chloroform, 1,2-DCA and methylene chloride detected in indoor air at four residences during April 2009 investigations are not expected to harm people's health. As no health-based comparison values were exceeded, adverse non-cancer health effects are not expected to occur for present and future exposures to these contaminants in indoor air to adults and children occupying the residences. Based on the exposure point concentrations of contaminants detected in indoor air, levels are expected to pose a low increase in risk of cancer for Residence B and no apparent increase in risk of cancer for occupants of Residences A, C and D, including children. Contaminant concentrations detected in indoor air during the April 2009 investigation are likely present from consumer-related sources and background concentrations present in ambient air as the investigation data did not indicate a soil gas source was present below tested homes. In addition, groundwater sampling data for monitoring wells within a 100-foot radius of the residential area did not exceed NJDEP GVISLG since 2002 regarding average concentrations of benzene in groundwater. Toluene concentrations in groundwater for monitoring wells within a 100-foot radius have been far below the NJDEP GVISLG since routine monitoring began in 1987. Groundwater data further supports evidence that the benzene and toluene groundwater plumes have likely not extended into the residential investigation area since 2002.

The potential for present and future exposures to site-related contamination via vapor intrusion is considered interrupted as the NJDEP is actively monitoring continued groundwater investigations and mitigation measures to capture and treat contaminated groundwater to prevent the threat of vapor intrusion and potential exposures.

The NJDOH conclude that past exposures to benzene in indoor air at six of the seventeen residences tested in 1989 may have harmed people's health. Based on the 1989 indoor air investigations, non-cancer adverse health effects from chronic inhalation exposures to benzene to residents living at Residences A, B, D, F, K, and L along New York Avenue could have occurred from past exposures prior to 2009. Based on the 1989 indoor air investigations, the exposure point concentrations of benzene in indoor air and a 30-year exposure duration up to 2009 resulted in a low increase in risk of cancer at four tested residences and no apparent or no increase in cancer risk for occupants of the remaining residences, including children. Limitations in the indoor air assessment exist due to the lack of soil gas data to verify a benzene source was present at the time of the 1989 investigations and the presence of consumer products within the home which could have contributed, in whole or in part, to indoor air concentrations. However, groundwater data from 1987 investigations indicate the benzene groundwater plume was estimated to extend into the residential area which supports the plausibility that benzene present in indoor air of tested homes could have originated, in whole or in part, from site-related contamination. In addition, there were complaints to the township by some residents of solvent-like odors in their home both following the 1980 spill and in survey information from the 1989 indoor air investigation. As noted above, groundwater data from 2002 to the present show that the benzene and toluene plumes have likely not extended into the residential area since this period.

The NJDOH conclude that the number of all malignant cancers combined and the number of multiple myeloma cancers have not been elevated in Lyndhurst in the period 1990-2008. NJDOH CES conducted standardized incidence ratio (SIR) analyses for all cancers combined and for multiple myeloma for the period 1990 through 2008 in Lyndhurst. The results of the Lyndhurst SIR analyses indicate that the number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated.

Recommendations

1. The NJDEP should continue remedial investigations and monitoring of contaminant levels regarding the existing toluene and benzene groundwater plumes to ensure contaminant levels do not pose a risk through vapor intrusion to nearby residents or to employees and consumers who frequent the shopping center located at the former Penick/Penco site.

2. The NJDEP should continue monitoring the operation and effectiveness of the groundwater remediation system to ensure the contaminated groundwater plume is under hydraulic control and not migrating towards nearby residential areas.

3. The NJDEP should continue to oversee the remediation of all contamination on or emanating from the Penick/Penco site. Additionally, the NJDEP should continue to monitor the effectiveness of all engineering controls associated with the deed notice for the site to ensure that residual contaminants below the protective cap do not pose an exposure risk to residents, employees, or consumers who frequent the shopping center located at the former Penick/Penco site.

Public Health Action Plan

The purpose of a Public Health Action Plan is to ensure that this Public Health Assessment 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 the NJDOH to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDOH are as follows:

Public Health Actions Taken

1. The NJDOH has reviewed information and relevant data to evaluate the potential health implications for exposures to site-related contaminants present in surface soil, groundwater, and in indoor air for nearby residences, a day-care facility, the former site area and off-site areas.

2. The NJDOH CES conducted standardized incidence ratio (SIR) analyses in 2008, 2010 and 2011. The results of the Lyndhurst SIR analysis indicated that the number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated. A copy of the NJDOH SIR reports are provided as Appendix A.

Public Health Actions Planned

1. Copies of this public health assessment will be provided to concerned residents in the vicinity of the site via the township libraries and the Internet.

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Table 1: Summary of Typical Annual Materials Storage at Site Under Penick/Penco Operations: Former Penick/Penco Site, Bergen County

Hazardous Material	Capacity	Units	Penick Operations	Capacity	Units	Penco Operations [(b)]
Acetaminophen	NS	NS	Yes	NA	NA	Yes
Acetic Acid	NS	NS	NS	NA	NA	Yes
Acetic Anhydride Tech Grade	5,000	gallons	Yes	NA	NA	Yes
Acetone	15,000	gallons	Yes	NA	NA	Yes
Anhydrous Ammonia	50,000	pounds	Yes	NA	NA	Yes
Ammonium Hydroxide (28-30%)	NS	NS	NS	NA	NA	Yes
Ammonium Carbonate	NS	NS	NS	NA	NA	Yes
Aromatic Cascara Fluid Extract USP	NS	NS	NS	NA	NA	Yes
Belladonna Alkaloids in 95% Ethanol Solution	NS	NS	NS	NA	NA	Yes
Benzoic Acid	NS	NS	NS	NA	NA	Yes
Benzoin Tincture USP	NS	NS	NS	NA	NA	Yes
Benzyl Chloride	NS	NS	NS	NA	NA	Yes
Benzl Cyanide	25,000	pounds	Yes	NA	NA	Yes
Calamine	NS	NS	NS	NA	NA	Yes
Calcium Hydroxide	NS	NS	NS	NA	NA	Yes
Calcium Oxide	25,000	pounds	NA	NA	NA	Yes
Carbon Monoxide	22,000	pounds	Yes	NA	NA	Yes
Carbon Tetrachloride	NS	NS	Yes	NA	NA	NS
Caustic	50,000	pounds	Yes	NA	NA	Yes
Chloroglycerine	NS	NS	NS	NA	NA	Yes
Chloroform	NS	NS	Yes	NA	NA	NS
Cyanopiperidine	NS	NS	NS	NA	NA	Yes
Diethanolamine	NS	NS	NS	NA	NA	Yes
3,4-Dimethoxy-1-methylbenzene	NS	NS	NS	NA	NA	Yes
Dimethylaniline	NS	NS	Yes	NA	NA	Yes
Dimethyl Succinate	50,000	pounds	Yes	NA	NA	Yes
Dimethyl Carbonate	NS	NS	Yes	NS	NS	NS
Ethyl Alcohol	10,000	gallons	Yes	NA	NA	Yes
Ethylene Glycol	10,000	gallons	Yes	NA	NA	Yes
Formaldehyde	6,000	gallons	Yes	NA	NA	Yes
Guarana Solid Extract	NS	NS	NS	NA	NA	Yes
Henna Extract Decolorized	NS	NS	NS	NA	NA	Yes
Heptane	15,000	gallons	Yes	NA	NA	Yes
Hexane	NS	NS	Yes	NS	NS	NS
Hydrochloric Acid	10,000	gallons	Yes	NA	NA	Yes
Hydrogen Peroxide (3%, 35%)	NS	NS	NS	NA	NA	Yes
Iron Oxide	NS	NS	NS	NA	NA	Yes
Isopropyl Acetate	NS	NS	NS	NA	NA	Yes
Isopropyl Alcohol	15,000	gallons	Yes	NA	NA	Yes
Kerosene Deodorized	5,000	gallons	Yes	NA	NA	Yes
Liquid Quillaia, Liquid Quillaia-CC, Liquid Quillaia .75 (contains saponins)	NS	NS	NS	NA	NA	Yes
Magnesium Oxide	NS	NS	NS	NA	NA	Yes
Methyl Alcohol	NS	NS	NS	NA	NA	Yes
Methylene Chloride	5,000	gallons	Yes	NA	NA	Yes

Table 1 - continued

Hazardous Material	Capacity	Units	Penick Operations	Capacity	Units	Penco Operations [b]
Methyl Chloride (gas)	NS	NS	Yes	NS	NS	NS
Methanol	25,000	gallons	Yes	NA	NA	Yes
Nalclean 2564 Resin Cleaner (contains sodium hydroxide and sodium metabisulfite)	NS	NS	NS	NA	NA	Yes
Nalco 8365LF (contains sodium tetraborate)	NS	NS	NS	NA	NA	Yes
Nitrogen	NS	NS	NS	NA	NA	Yes
Oakite 62 (contains sodium hydroxide and sodium carbonate)	NS	NS	NS	NA	NA	Yes
Papain Powdered Purified (contains papain, a proteolytic enzyme)	NS	NS	NS	NA	NA	Yes
p-Methoxy Phenylacetic Acid	NS	NS	NS	NA	NA	Yes
p-Methoxy Phenylacetonitrile	NS	NS	NS	NA	NA	Yes
p-Nitrophenol (p-Nitro Sodium Phenolate)	600,000	pounds	Yes	NA	NA	Yes
Phenyltrimethylammonium Chloride	NS	NS	NS	NA	NA	Yes
Powdered Extract Quillaia Low Dust (contains saponin)	NS	NS	NS	NA	NA	Yes
Propiophenone	NS	NS	NS	NA	NA	Yes
Quassa II (Penco Product - contains quassinoid compounds)	NS	NS	NS	NA	NA	Yes
Quassia Fluid Extract (22-26% alcohol)	NS	NS	NS	NA	NA	Yes
Quassia Purified (Penco product - contains quassinoid compounds)	NS	NS	NS	NA	NA	Yes
Quassia Purified Solution (Penco product - contains ethanol)	NS	NS	NS	NA	NA	Yes
Saccharin	NS	NS	NS	NA	NA	Yes
Saponin #1 Powder (contains saponin and formaldehyde residue)	NS	NS	NS	NA	NA	Yes
Saponin #1 Code N.D. Powder (contains saponins)	NS	NS	NS	NA	NA	Yes
Soap Bark Fluid Extract (contains ethanol)	NS	NS	NS	NA	NA	Yes
Sodium Bisulfite	NS	NS	NS	NA	NA	Yes
Sodium Carbonate	NS	NS	NS	NA	NA	Yes
Sodium Cyanide	NS	NS	NS	NA	NA	Yes
Sodium Hydrosulfide	NS	NS	NS	NA	NA	Yes
Sodium Hydroxide	NS	NS	NS	NA	NA	Yes
Sulfur Dioxide	NS	NS	NS	NA	NA	Yes
Sulfuric Acid 66 Be'	10,000	gallons	Yes	NA	NA	Yes
Sulfuric Acid Be' Electrolyte	10,000	gallons	Yes	NA	NA	Yes
Sulfuric Acid	20,000	gallons	Yes	NA	NA	Yes
p-Toluene Sulfonic Acid	40,000	gallons	Yes	NA	NA	Yes
Thionyl Chloride	NS	NS	NS	NA	NA	Yes
Toluene	25,000	gallons	Yes	NA	NA	Yes
Zinc Oxide	NS	NS	NS	NA	NA	Yes
Hazardous Wastes [a]	15,000	pounds	Yes	NA	NA	Yes

(a) Penick monthly inventory noted as not exceeding 15,000 pounds and stored on-site in 55-gallon drums prior to disposal.
(b) Quantities for many listed chemicals not specified in master list of hazardous chemicals for Penco operations.
Sources:
- Penick Corporation. Initial ECRA Notice of Requirements to the New Jersey Department of Environmental Protection. April 30, 1984.
- Cole, Schotz, Meisel, Forman & Leonard (Law Firm). Preliminary Assessment Report for Penco of Lyndhurst, Inc. to the New Jersey Department of Environmental Protection. June 5, 1997.
NA - Not Available (evidence material stored in master list inventory)
NS - Not Specified

Table 2: Summary of Above Ground Storage Tank Materials During Penco of Lyndhurst Operational Period:
Former Penick/Penco Site, Bergen County

AST ID	Building No. Location	Capacity (gallons)	Material Content	Last Use	Containment System	Containment System Condition
6	2A	2,000	50% ETOH	1993	Yes	Good
7	2A	2,000	95% ETOH	1993	Yes	Good
8	2A	2,000	95% ETOH	1993	No	Good
9	2	1,000	Spent Alcohol	<1986	No	Good
9	2	550	Spent Alcohol	<1986	No	Good
12	2	4,000	Spent ETOH	1993	Yes	Unknown
48	7	2,000	Heptane	<1989	Yes	Good
63	7	3,000	Xylol/Panasol	<1989	Yes	Good
64	7	3,000	Benzol/Panasol	<1989	Yes	Good
71	7	1,500	M/T (Bayold)	<1986	Yes	Not provided
72	7	1,500	Benzol/Bayold	<1986	Yes	Not provided
73	7	1,500	Benzol/Bayold	<1986	Yes	Not provided
76	7	2,000	Pyrafume/ Panasol	<1986	Yes	Not provided
77	7	2,000	Panasol AN-3	<1986	Yes	
80	7	4,500	Nusyn Noxfish	<1989	Yes	Good
21	12	1,000	IPA restored from Warfarian	<1993	Yes	Good
22	12	2,000	IPA	<1993	Yes	Good
23	12	3,000	Toluol from Valerate	<1993	Yes	Good
26	12 or 14c	2,000	50% Caustic (NaOH)	1993	No	Good
28	12	2,000	Methanol (recovered)	1993	Yes	Good
62	12	1,000	30% DDT	<1993	Yes	Good
29	14	2,000	Acetone	1993	Yes	Good
31	14	3,000	Methanol (recovered)	1993	Yes	Good
32	14	2,000	Ethanol	1993	Yes	Good

Table 2 - continued

AST ID	Building No. Location	Capacity (gallons)	Material Content	Last Use	Containment System	Containment System Condition
3	19	2,000	Spent solvents/IPA	1993	Yes	Good
5	19	2,000	Spent solvents/IPA	1993	Yes	Good
14	19	5,000	ETOH	<1986	Yes	Unknown
15	19	5,000	ETOH	<1986	Yes	Unknown
42	19	NA	Unknown solvent	1993	Yes	Good
42-1/3D	19	1,500	M/T (restore IPA)	1993	Yes	Good
42 2/5-E	19	1,500	M/T (restore IPA)	1993	Yes	Good
47	19	10,000	Pyrafume	<1986	Yes	Unknown
50	19	2,000	Spent solvents	1993	Yes	Good
94	19	1,750	Acetone/IPA	1993	Yes	Unknown
33	41	5,000	Acetic Anhydride	1993	Yes	Unknown
34	41	6,000	Sulfuric acid	1993	Yes	Unknown
34	41	6,000	Acetic Anhydride	<1985	No	Good
1	41B	13,000	Isopropyl Alcohol (IPA)	NA	NA	NA
2	41B	8,000	IPA	NA	NA	NA
25	41B	3,000	ETOH	1993	Yes	Unknown
120	42	4,000	Mineral oil	1989	Yes	Unknown
	121	300,000	Water	1993	No	Good
*		NA	Hydrogen	1992	No	Good
*		NA	Nitrogen	1992	No	Good

* - Maintained, serviced and supplied by Union Carbide during operational period.

Sources:

(1) Environmental Waste Management Associates, LLC., Report summarizing above ground storage tank information for Penco facility to the New Jersey Department of Environmental Protection. May 29, 1998.

(2) Environmental Waste Management Associates, LLC., Report summarizing NJDEP requested information for Penco facility. May 15, 1998.

Table 3: Summary of Permits and Registration Numbers for Penco of Lyndhurst Facility Operations: Former Penick/Penco Site, Bergen County

Issuing Agency	Permit Number	Type of Permit/Registration	Approval and Expiration Dates
Penco of Lyndhurst Operations: 1986 - 1993			
New Jersey Department of Environmental Protection (NJDEP)	0008534	Underground Storage Tank	Unknown
NJDEP	NJ0003531	Stormwater	6/28/1974 - 4/4/1977 exempt by USEPA
United States Environmental Protection Agency (USEPA)	NJD-081894842	Resource Conservation and Recovery Act (RCRA)	1981 - unknown
Passaic Valley Sewer Commission	1840492	Waste Water	3/17/1991 - 3/17/1996
NJDEP	10126W	Water Allocation	11/24/1986 - 6/30/1991
NJDEP	2467006	Solid Waste Collection	4/29/1972 - 6/30/1973
NJDOH	450	Deep Well	3/18/1969
Township of Lyndhurst	28	Permit to Operate	12/31/1985
New Jersey Department of Health (NJDOH)	F-004331	Food Cosmetic Establishment	6/30/1986
US Department of Treasury	SPA-NJ-1154	Permit to Use Specially Denatured Alcohol	unknown
Passaic Valley Sewer Commission	18402412	Sewer Connection	1/26/1986
Township of Lyndhurst	107	Welding/Cutting Operations	12/31/1985
US Department of Justice	PS0022032	Controlled Substances Registration/Analytical Lab	2/28/1986
NJDOH	0386	Drug Certificate of Registration	1/31/1986
NJDOH	019759	Certificate of Registration Controlled Substances Registration/Analytical Lab	3/31/1986
NJDOH	028780	Certificate of Registration Controlled Dangerous Substances/Researcher	6/30/1986
USEPA	NJD-081894842	Acknowledgement of RCRA	NA
NJDEP	10126W	Water Diversion	NA
Township of Lyndhurst	NA	Sprinkler Tie-In	NA
Township of Lyndhurst	NA	Registrations of Wells	NA
NJDEP	NA	Operate Control Apparatus	NA

NA - Not Available

Table 4: Summary of Reported Discharges of Various Materials at Site: Former Penick/Penco Site, Bergen County

Discharge Material	Date of Discharge	Quantity of Discharge	Units of Discharge	Spill Report Comment	Discharge Reported Cleaned-up
Penick Corporation Operations: 1941 - 1986					
p-Nitro Phenol (powder)	5/5/1977	100-500	pounds	Spill cleaned, near Building 28	Yes
Sulfuric Acid	1/19/1978	500	gallons	Plugged sanitary sewer line; unplugged; spill cleaned	Yes
p-Nitro Phenol (powder)	6/16/1978	10	pounds	Washed into sanitary sewer	Yes
Acid (unidentified)	8/31/1979	unknown	gallons	Spill cleaned	Yes
Calcium Sulfate	10/29/1979	1-100	pounds	Spill cleaned	Yes
Tolulene	5/9/1980	unknown	gallons	UST #24 10,000 Gallon UST	No
#6 Fuel Oil	2/18/1981	100-500	gallons	Spill cleaned	Yes
Toluene	12/9/1981	1-100	gallons	Process vessel overfill; some recovered	Partial
Toluene	4/20/1982	1-100	gallons	Spill cleaned	yes
Toluol	10/6/1982	100-500	gallons	Spill cleaned	yes
Toluene	8/4/1983	1-100	gallons	Storage tank overfilled; Spill cleaned	yes

Sources:
Penick Corporation April 1984.
EWMA May 15, 1998; May 29, 1998
Langan July 1990
Cole, Schotz, Meisel, Forman & Leonard June 1997.

Table 5a: Summary Soil Remediation for Areas of Concern
Former Penick/Penco Site, Bergen County

Area of Concern	Volume Soil Removed (cubic yards)	Remedial Completion Date
Foam Basin	20	June 26, 1991
Equipment Storage Area	1 (asbestos removal only)	February 14, 1991
Stained Soil Area	139	June 26, 1991
Drum Storage Area	48	March 5, 1991
Vent Overflow Area	14	March 13, 1991
Other Plant Area (OPA)-6	4	November 20, 1991
OPA-11	50	March 8, 1991
OPA-13	78	June 25, 1991
OPA-16/17	34	March 22, 1991
OPA-20	8	June 25, 1991
OPA-21	16	June 25, 1991
OPA-22	8	June 25, 1991
OPA-46	39	November 21, 1991
Railroad Siding/South Drainage Ditch	1,000	June 27, 1991
Underground Storage Tank (UST)-112/113	24	March 13, 1991
UST-65	6	March 25, 1991
UST-75	22	March 25, 1991
UST-78	24	June 25, 1991
UST-116	22	November 19, 1991
Leaching Tank (Building 19)	50	November 13, 1991
Total	**1,606**	

Source: Langan 1991a, 1991b, 1992, & 1993b

Table 5b: Summary of Underground Ground Storage Tank Information
Former Penick/Penco Site, Bergen County

UST Plant No./ State Permit No.	Capacity (gallons)	Material Content	Last Use	Integrity Test/Status
2/NA	NA	Acetone	NA	Passed 1991; 1992
4/6	10,000	Spent Methanol (MEOH)	Pre-1990	Passed 5/1982; 6/1985; 1990
12/24	3,000	S.D. 3A Alcohol, 75%	Pre-1990	Removed 2/1982; Replaced with 4,000 gallon AST
13/7	5,000	Ethanol (EtOH)	Pre-1990	Passed 5/1982; 6/1985; 1990
16/8	10,000	Methanol/ Ethanol	Pre-1990	Passed 5/1982; 6/1985; 1990; 1992
17/9	6,000	Acetone; Panasol AN-2 (petroleum naphtha); Tenneco	Pre-1990	Passed 8/1982; 6/1985; 1990; 1992
18/10	6,000	Methanol; Heptane	Pre-1990	Leak at union and manhole cover gasket - repaired 4/1981; Passed 8/1982; 6/1985; 1990; 1992
19/11	6,000	Methanol/ Ethanol; Heptane	Pre-1990	Passed 5/1981 (note - manhole gasket replaced prior to test); 6/1985; 1990; 1992
20/12	6,000	Acetone; Toluol	Pre-1990	Passed 11/1981; 6/1985; 1990; 1992
24/13	6,000	Toluol; Toluol Distillate	Pre-1990	Replaced 5/1980 or 6/1981; Passed 8/1982; 6/1985; 1990; 1992
27/33	2,000	No. 2 Fuel Oil	In use 1990	Passed 1990
30/14	5,000	Toluol	Pre-1990	Passed 5/1982; 6/1985; **Failed 1990**
41/28	8,000	Spent Acetone	Pre-1990	Passed 1990
65/27	1,000	Unknown	Pre-1990	Abandoned and sand filled
66/15	5,000	Waste Mixed Solvent	Pre-1990	Passed 8/1981; 6/1985; 1990
67/1	10,000	Panasol AN-2 (petroleum naphtha)	Pre-1990	Passed 5/1982; 6/1985; 1990
74/26	1,750	Unknown	Pre-1990	Abandoned and sand filled
75/31	1,750	Unknown	Pre-1990	Removed
78/NA	2,500	Unknown	Pre-1983	Removed 12/1982
79/NA	7,000	Unknown	Pre-1983	Removed 12/1982
91/2	10,000	Acetone	Pre-1990	Passed 6/1982; 6/1985; 1990
92/3	10,000	Spent Ethanol	Pre-1990	Passed 6/1982; 6/1985; 1991
93/NA	1,000	Ether	Pre-1983	Removed 12/1982
95/4	10,000	Toluol	Pre-1990	Leak in return line - plugged 4/1982; Passed 8/1982; 6/1985; 1990

Table 5b - continued

UST Plant No./ State Permit No.	Capacity (gallons)	Material Content	Last Use	Integrity Test/Status
96/30	5,000	Unknown	Pre-1990	Removed
97/29	2,000	Unknown	Pre-1990	Removed
111/21	10,000	Waste Oil	Pre-1990	**Failed 1990**
112/22	30,000	No. 6 Fuel Oil	Pre-1990	Passed 1990
113/23	30,000	No. 6 Fuel Oil	Pre-1990	Passed 1990
114/34	1,000	No. 2 Fuel Oil	Pre-1990	Passed 1990
116/25	5,000	Unknown	Pre-1990	Abandoned and sand filled
117/5	10,000	Toluol	Pre-1990	Minor leak at pump pack - pump repacked 3/1982; Passed 6/1985; 1990
118/32	550	Unknown	Pre-1990	Abandoned and sand filled
119/NA	550	No. 2 Fuel Oil	Pre-1990	Removed
121/16	10,000	Isopropyl Alcohol (IPA); Acetone; MeOH; EtOH	Pre-1990	Passed 6/1982; 6/1985; 1990
122/17	10,000	IPA; Acetone; MeOH; EtOH	Pre-1990	Passed 6/1982; 6/1985; 1990
123/18	10,000	IPA; Acetone; MeOH; EtOH	Pre-1990	Passed 6/1982; 6/1985; 1990
124/19	10,000	IPA; Acetone; MeOH; EtOH	Pre-1990	Passed 6/1982; 6/1985; 1990
125/20	15,000	IPA; Acetone; MeOH; EtOH	Pre-1990	Passed 6/1982; 6/1985; 1990
127/NA	2,000	Gasoline	Pre-1990	Passed 11/1980; Removed 1981 or 1983

UST - Underground Storage Tank

Sources:

(1) EWMA May 29, 1998
(2) Langan July 1990
(3) Penick Corporation underground storage tank pressure test records 1981 - 1982

Table 6: Summary of Detected Contaminant Concentrations in Groundwater for Overburden (Uppermost) Aquifer:
Well Depth Range: 6.6 to 24.6 feet
Sample Data: June 1987 through January 2010
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC (a)	
Volatile Organic Compounds - Well Count 71								
Acetone	906	141	ND	230	7.2	9,000 (RMEG) (b)	6,000	No
Benzene	1,022	239	ND	88,700	768	0.6 (CREG) (c)	1	**Yes**
Bromdichloromethane	119	1	ND	5	0.05	0.6 (CREG)	1	**Yes**
2-Butanone	85	3	ND	32	0.7	4,000 (LTHA) (f)	300	No
Carbon Disulfide	523	5	ND	3	0.01	1,000 (RMEG)	700	No
Carbon Tetrachloride	220	38	ND	1,800	92	0.5 (CREG)	1	**Yes**
Chlorobenzene	663	19	ND	2,700	8	100 (LTHA)	50	**Yes**
Chloroethane	263	4	ND	14	0.10	NA	100	**Yes**
Chloroform	760	65	ND	530	7.8	70 (LTHA)	70	**Yes**
1,1-Dichloroethane	389	9	ND	21	0.1	NA	50	No
1,1-Dichloroethene	121	1	ND	0.30	0.00	7 (MCL) (e)	1	No
1,2-Dichloroethane	625	41	ND	17	0.3	5 (MCL)	2	**Yes**
1,2-Dichloroethene (cis)	606	6	ND	2	0.0	70 (LTHA)	70	**Yes**
1,2-Dichloropropane	347	37	ND	13	0.6	5 (MCL)	1	**Yes**
Ethylbenzene	1,045	35	ND	290	0.4	700 (LTHA)	700	No
Methylene chloride	1,022	31	ND	5,800	11	5 (CREG)	3	**Yes**
4-Methyl-2-Pentanone	299	10	ND	17	0.23	NV	400	No
t-Butyl Alcohol	323	2	ND	6	0.04	NA	100	No
Tetrachloroethylene	507	39	ND	73	1.1	5 (MCL)	1	**Yes**
1,1,1-Trichloroethane	140	1	ND	13	0.1	200 (MCL)	30	No
Toluene	1,022	501	ND	580,000	55,463	200 (EMEG) (d)	1,000	**Yes**
Trichloroethylene	482	18	ND	7	0.1	5 (MCL)	1	**Yes**
Vinyl chloride	267	3	ND	2	0.02	0.02 (CREG)	1	**Yes**
Xylene (Total)	908	23	ND	35	0.2	2,000 (EMEG)	1,000	No

Table 6 - continued

Semi-Volatile Organic Compounds - Well Count: 71								
Acenaphthene	107	3	ND	0.67	0.01	600 (RMEG)	400	No
Bis(2-ethylhexyl)phathalate	289	18	ND	48	0.6	2 (CREG)	3	**Yes**
Diethyl phthalate	107	1	ND	74	0.7	8,000 (RMEG)	6,000	No
Fluorene	107	1	ND	0.16	0.001	400 (RMEG)	300	No
Naphthalene	253	22	ND	48	1.2	100 (LTHA)	300	No
Nitrobenzene	109	1	ND	63	0.6	20 (RMEG)	6	**Yes**
Phenol	290	33	ND	2300	12.0	2,000 (LTHA)	2,000	**Yes**
Organochlorine Pesticides - Well Count: 71								
DDD - P,P'	261	31	ND	6.50	0.12	0.1 (CREG)	0.1	**Yes**
DDE - P,P'	259	22	ND	5.60	0.09	0.1 (CREG)	0.1	**Yes**
DDT - P,P'	259	15	ND	6.60	0.08	0.1 (CREG)	0.1	**Yes**
Chlordane	168	5	ND	8.40	0.13	0.1 (CREG)	0.5	**Yes**
a-BHC Hexachlorocyclohexane, alpha	178	3	ND	0.28	0.002	0.006 (CREG)	0.02	**Yes**
b-BHC Hexachlorocyclohexane, beta	168	5	ND	2.01	0.02	0.02 (CREG)	0.04	**Yes**
d-BHC Hexachlorocyclohexane, delta	118	1	ND	0.23	0.002	NV	0.2	**Yes**
Dieldrin	178	2	ND	0.22	0.0014	0.002 (CREG)	0.03	**Yes**
Total Metals - Well Count: 71								
Aluminum	255	9	ND	5,440	45.4	10,000 (EMEG)	200	**Yes**
Antimony	277	13	ND	86	1.7	4 (RMEG)	6	**Yes**
Arsenic	289	134	ND	1,717	15	0.02 (CREG)	3	**Yes**
Barium	258	6	ND	214	2.6	2,000 (EMEG)	2,000	No
Beryllium	277	6	ND	20	0.107	20 (EMEG)	1	**Yes**
Cadmium	271	24	ND	34	0.9	1 (EMEG)	4	**Yes**
Calcium	44	9	ND	190,000	14110	NV	NV	No
Chromium (Total)	285	99	ND	1,610	35	100 (MCL)	70	**Yes**
Copper	227	76	ND	464	16	100 (EMEG)	1,300	**Yes**
Iron	264	17	ND	43,300	752	NV	300	**Yes**
Lead	279	93	ND	240	7	15 (MCL)	5	**Yes**
Magnesium	26	9	ND	29,000	2727	NV	NV	No
Manganese	105	9	ND	7430	164.324	300 (LTHA)	50	**Yes**
Mercury	278	26	ND	21	0.4	2 (MCL)	2	**Yes**
Nickel	277	104	ND	990	23	100 (LTHA)	100	**Yes**

Table 6 - continued

Total Metals - Well Count: 71								
Potassium	261	168	ND	152,000	11,896	NV	21,700 background	**Yes**
Selenium	224	17	ND	54	0.7	50 (EMEG)	40	**Yes**
Sodium	266	5	ND	185,000	1053	NV	50,000	**Yes**
Thallium	278	31	ND	1,790	9	0.5 (LTHA)	2	**Yes**
Zinc	275	158	ND	1,550	46	2,000 (LTHA)	2,000	**Yes**
Total Dissolved Solids (ppm)	433	433	26	16,700	602	NV	500	**Yes**
Dissolved Metals - Well Count: 21								
Aluminum	43	6	ND	982	52.9	10,000 (EMEG)	200	**Yes**
Antimony	48	0	ND	ND	ND	4 (RMEG)	6	No
Arsenic	50	33	ND	23	6.8	0.02 (CREG)	3	**Yes**
Barium	45	5	ND	210	10.9	2,000 (EMEG)	2,000	No
Beryllium	48	1	ND	0.3	0.01	20 (EMEG)	1	No
Cadmium	47	3	ND	0.7	0.03	1 (EMEG)	4	No
Calcium	9	9	1,480	211000	72637	NV	NV	No
Chromium (Total)	49	15	ND	7.3	0.7	100 (MCL)	70	No
Copper	49	9	ND	14.2	0.9	100 (EMEG)	1,300	No
Iron	46	11	ND	33,400	2,493	NV	300	**Yes**
Lead	49	5	ND	4.5	0.3	15 (MCL)	5	No
Magnesium	9	5	ND	23,100	3,516	NV	NV	No
Manganese	15	9	ND	7,160	1,167	300 (LTHA)	50	**Yes**
Mercury	48	1	ND	0.1	0.0	2 (MCL)	2	No
Nickel	32	29	ND	47	4.5	100 (LTHA)	100	No
Potassium	14	8	ND	10,900	1,963	NV	21,700 background	**Yes**
Selenium	45	3	ND	5.0	0.2	50 (EMEG)	40	No
Sodium	45	5	ND	195000	6569	NV	50,000	**Yes**
Thallium	48	9	ND	7.2	0.9	0.5 (LTHA)	2	**Yes**
Zinc	49	42	ND	44	14	2,000 (LTHA)	2,000	No

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide; (d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; NA - Not Analayzed; ND - Not Detected; NV - No Value

Table 7: Summary of Detected Contaminant Concentrations in Groundwater for Shallow Bedrock Aquifer:
Well Depth Range: 53 to 56 feet
Sample Data: June 1987 through January 2010
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC [(a)]	
Volatile Organic Compounds - Well Count 4								
Acetone	66	12	ND	100	8.1	9,000 (RMEG) [(b)]	6,000	No
Benzene	66	34	ND	200	37	0.6 (CREG) [(c)]	1	**Yes**
Chlorobenzene	66	1	ND	12	0.180	100 (LTHA)	50	No
Chloroform	66	11	ND	2	0.2	70 (LTHA)	70	No
1,1-Dichloroethane	66	1	ND	2	0.0	NA	50	No
1,2-Dichloroethane	66	7	ND	6	0.3	5 (MCL)	2	**Yes**
1,2-Dichloroethene (cis)	66	4	ND	400	6.1	70 (LTHA)	70	**Yes**
1,2-Dichloropropane	66	0	ND	ND	ND	5 (MCL)	1	No
Ethylbenzene	66	2	ND	80	1.2	700 (LTHA)	700	No
Methylene chloride	66	2	ND	2	0	5 (CREG)	3	No
Tetrachloroethylene	66	15	ND	310	4.9	5 (MCL)	1	**Yes**
Toluene	66	41	ND	59,000	9,683	200 (EMEG) [(d)]	1,000	**Yes**
Trichloroethylene	66	20	ND	270	4.8	5 (MCL)	1	**Yes**
Vinyl chloride	66	2	ND	25	0.39	0.02 (CREG)	1	**Yes**
Xylene (Total)	66	7	ND	520	8.1	2,000 (EMEG)	1,000	No
Semi-Volatile Organic Compounds - Well Count: 4								
Bis(2-ethylhexyl)phathalate	11	1	ND	1	0.1	2 (CREG)	3	No
Phenol	11	1	ND	2	0.2	2,000 (LTHA)	2,000	No
Organochlorine Pesticides - Well Count: 4								
DDD - P,P'	11	1	ND	0.15	0.01	0.1 (CREG)	0.1	**Yes**
DDE - P,P'	11	1	ND	0.27	0.02	0.1 (CREG)	0.1	**Yes**
DDT - P,P'	11	0	ND	ND	ND	0.1 (CREG)	0.1	No
Total Metals - Well Count: 4								
Aluminum	11	0	ND	ND	ND	10,000 (EMEG)	200	No
Antimony	11	0	ND	ND	ND	4 (RMEG)	6	No
Arsenic	11	1	ND	3	0	0.02 (CREG)	3	**Yes**

Table 7 - continued

Total Metals - Well Count: 4								
Barium	11	0	ND	ND	ND	2,000 (EMEG)	2,000	No
Beryllium	11	0	ND	ND	ND	20 (EMEG)	1	No
Cadmium	11	0	ND	ND	ND	1 (EMEG)	4	No
Chromium (Total)	11	3	ND	11	1	100 (MCL)	70	No
Copper	11	1	ND	13	1	100 (EMEG)	1,300	No
Iron	11	0	ND	ND	ND	NV	300	No
Lead	11	0	ND	ND	ND	15 (MCL)	5	No
Manganese (1 Well)	1	1	ND	0.42	0.42	300 (LTHA)	50	No
Mercury	11	1	ND	3	0.2	2 (MCL)	2	**Yes**
Nickel	11	3	ND	3	1	100 (LTHA)	100	No
Potassium	5	0	ND	ND	ND	NV	21,700 background	No
Selenium	10	0	ND	ND	ND	50 (EMEG)	40	No
Sodium	11	0	ND	ND	ND	NV	50,000	No
Thallium	11	2	ND	78	11	0.5 (LTHA)	2	**Yes**
Zinc	11	4	ND	22	3	2,000 (LTHA)	2,000	No
Total Dissolved Solids (ppm) (2 Wells)	25	25	392	678	555	NV	500	**Yes**

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide; (d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; NA - Not Analayzed; ND - Not Detected; NV - No Value

Table 8: Summary of Detected Contaminant Concentrations in Groundwater from Facility Process Wells (Deep Bedrock Aquifer):
Well Depth Range: 267 to 410 feet
Sample Data: June 1987 through January 1998
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC (a)	
Volatile Organic Compounds - Well Count 4								
Acetone	5	0	ND	ND	ND	9,000 (RMEG) (b)	6,000	No
Benzene	5	0	ND	ND	ND	0.6 (CREG) (c)	1	No
Chlorobenzene	5	0	ND	ND	ND	100 (LTHA)	50	No
Chloroform	5	0	ND	ND	ND	70 (LTHA)	70	No
1,1-Dichloroethane	5	0	ND	ND	ND	NA	50	No
1,2-Dichloroethane	5	0	ND	ND	ND	5 (MCL)	2	No
1,2-Dichloroethene (cis)	5	0	ND	ND	ND	70 (LTHA)	70	No
1,2-Dichloropropane	5	0	ND	ND	ND	5 (MCL)	1	No
Ethylbenzene	5	0	ND	ND	ND	700 (LTHA)	700	No
Methylene chloride	5	3	ND	86	20	5 (CREG)	3	**Yes**
Tetrachloroethylene	5	2	ND	8	2.6	5 (MCL)	1	**Yes**
Toluene	5	0	ND	ND	ND	200 (EMEG) (d)	1,000	No
Trichloroethylene	5	2	ND	8	2.1	5 (MCL)	1	**Yes**
Vinyl chloride	5	0	ND	ND	ND	0.02 (CREG)	1	No
Xylene (Total)	5	0	ND	ND	ND	2,000 (EMEG)	1,000	No
Semi-Volatile Organic Compounds - Well Count: 4								
Bis(2-ethylhexyl)phathalate	5	0	ND	ND	ND	2 (CREG)	3	No
Phenol	5	0	ND	ND	ND	2,000 (LTHA)	2,000	No
Organochlorine Pesticides - Well Count: 4								
DDD - P,P'	7	0	ND	ND	ND	0.1 (CREG)	0.1	No
DDE - P,P'	7	3	ND	0.30	0.11	0.1 (CREG)	0.1	**Yes**
DDT - P,P'	7	0	ND	ND	ND	0.1 (CREG)	0.1	No
Total Metals - Well Count: 4								
Aluminum	4	0	ND	ND	ND	10,000 (EMEG)	200	No
Antimony	7	0	ND	ND	ND	4 (RMEG)	6	No
Arsenic	7	2	ND	260	38	0.02 (CREG)	3	**Yes**

Table 8 - continued

Total Metals - Well Count: 4								
Barium	5	0	ND	ND	ND	2,000 (EMEG)	2,000	No
Beryllium	7	0	ND	ND	ND	20 (EMEG)	1	No
Cadmium	7	1	ND	ND	ND	1 (EMEG)	4	No
Chromium (Total)	7	3	ND	3	0	100 (MCL)	70	No
Copper	7	0	ND	ND	ND	100 (EMEG)	1,300	No
Iron	5	1	ND	1,030	206	NV	300	**Yes**
Lead	7	4	ND	1,190	180	15 (MCL)	5	**Yes**
Manganese	4	0	ND	ND	ND	300 (LTHA)	50	No
Mercury	7	1	ND	180	26	2 (MCL)	2	**Yes**
Nickel	7	1	ND	718	103	100 (LTHA)	100	**Yes**
Selenium	2	0	ND	ND	ND	50 (EMEG)	40	No
Sodium	5	0	ND	ND	ND	NV	50,000	No
Thallium	7	2	ND	24	4	0.5 (LTHA)	2	**Yes**
Zinc	7	1	ND	33,000	4714	2,000 (LTHA)	2,000	**Yes**

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide; (d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; NA - Not Analayzed; ND - Not Detected; NV - No Value

Table 9: Contaminants Remaining in Surface Soil Exceeding NJDEP Non-Residential Criteria (0 - 0.5 feet)
Draft Deed Notice April 2008.
Former Penick/Penco Site

Contaminant	Number of Samples/ Detections	Concentration: milligrams/kilogram					Contaminant of Concern
		Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP NRDCSCC (a)	
Former Foam Basin Area							
Chlordane	23	1.0	210	17	2 (CREG) (b)	NV	**Yes**
4,4'-DDD	14	0.8	290	36	-	12	**Yes**
4,4'-DDE	14	0.9	59	12	-	9	**Yes**
4,4'-DDT	14	2.4	60	17	-	9	**Yes**
Former OPA-53 Area							
Benzo (a) Anthracene	3	12	120	49	-	4	**Yes**
Benzo (b) Fluoranthene	4	15	130	45	-	4	**Yes**
Benzo (k) Fluoranthene	1	NA	18	NA	-	4	**Yes**
Benzo (a) Pyrene	3	10	100	41	-	0.66	**Yes**
Chrysene	1	NA	150	NA	-	40	**Yes**
Indeno (1,2,3-cd) Pyrene	1	NA	38	NA	-	4	**Yes**
Non-Specific Areas							
Beryllium	1	NA	2.5	NA	-	1	**Yes**
4,4'-DDT	1	NA	13	NA	-	9	**Yes**
Former UST No. 78							
Chlordane	1	NA	6.4	NA	2 (CREG)	NV	**Yes**

(a) New Jersey Department of Environmental Protection Non-Residential Direct Contact Soil Cleanup Criteria - Future site use will be restricted to non-residential use as per NJDEP communication 12/22/2010

(b) Cancer Risk Evaluation Guide - Most conservative guideline was used in absence of NJDEP NRDCSCC

NA - Not Applicable; NV - No Value Available

Table 10: Contaminants Remaining in Subsurface Soil Exceeding NJDEP Criteria (0.5 - 10 feet)

Draft Deed Notice April 2008.

Former Penick/Penco Site

Contaminant	Number of Samples/ Detections	Concentration: milligrams/kilogram					Contaminant of Concern
		Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP NRDCSCC [(a)]	
Former Building 19 - Sampling Depth: 5.5 - 6'							
Chlordane	2	2	19	10.5	2 (CREG) [(b)]	NV	**Yes**
Former Foam Basin Area - Sampling Depth: 2 - 6.5'							
Chlordane	10	1.4	220	34	2 (CREG)	NV	**Yes**
Heptachlor	1	NA	0.74	NA	-	0.65	**Yes**
4,4'-DDD	6	7.3	60	35	-	12	**Yes**
4,4'-DDE	6	0.0	36	11	-	9	**Yes**
4,4'-DDT	6	6.4	21	11	-	9	**Yes**
OPA-53 Soil Sampling Area - Sampling Depth: 0.5 - 2.5'							
Benzo (a) Anthracene	2	16	22	19	-	4	**Yes**
Benzo (b) Fluoranthene	2	21	22	22	-	4	**Yes**
Benzo (k) Fluoranthene	2	14	19	17	-	4	**Yes**
Benzo (a) Pyrene	3	7.3	25	17	-	0.66	**Yes**
Non-Specific Areas - Sampling Depth: 1.0 - 10'							
Benzene	2	7	38	23	-	13	**Yes**
Toluene	1	NA	3,500	NA	-	1,000	**Yes**
Chlordane	6	1.1	350	75	2 (CREG)	NV	**Yes**
4,4'-DDD	2	11	26	19	-	12	**Yes**
Former Railroad Siding - Sampling Depth: 1.0 - 2.5'							
Chlordane	1	NA	4.60	NA	2 (CREG)	NV	**Yes**

Table 10 - continued

Former UST No. 78 - Sampling Depth: 0.75 - 3.5'							
Chlordane	6	1.3	30.0	7.1	2 (CREG)	NV	**Yes**
Former UST No. 111 - Sampling Depth: 1.5 - 5.5'							
Chlordane	7	1.4	57	27	2 (CREG)	NV	**Yes**
Arsenic	1	NA	20	NA	-	20	**Yes**
Beryllium	1	NA	1.4	NA	-	1	**Yes**
Former Vent Overflow Area - Sampling Depth: 3 - 3.5'							
Total Petroleum Hydrocarbons	1	NA	28,000	NA	NV	10,000	**Yes**
I6-3 - Sampling Depth: 6 - 6.5'							
Tetrachloroethylene	1	NA	8	NA	-	6	**Yes**
Former Tank No. 4 - Sampling Depth: 9.5 - 10'							
Tetrachloroethylene	1	NA	37	NA	-	6	**Yes**
Boring 27-1 - Sampling Depth: 2.5 - 3'							
Benzo (a) Pyrene	1	NA	2.2	NA	-	0.66	**Yes**
Former Wastewater Treatment Pit - Sampling Depth: 8.5 - 9'							
Benzo (a) Anthracene	1	NA	4.72	NA	-	4	**Yes**
Benzo (a) Pyrene	1	NA	3.62	NA	-	0.66	**Yes**
Dibenzo (1,2,3-cd) Pyrene	1	NA	0.73	NA	-	0.66	**Yes**

(a) New Jersey Department of Environmental Protection Non-Residential Direct Contact Soil Cleanup Criteria - Future site use will be restricted to non-residential use as per NJDEP communication 12/22/2010

(b) Cancer Risk Evaluation Guide - Most conservative guideline was used in absence of NJDEP NRDCSCC

NA - Not Applicable; NV - No Value Available

Table 11: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.5 feet) (f) - Former South Drainage Ditch
Sample Data: April 1987; March 1989
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Antimony	8	3	ND	2.56	0.82	20 (RMEG)	No
Arsenic	10	10	3.7	19	9.3	0.5 (CREG) (a)	**Yes**
Beryllium	10	10	0.25	0.71	0.44	100 (EMEG) (b)	No
Cadmium	10	9	ND	6.7	1.3	5 (EMEG)	**Yes**
Chromium	10	10	9.3	110	33	200 (RMEG) (c)	No
Copper	10	10	23.6	568	148	500 (RMEG)	**Yes**
Lead	10	10	47	1,090	353	400 (RSCC) (d)	**Yes**
Mercury	10	9	ND	13.6	1.9	5.6 (SL R) (e)	**Yes**
Nickel	10	10	7.1	41	20	1,000 (RMEG)	No
Selenium	8	2	ND	1.33	0.2	300 (EMEG)	No
Silver	2	2	1.3	1.3	1.3	300 (RMEG)	No
Thallium	2	2	1.3	1.3	1.3	2 (RSCC)	No
Zinc	10	10	57	1,220	306	20,000 (RMEG)	No
Benzene	12	1	ND	0.0821	0.01	10 (CREG)	No
Chlorobenzene	12	3	ND	60	5.4	1,000 (RMEG)	No
Chloroform	2	1	ND	0.008	0.004	500 (EMEG)	No
Ethylbenzene	6	1	ND	0.122	0.02	5,000 (RMEG)	No
Methylene Chloride	18	13	ND	5.0	0.44	90 (CREG)	No
Toluene	18	8	ND	0.891	0.15	1,000 (EMEG)	No
Acenaphthene	16	6	ND	24	3.5	3,400 (SL R)	No
Anthracene	16	11	ND	33	4.4	20,000 (RMEG)	No
Benzo (a) Anthracene	16	11	ND	48	6.3	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	16	11	ND	19	5.8	0.15 (SL R)	**Yes**

Table 11 - continued

Benzo (k) Fluoranthene	10	2	ND	18	3.1	1.5 (SL R)	**Yes**
Benzo (g,h,i) Perylene	16	10	ND	15	2.9	380,000 (RSCC)	No
Benzo (a) Pyrene	16	10	ND	27	4.6	0.015 (SL R)	**Yes**
Chrysene	16	13	ND	59	9.2	15 (SL R)	**Yes**
1,2-Dichlorobenzene	8	3	ND	2.0	0.40	5,000 (RMEG)	No
1,3-Dichlorobenzene	6	1	ND	1.7	0.28	1,000 (EMEG)	No
1,4-Dichlorobenzene	6	1	ND	8.0	1.3	4,000 (EMEG)	No
Bis (2-ethylhexyl) phthalate	8	2	ND	5.6	0.76	35 (SL R)	No
Fluoranthene	16	15	ND	70	14	2,300 (SL R)	No
Fluorene	16	6	ND	20	2.8	2,300 (SL R)	No
Indeno (1,2,3-cd) Pyrene	10	9	ND	36.0	6.8	0.15 (SL R)	**Yes**
Napththalene	14	6	ND	19	2.1	1,000 (RMEG)	No
Phenanthrene	16	12	ND	160	21	0.015 (SL R)	**Yes**
Pyrene	16	14	ND	83	14	1,700 (SL R)	No
4-Nitrophenol	18	9	ND	86	12	NV	No
Aroclor 1254	6	1	ND	148	25	1 (EMEG)	**Yes**
Chlordane	8	4	ND	21.8	5.7	2 (CREG)	**Yes**
4,4'-DDD	12	6	ND	5.5	0.8	3 (CREG)	**Yes**
4,4'-DDE	8	5	ND	2	0.4	2 (CREG)	**Yes**
4,4'-DDT	8	4	ND	3	0.9	2 (CREG)	**Yes**
Cyanide	10	7	ND	8.4	2.2	1,000 (RMEG)	No
Phenols	16	12	ND	4,740	519	2,000 (EMEG)	**Yes**
Total Petroleum Hydrocarbons	10	10	10	1,100	386	10,000 (RSCC)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential;

(f) Note: Some April samples were collected from 0 - 2 feet; therefore, to be conservative of direct contact exposures they are considered surface samples.

ND - Not Detected; NV - No Value Available

Table 12: Pre-Remedial Contaminants Detected in Subsurface Soil (1.0 - 8.5 feet) - Former South Drainage Ditch
Sample Data: March 1989
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Antimony	6	6	2.2	2.5	2.3	20 (RMEG)	No
Arsenic	6	6	1.1	2.2	1.6	0.5 (CREG) (a)	**Yes**
Beryllium	6	6	0.5	0.63	0.57	100 (EMEG) (b)	No
Cadmium	6	6	0.5	0.63	0.57	5 (EMEG)	No
Chromium	6	6	5.0	12	8	200 (RMEG) (c)	No
Copper	6	6	10	31	18	500 (RMEG)	No
Lead	6	6	6.7	29	14	400 (RSCC) (d)	No
Mercury	6	6	0.1	0.17	0.12	5.6 (SL R) (e)	No
Nickel	6	6	4.9	11	8	1,000 (RMEG)	No
Selenium	6	6	0.5	0.63	0.58	300 (EMEG)	No
Silver	6	6	1.1	1.8	1.3	300 (RMEG)	No
Thallium	6	6	1.1	1.3	1.1	2 (RSCC)	No
Zinc	6	6	11	70	34	20,000 (RMEG)	No
Benzene	11	4	ND	11	1.0	10 (CREG)	**Yes**
Chlorobenzene	11	2	ND	12	1.1	1,000 (RMEG)	No
Ethylbenzene	11	2	ND	0.055	0.01	5,000 (RMEG)	No
Methylene Chloride	11	4	ND	0.02	0.01	90 (CREG)	No
Toluene	11	9	ND	510	46.37	1,000 (EMEG)	No
Chrysene	6	1	ND	0.6	0.1	15 (SL R)	No
Fluoranthene	6	1	ND	0.7	0.11	2,300 (SL R)	No
Pyrene	6	2	ND	0.6	0.17	1,700 (SL R)	No
4-Nitrophenol	6	1	ND	5.1	0.9	NV	No
4,4'-DDD	6	1	ND	0.032	0.01	3 (CREG)	No
Cyanide	6	6	1.1	1.3	1.2	1,000 (RMEG)	No
Phenols	6	6	0.5	4.6	1.4	2,000 (EMEG)	No
Total Petroleum Hydrocarbons	11	11	10	1,100	218	10,000 (RSCC)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected; NV - No Value Available

Table 13: Summary of Detected Contaminant Concentrations in Shallow Groundwater During Investigation of the Former South Drainage Ditch: Sample Data: April and June 1993
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC (a)	
Volatile Organic Compounds - 10 Monitoring Wells								
Acetone	4	3	ND	14	8	9,000 (RMEG) (b)	6,000	No
Benzene	14	5	ND	45	9	0.6 (CREG) (c)	1	**Yes**
Chlorobenzene	14	3	ND	64	7	100 (LTHA)	50	**Yes**
Chloroform	14	3	ND	2	0.3	70 (LTHA)	70	No
1,2-Dichlorobenzene	14	2	ND	7	1	600 (LTHA)	600	No
1,4-Dichlorobenzene	4	1	ND	6	2	75 (LTHA)	75	No
Ethylbenzene	14	2	ND	2	0.2	700 (LTHA)	700	No
Toluene	14	9	ND	320	66	200 (EMEG) (d)	1,000	**Yes**
Xylene (Total)	14	3	ND	5	1	2,000 (EMEG)	1,000	**Yes**
Semi-Volatile Organic Compounds - 10 Monitoring Wells								
Benzo (a) Anthracene	10	1	ND	1	0	NA	0.05	**Yes**
Chrysene	10	1	ND	1	0	NA	5	No
Fluoranthene	10	1	ND	2	0	400 (RMEG)	300	No
4-Nitrophenol	14	3	ND	12,000	867	60 (LTHA)	NA	**Yes**
Phenol	14	5	ND	2,300	175	2,000 (LTHA)	2,000	**Yes**
Phenanthrene	10	1	ND	1	0	NA	100	No
Library Search Compounds - Semi-Volatile Organics								
2-Ethylhexanoic Acid	4	1	ND	3,900	975	NV	NV	**Yes**
N-(hydroxyphenyl) acetamide isomer	14	7	ND	176,000	13,009	NV	NV	**Yes**
N-phenylacetamide	14	6	ND	8,000	1,354	NV	NV	**Yes**
Unknown	14	8	ND	2,000	387	NV	NV	**Yes**
Organochlorine Pesticides/Polychlorinated Biphenyls - 10 Monitoring Wells								
All	14	0	ND	ND	ND	-	-	No
Metals - 10 Monitoring Wells								
Arsenic	10	9	ND	30	9.9	0.02 (CREG)	3	**Yes**
Beryllium	10	1	ND	2.7	0.3	20 (EMEG)	1	**Yes**
Chromium (Total)	10	4	ND	163	20	100 (MCL)	70	**Yes**
Copper	10	3	ND	251	28	100 (EMEG)	1,300	**Yes**
Lead	10	6	ND	140	16	15 (MCL)	5	**Yes**
Mercury	10	1	ND	0.1	0.0	2 (MCL)	2	No

Table 13 - continued

Metals - 10 Monitoring Wells								
Nickel	10	3	ND	390	41	100 (LTHA)	100	**Yes**
Selenium	10	1	ND	3.8	0.4	50 (EMEG)	40	No
Thallium	10	2	ND	3.1	0.5	0.5 (LTHA)	2	**Yes**
Zinc	10	10	8.6	1,550	249	2,000 (LTHA)	2,000	No

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide;
(d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; NA - Not Analayzed; ND - Not Detected; NV - No Value

Table 14: Summary of Detected Contaminant Concentrations in Surface Water within the Former South Drainage Ditch:
Sample Data: April and June 1993
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Volatile Organic Compounds							
Acetone	4	4	18	170	89	9,000 (RMEG) (b)	No
Benzene	4	1	ND	1	0	0.6 (CREG) (c)	**Yes**
Bromoform	5	1	ND	2	0	4 (CREG)	No
Chloroform	5	1	ND	1	0	70 (LTHA)	No
1,1,1-Trichloroethane	5	1	ND	2	0	200 (MCL)	No
Toluene	9	6	ND	660	148	200 (EMEG) (d)	**Yes**
Xylene (Total)	5	1	ND	3	1	2,000 (EMEG)	No
Library Search Compounds - Volatile Organics							
2-Ethyel-1-Hexanol	9	4	ND	6,000	754	NV	No
Ethyl Ester Benzoic Acid	9	5	ND	13,000	2,233	NV	No
C8H16 Hydrocarbon	5	1	ND	1,190	238	NV	No
Hexanoic Acid 2-Propenyl Ester	5	1	ND	1,000	200	NV	No
Isonoyl Ester Acetic Acid	4	2	ND	3,900	1,008	NV	No
Unknown	9	3	ND	2,600	344	NV	No
Semi-Volatile Organic Compounds							
Diethyl phthalate	5	3	ND	1,400	614	8,000 (RMEG)	No
Fluoranthene	5	1	ND	3.0	0.6	400 (RMEG)	No
4-Nitrophenol	9	6	ND	1,700	474	60 (LTHA)	**Yes**
Phenol	4	3	ND	160	59	2,000 (LTHA)	No
Phenanthrene	5	1	ND	12	2.4	100 (GWQS) (g)	No
Library Search Compounds - Semi-Volatile Organics							
Ethyl benzoate	4	2	ND	6,500	1,646	NV	**Yes**
2-Ethyl Hexanol	5	3	ND	14,000	3,740	NV	**Yes**
2-Ethylhexanoic Acid	4	2	ND	6,500	1,725	NV	**Yes**
Ethyl Ester Benzoic Acid	5	3	ND	110,000	30,400	NV	**Yes**
N-(hydroxyphenyl) acetamide isomer	4	2	ND	2,020	565	NV	**Yes**
N-phenylacetamide	4	1	ND	1,700	425	NV	**Yes**

Table 14 - continued

Semi-Volatile Organic Compounds							
Octadecylester 9-Octadecanoic acid isome	4	2	ND	6,000	1,800	NV	No
3,5,5-Trimethylhexanoic acid	4	2	ND	7,500	1,923	NV	No
3,5,5-Trimethyl-1-hexanol	4	1	ND	6,500	1,625	NV	No
Unknown Alkane	5	1	ND	1,227	245	NV	No
Unknown Cycloalkane	5	1	ND	1,000	200	NV	No
Unknown organic acid	4	3	ND	3,500	1,046	NV	No
Unknown	9	7	ND	17,500	3,270	NV	No
Organochlorine Pesticides							
Aldrin	5	1	ND	0.9	0.2	0.002 (CREG)	**Yes**
Hepachlor	5	1	ND	1.4	0.3	0.008 (CREG)	**Yes**
Metals							
Arsenic	5	5	2.6	7.0	4.4	0.02 (CREG)	**Yes**
Chromium (Total)	5	3	ND	7.0	3.5	100 (MCL)	No
Copper	5	2	ND	13	4.7	100 (EMEG)	No
Lead	5	5	3.6	21	8.2	15 (MCL)	**Yes**
Mercury	5	4	ND	0.1	0.1	2 (MCL)	No
Selenium	5	2	ND	2.9	1.0	50 (EMEG)	No
Zinc	5	5	30	100	62	2,000 (LTHA)	No

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide; (d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; (g) New Jersey Department of Environmental Protection Groundwater Quality Standard; NA - Not Analayzed; ND - Not Detected; NV - No Value

Table 15: Pre-Remedial Contaminants Detected in Subsurface Soil (0.74 - 3.75 feet)
Underground Storage Tank Locations
Former Penick/Penco Site

Contaminant	**Number of Samples**	**Number of Detections**	**Concentration: milligrams/kilogram**				**Contaminant of Concern**
			Minimum	**Maximum**	**Average**	**Environmental Guideline Comparison Value**	
Former UST No. 27 - Sampling Depth: 3'; Sample Period: April 1987							
Di-n-butyl phthalate	4	1	ND	0.47	0.12	5,000 (RMEG)	No
Former UST No. 41 - Sampling Depth: 1.75 - 3.25'; Sample Period: May 1987							
Arsenic	3	3	1.4	2.9	2.1	0.5 (CREG) (a)	**Yes**
Beryllium	3	3	0.16	0.2	0.2	100 (EMEG) (b)	No
Chromium	3	3	4.3	7.1	5.5	200 (RMEG) (c)	No
Copper	3	3	6.3	9.3	8.2	500 (RMEG)	No
Lead	3	3	7.4	24	14	400 (RSCC) (d)	No
Nickel	3	3	4.4	5.9	5.0	1,000 (RMEG)	No
Benzene	3	2	ND	0.01	0.01	10 (CREG)	No
1,2-Dichloroethane	3	1	ND	0.02	0.01	8 (CREG)	No
Methylene Chloride	3	3	0.10	0.20	0.14	90 (CREG)	No
Anthracene	3	3	0.12	0.17	0.15	20,000 (RMEG)	No
Benzo (a) Anthracene	3	3	1	2	2	0.15 (SL R) (e)	**Yes**
Benzo (b) Fluoranthene	3	3	2	3	2	0.15 (SL R)	**Yes**
Benzo (g,h,i) Perylene	3	3	1	4	3	380,000 (RSCC)	No
Benzo (a) Pyrene	3	3	2	3	2	0.015 (SL R)	**Yes**
Chrysene	3	3	2	2	2	15 (SL R)	No
Dibenzo (a,h) anthracene	3	3	ND	2	1	0.015 (SL R)	**Yes**
Fluoranthene	3	3	ND	2	1	2,300 (SL R)	No
Indeno (1,2,3-cd) Pyrene	3	3	1	5	3	0.15 (SL R)	**Yes**
Phenanthrene	3	3	1	1	1	0.015 (SL R)	**Yes**
4,4'-DDE	3	2	ND	0.02	0.01	2 (CREG)	No
Heptachlor Epoxide	3	1	ND	0.02	0.01	0.08 (CREG)	No
Total Petroleum Hydrocarbons	3	3	10	23	17	10,000 (RSCC)	No
Former UST No. 65 - Sampling Depth: 0.74'; Sample Period: May 1987							
Arsenic	1	1	3.9	3.9	3.9	0.5 (CREG)	**Yes**
Beryllium	1	1	0.17	0.17	0.17	100 (EMEG)	No
Cadmium	1	1	0.69	0.69	0.69	5 (EMEG)	No
Chromium	1	1	76	76	76	200 (RMEG)	No
Copper	1	1	20	20	20	500 (RMEG)	No
Lead	1	1	32	32	32	400 (RSCC)	No
Mercury	1	1	0.12	0.12	0.12	5.6 (SL R)	No
Nickel	1	1	9.2	9.2	9.2	1,000 (RMEG)	No
Methylene Chloride	1	1	0.0915	0.09	0.09	90 (CREG)	No
Napthalene	1	1	366	366	366	1,000 (RMEG)	No
4,4'-DDD	1	1	10,200	10,200	10,200	3 (CREG)	**Yes**
4,4'-DDT	1	1	9,700	9,700	9,700	2 (CREG)	**Yes**
Phenols	1	1	0.8	0.8	0.8	2,000 (EMEG)	No
Total Petroleum Hydrocarbons	1	1	340	340	340	10,000 (RSCC)	No
Former UST No. 74 - Sampling Depth: NA; Sample Period: September 1987							
Arsenic	1	1	0.71	0.71	0.71	0.5 (CREG)	**Yes**
Chromium	1	1	5.9	5.9	5.9	200 (RMEG)	No
Copper	1	1	5.7	5.7	5.7	500 (RMEG)	No
Lead	1	1	2	2	2	400 (RSCC)	No
Nickel	1	1	41	41	41	1,000 (RMEG)	No
Zinc	1	1	18	18	18	20,000 (RMEG)	No
Chloroform	1	1	0.002	0.002	0.002	500 (EMEG)	No
Methylene Chloride	1	1	0.019	0.019	0.019	90 (CREG)	No

Table 15 - continued

Former UST No. 74 - Sampling Depth: NA; Sample Period: September 1987							
Toluene	1	1	0.001	0.001	0.001	1,000 (EMEG)	No
Acenaphthylene	1	1	0.079	0.079	0.079	3,000 (RMEG)	No
Anthracene	1	1	0.14	0.14	0.14	20,000 (RMEG)	No
Benzo (a) Anthracene	1	1	0.39	0.39	0.39	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	1	1	0.45	0.45	0.45	0.15 (SL R)	**Yes**
Benzo (k) Fluoranthene	1	1	0.45	0.45	0.45	1.5 (SL R)	No
Benzo (a) Pyrene	1	1	0.3	0.3	0.3	0.015 (SL R)	**Yes**
Chrysene	1	1	0.46	0.46	0.46	15 (SL R)	No
Bis (2-ethylhexyl) phthalate	1	1	0.35	0.35	0.35	35 (SL R)	No
Fluoranthene	1	1	0.46	0.46	0.46	2,300 (SL R)	No
Fluorene	1	1	0.05	0.05	0.05	2,300 (SL R)	No
Phenanthrene	1	1	0.72	0.72	0.72	0.015 (SL R)	**Yes**
Pyrene	1	1	0.92	0.92	0.92	1,700 (SL R)	No
4,4'-DDT	1	1	0.019	0.019	0.019	2 (CREG)	No
Former UST No. 75 - Sampling Depth: 2.25 - 3.08'; Sample Period: May 1987							
Arsenic	3	3	1.2	1.8	1.4	0.5 (CREG)	**Yes**
Beryllium	3	3	0.11	0.15	0.12	100 (EMEG)	No
Chromium	3	3	8	9.1	8.47	200 (RMEG)	No
Copper	3	3	3.8	5.9	4.87	500 (RMEG)	No
Lead	3	3	3	3.8	3.50	400 (RSCC)	No
Nickel	3	3	3.3	4.9	3.93	1,000 (RMEG)	No
Zinc	3	3	8.5	14	11	20,000 (RMEG)	No
Methylene Chloride	3	3	0.0065	0.12	0.05	90 (CREG)	No
Di-n-butyl phthalate	3	2	ND	1.07	0.70	5,000 (RMEG)	No
Chlordane	3	1	ND	0.684	0.23	2 (CREG)	No
4,4'-DDD	3	2	ND	1.62	0.55	3 (CREG)	No
4,4'-DDE	3	2	ND	0.62	0.22	2 (CREG)	No
4,4'-DDT	3	1	ND	0.34	0.11	2 (CREG)	No
Heptachlor Epoxide	3	1	ND	0.01	0.004	0.08 (CREG)	No
Phenols	3	2	ND	0.2	0.10	2,000 (EMEG)	No
Total Petroleum Hydrocarbons	3	1	ND	11,200	3,733	10,000 (RSCC)	**Yes**
Former UST No. 78 - Sampling Depth: 2.3 - 2.88'; Sample Period: May 1987							
Arsenic	3	2	ND	3.9	2.1	0.5 (CREG)	**Yes**
Beryllium	3	3	0.13	320	107	100 (EMEG)	**Yes**
Chromium	3	3	3.6	7.6	5.9	200 (RMEG)	No
Copper	3	3	3.8	32	17	500 (RMEG)	No
Lead	3	3	3.6	33	20	400 (RSCC)	No
Mercury	3	2	ND	0.17	0.10	5.6 (SL R)	No
Nickel	3	3	3.6	189	66	1,000 (RMEG)	No
Zinc	3	3	10	88	44	20,000 (RMEG)	No
Methylene Chloride	3	3	0.0414	0.07	0.05	90 (CREG)	No
Trichloroethylene	1	1	0.016	0.02	0.02	2.8 (SL R)	No
Acenaphthene	3	2	ND	0.29	0.14	3,000 (RMEG)	No
Anthracene	3	2	ND	0.59	0.34	20,000 (RMEG)	No
Benzo (a) Anthracene	3	2	ND	6.42	2.8	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	3	1	ND	8.79	2.9	0.15 (SL R)	**Yes**
Benzo (g,h,i) Perylene	3	1	ND	2.91	0.97	380,000 (RSCC)	No
Benzo (a) Pyrene	3	2	ND	4.23	2.0	0.015 (SL R)	**Yes**
Chrysene	3	2	ND	3.93	2.3	15 (SL R)	No
Dibenzo (a,h) anthracene	3	1	ND	9.71	3.2	0.015 (SL R)	**Yes**
Fluoranthene	3	2	ND	2.03	0.79	2,300 (SL R)	No
Napththalene	3	2	ND	0.22	0.12	1,000 (RMEG)	No
Phenanthrene	3	2	ND	6.7	3.7	0.015 (SL R)	**Yes**
Pyrene	3	1	ND	11.9	4.0	1,700 (SL R)	No
Chlordane	3	1	ND	30	10	2 (CREG)	**Yes**
4,4'-DDD	3	1	ND	0.97	0.32	3 (CREG)	No
4,4'-DDE	3	1	ND	0.65	0.22	2 (CREG)	No
4,4'-DDT	3	1	ND	5.2	1.7	2 (CREG)	**Yes**

Table 15 - continued

Former UST No. 78 - Sampling Depth: 2.3 - 2.88'; Sample Period: May 1987							
Heptachlor Epoxide	3	1	ND	2.2	0.73	0.08 (CREG)	**Yes**
Phenols	3	2	ND	1,250	417	2,000 (EMEG)	No
Total Petroleum Hydrocarbons	3	2	ND	1,360	613	10,000 (RSCC)	No
Former UST No. 79 - Sampling Depth: 2.3'; Sample Period: May 1987							
Beryllium	1	1	120	120	120	100 (EMEG)	**Yes**
Chromium	1	1	6.8	6.8	6.8	200 (RMEG)	No
Copper	1	1	2.9	2.9	2.9	500 (RMEG)	No
Lead	1	1	3.5	3.5	3.5	400 (RSCC)	No
Nickel	1	1	4.1	4.1	4.1	1,000 (RMEG)	No
Zinc	1	1	8.8	8.8	8.8	20,000 (RMEG)	No
Methylene Chloride	1	1	0.01	0.01	0.01	90 (CREG)	No
4,4'-DDE	1	1	0.03	0.03	0.03	2 (CREG)	No
4,4'-DDT	1	1	0.19	0.19	0.19	2 (CREG)	No
Heptachlor Epoxide	1	1	0.03	0.03	0.03	0.08 (CREG)	No
Phenols	1	1	0.1	0.1	0.1	2,000 (EMEG)	No
Former UST No. 111 - Sampling Depth: 2.95 - 3.75'; Sample Period: May 1987							
Arsenic	2	2	1.3	20.3	10.8	0.5 (CREG)	**Yes**
Beryllium	2	1	ND	1.4	0.7	100 (EMEG)	No
Cadmium	2	1	ND	1	0.5	5 (EMEG)	No
Chromium	2	2	4.8	6.2	5.5	200 (RMEG)	No
Copper	2	2	4.6	7.7	6.15	500 (RMEG)	No
Lead	2	2	3	3.5	3.25	400 (RSCC)	No
Nickel	2	2	3.3	3.6	3.45	1,000 (RMEG)	No
Zinc	2	2	9.4	17	13.2	20,000 (RMEG)	No
Methylene Chloride	2	2	0.05	0.10	0.08	90 (CREG)	No
Toluene	2	1	ND	1.07	0.54	1,000 (EMEG)	No
1,1,2,2 Tetrachloroethane	2	1	ND	1.79	0.90	0.56 (SL R)	**Yes**
Acenaphthene	2	1	ND	0.40	0.20	3,000 (RMEG)	No
Anthracene	2	1	ND	0.70	0.35	20,000 (RMEG)	No
Benzo (a) Anthracene	2	1	ND	2.02	1.01	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	2	1	ND	2.58	1.29	0.15 (SL R)	**Yes**
Benzo (g,h,i) Perylene	2	1	ND	1.05	0.53	380,000 (RSCC)	No
Benzo (a) Pyrene	2	1	ND	1.76	0.88	0.015 (SL R)	**Yes**
Chrysene	2	1	ND	2.09	1.05	15 (SL R)	No
Dibenzo (a,h) anthracene	2	1	ND	0.47	0.23	0.015 (SL R)	**Yes**
Fluoranthene	2	1	ND	2.95	1.48	2,300 (SL R)	No
Fluorene	2	1	ND	0.30	0.15	2,300 (SL R)	No
Indeno (1,2,3-cd) Pyrene	2	1	ND	0.88	0.44	0.15 (SL R)	**Yes**
Napththalene	2	1	ND	1.09	0.55	1,000 (RMEG)	No
Phenanthrene	2	1	ND	2.90	1.45	0.015 (SL R)	**Yes**
Pyrene	2	1	ND	4.63	2.32	1,700 (SL R)	No
Chlordane	2	1	ND	23.00	11.50	2 (CREG)	**Yes**
4,4'-DDD	2	1	ND	3.50	1.75	3 (CREG)	**Yes**
4,4'-DDE	2	1	ND	0.40	0.20	2 (CREG)	No
4,4'-DDT	2	1	ND	7.0	3.5	2 (CREG)	**Yes**
Heptachlor Epoxide	2	1	ND	0.26	0.13	0.08 (CREG)	**Yes**
Total Petroleum Hydrocarbons	2	2	13	150	81.5	10,000 (RSCC)	No
Former UST No. 116 - Sampling Depth: NA; Sample Period: September 1987							
Arsenic	3	3	0.32	0.71	0.48	0.5 (CREG)	**Yes**
Chromium	3	3	1.1	2.4	1.7	200 (RMEG)	No
Copper	3	3	0.84	11	6	500 (RMEG)	No
Lead	3	3	1.2	12	6	400 (RSCC)	No
Mercury	3	2	ND	31	19	5.6 (SL R)	**Yes**
Zinc	3	3	33	65	46	20,000 (RMEG)	No
Methylene Chloride	3	3	0.02	0.04	0.02	90 (CREG)	No
Toluene	3	1	ND	0.00	0.00	1,000 (RMEG)	No
Pentachlorophenol	3	1	ND	0.09	0.03	6 (CREG)	No

Table 15 - continued

Former UST No. 116 - Sampling Depth: NA; Sample Period: September 1987							
γ - Lindane (gamma-Hexachlorocyclohexane)	3	1	ND	0.014	0.005	0.5 (EMEG)	No
Chlordane	3	2	ND	7.3	2.5	2 (CREG)	**Yes**
4,4'-DDD	3	2	ND	21	7.1	3 (CREG)	**Yes**
4,4'-DDE	3	2	ND	2.9	0.98	2 (CREG)	**Yes**
4,4'-DDT	3	2	ND	120	40	2 (CREG)	**Yes**
Cyanide	3	2	ND	4.6	1.8	1,000 (RMEG)	No
Former UST No. 118 - Sampling Depth: 2.2 - 2.8'; Sample Period: September 1987							
Arsenic	4	4	0.78	1.20	0.96	0.5 (CREG)	**Yes**
Beryllium	4	4	0.23	0.24	0.24	100 (EMEG)	No
Chromium	4	4	4.9	7.10	5.75	200 (RMEG)	No
Copper	4	4	3.2	5.60	4.08	500 (RMEG)	No
Lead	4	4	1.9	14.00	5.20	400 (RSCC)	No
Nickel	4	3	ND	4.00	2.06	1,000 (RMEG)	No
Thallium	4	1	ND	0.23	0.06	2 (RSCC)	No
Zinc	4	4	15	28.00	19.00	20,000 (RMEG)	No
Benzene	4	1	ND	0.00	0.00	10 (CREG)	No
Methylene Chloride	4	4	0.02	0.03	0.02	90 (CREG)	No
Trichlorofluoromethane	4	2	ND	0.00	0.00	20,000 (RMEG)	No
Bis (2-ethylhexyl) phthalate	4	2	ND	0.14	0.04	35 (SL R)	No
Phenols	4	1	ND	0.13	0.03	2,000 (EMEG)	No
Former UST No. 119 - Sampling Depth: 3.0 - 3.75'; Sample Period: April/September 1987							
Arsenic	1	1	3.5	3.5	3.5	0.5 (CREG)	**Yes**
Beryllium	1	1	0.24	0.24	0.24	100 (EMEG)	No
Chromium	1	1	7.9	7.9	7.9	200 (RMEG)	No
Copper	1	1	17	17	17	500 (RMEG)	No
Lead	1	1	24	24	24	400 (RSCC)	No
Mercury	1	1	0.2	0.2	0.2	5.6 (SL R)	No
Nickel	1	1	4.8	4.8	4.8	1,000 (RMEG)	No
Zinc	1	1	31	31	31	20,000 (RMEG)	No
Methylene Chloride	1	1	0.02	0.02	0.02	90 (CREG)	No
Benzo (a) Anthracene	2	2	0.13	0.33	0.23	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	2	2	0.19	0.41	0.30	0.15 (SL R)	**Yes**
Benzo (k) Fluoranthene	2	1	ND	0.19	0.10	0.15 (SL R)	**Yes**
Benzo (a) Pyrene	2	2	0.10	0.28	0.19	0.015 (SL R)	**Yes**
Chrysene	2	2	0.20	0.46	0.33	15 (SL R)	No
Di-n-butyl phthalate	2	1	ND	0.08	0.04	5,000 (RMEG)	No
Fluoranthene	2	2	0.16	0.29	0.23	2,300 (SL R)	No
Phenanthrene	2	1	ND	0.13	0.07	0.015 (SL R)	**Yes**
Pyrene	2	2	0.32	0.49	0.41	1,700 (SL R)	No
Former UST No. 120 - Sampling Depth: 3.0; Sample Period: April 1987							
Benzo (a) Pyrene	1	1	0.11	0.11	0.11	0.015 (SL R)	**Yes**
Chrysene	1	1	0.13	0.13	0.13	15 (SL R)	No
Pyrene	1	1	0.09	0.09	0.09	1,700 (SL R)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 16: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.25 feet) and Subsurface Soil (1.75 - 4.17 feet)
Former Toluene Spill Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Surface Soil - Sampling Depth: 0 - 0.25'							
Arsenic	7	5	0	6.8	2.5	0.5 (CREG) (a)	**Yes**
Beryllium	7	7	0.16	0.33	0.2	100 (EMEG) (b)	No
Cadmium	7	1	0	0.28	0.0	5 (EMEG)	No
Chromium	7	7	4.1	23	8.3	200 (RMEG) (c)	No
Copper	7	7	3	202	50	500 (RMEG)	No
Lead	7	7	2.1	140	36	400 (RSCC) (d)	No
Mercury	7	2	0	0.41	0.1	5.6 (SL R) (e)	No
Nickel	7	7	3.4	7.6	5.5	1,000 (RMEG)	No
Zinc	7	7	11	110	46	20,000 (RMEG)	No
Methylene Chloride	1	1	0.02	0.02	0.02	90 (CREG)	No
Toluene	1	0	ND	ND	ND	1,000 (EMEG)	No
Subsurface Soil - Sampling Depth: 1.75 - 4.17'							
Arsenic	7	3	ND	1.4	0.5	0.5 (CREG) (a)	**Yes**
Beryllium	7	5	ND	0.4	0.2	100 (EMEG) (b)	No
Chromium	7	7	4.3	8.2	5.9	200 (RMEG) (c)	No
Copper	7	7	3.6	5.3	4.4	500 (RMEG)	No
Lead	7	7	1.5	3.4	2.4	400 (RSCC) (d)	No
Nickel	7	7	3.6	5.4	4.6	1,000 (RMEG)	No
Zinc	7	7	8.1	22	12.8	20,000 (RMEG)	No
Methylene Chloride	8	4	ND	0.05	0.0	90 (CREG)	No
Toluene	8	5	ND	0.44	0.1	1,000 (EMEG)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential

Table 17: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.5 feet) and Subsurface Soil (2.5 - 2.75 feet)
Former Catch Basin Inlet
Sample Data: May 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Surface Soil - Sampling Depth: 0 - 0.5'							
Arsenic	1	1	1.7	1.7	1.7	0.5 (CREG) (a)	**Yes**
Beryllium	1	1	0.16	0.16	0.16	100 (EMEG) (b)	No
Cadmium	1	1	0.57	0.57	0.57	5 (EMEG)	No
Chromium	1	1	13	13	13	200 (RMEG) (c)	No
Copper	1	1	44	44	44	500 (RMEG)	No
Lead	1	1	61	61	61	400 (RSCC) (d)	No
Mercury	1	1	0.1	0.1	0.1	5.6 (SL R) (e)	No
Nickel	1	1	23	23	23	1,000 (RMEG)	No
Zinc	1	1	236	236	236	20,000 (RMEG)	No
Methylene Chloride	1	1	0.09	0.09	0.09	90 (CREG)	No
Toluene	1	1	0.02	0.02	0.02	1,000 (EMEG)	No
Total Petroleum Hydrocarbons	1	1	1610	1,610	1,610	10,000 (RSCC)	No
Subsurface Soil - Sampling Depth: 2.5 - 2.75 '							
Methylene Chloride	1	1	0.04	0.04	0.04	90 (CREG)	No
Total Petroleum Hydrocarbons	1	1	170	170	170	10,000 (RSCC)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential

Table 18: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.5 feet) and Subsurface Soil (1.5 - 2 feet)
Former Equipment Storage Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Surface Soil - Sampling Depth: 0 - 0.5'							
Chrysene	4	1	ND	3.4	0.85	15 (SL R) (d)	No
Fluoranthene	4	1	ND	2.38	0.60	2,300 (SL R)	No
Phenanthrene	4	1	ND	3.0	0.75	0.015 (SL R)	**Yes**
Pyrene	4	2	ND	4	1.17	1,700 (SL R)	No
Total Petroleum Hydrocarbons	4	4	7	27	15	10,000 (RSCC) (c)	No
Subsurface Soil - Sampling Depth: 1.5 - 2.0'							
Benzene	4	1	ND	0.06	0.01	10 (CREG)) (a)	No
Methylene Chloride	4	4	0.05	0.59	0.24	90 (CREG)	No
Trichlorofluoromethane	4	1	ND	0.035	0.009	20,000 (RMEG) (b)	No

(a) Cancer Risk Evaluation Guide; (b) Reference Media Evaluation Guide; (c) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (d) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 19: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.25 feet) and Subsurface Soil (1.33 - 1.75 feet)
Former Drum Storage Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Surface Soil - Sampling Depth: 0 - 0.25'							
Benzo (k) Fluoranthene	6	2	ND	2.10	0.63	1.5 (SL R)	**Yes**
Benzo (a) Pyrene	6	3	ND	1.20	0.48	0.015 (SL R)	**Yes**
Chrysene	6	3	ND	1.72	0.80	15 (SL R)	No
Fluoranthene	6	2	ND	1.70	0.54	2,300 (SL R)	No
Pyrene	6	4	ND	4.24	1.77	1,700 (SL R)	No
Bis (2-ethylhexyl) phthalate	4	1	ND	0.65	0.16	35 (SL R)	No
Di-n-butyl phthalate	4	1	ND	0.63	0.16	5,000 (RMEG)	No
Napththalene	4	1	ND	0.87	0.22	1,000 (RMEG)	No
Phenanthrene	4	1	ND	0.67	0.17	0.015 (SL R)	**Yes**
Total Petroleum Hydrocarbons	6	6	11	1,000	267	10,000 (RSCC)	No
Subsurface Soil - Sampling Depth: 1.33 - 1.75'							
Methylene Chloride	6	3	ND	1.57	0.42	90 (CREG)	No
Toluene	6	1	ND	0.06	0.02	1,000 (EMEG)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 20: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.25 feet) - Former Foam Basin Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Arsenic	4	4	1	14	6.35	0.5 (CREG) (a)	**Yes**
Beryllium	4	1	ND	0.91	0.23	100 (EMEG) (b)	No
Cadmium	4	2	ND	0.51	0.22	5 (EMEG)	No
Chromium	4	4	19	44	26	200 (RMEG) (c)	No
Copper	4	4	52	89	64	500 (RMEG)	No
Lead	4	4	11	51	35	400 (RSCC) (d)	No
Mercury	4	3	ND	0.17	0.10	5.6 (SL R) (e)	No
Nickel	4	4	19	31	23	1,000 (RMEG)	No
Selenium	4	3	ND	1.7	0.69	300 (EMEG)	No
Zinc	4	4	50	96	70	20,000 (RMEG)	No
Acenaphthene	3	1	ND	0.20	0.07	3,000 (RMEG)	No
Anthracene	3	1	ND	0.32	0.11	20,000 (RMEG)	No
Benzo (a) Anthracene	3	1	ND	0.72	0.24	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	3	2	ND	0.46	0.29	0.15 (SL R)	**Yes**
Benzo (a) Pyrene	3	1	ND	0.64	0.21	0.015 (SL R)	**Yes**
Chrysene	3	2	ND	3.9	1.57	15 (SL R)	No
Di-n-butyl phthalate	3	1	ND	2.2	0.74	5,000 (RMEG)	No
Bis (2-ethylhexyl) phthalate	3	1	ND	0.45	0.15	35 (SL R)	No
Fluoranthene	3	2	ND	0.94	0.60	2,300 (SL R)	No
Fluorene	3	1	ND	0.12	0.04	2,300 (SL R)	No
Indeno (1,2,3-cd) Pyrene	3	1	ND	0.40	0.13	0.15 (SL R)	**Yes**
Napththalene	3	2	ND	0.60	0.23	1,000 (RMEG)	No
Phenanthrene	3	2	ND	2.9	1.47	0.015 (SL R)	**Yes**

Table 20 - continued

Pyrene	3	2	ND	16	5.75	1,700 (SL R)	No
Chlordane	4	1	ND	59	15	2 (CREG)	**Yes**
4,4'-DDD	4	4	1.9	283	73	3 (CREG)	**Yes**
4,4'-DDE	4	3	ND	7.4	2.94	2 (CREG)	**Yes**
4,4'-DDT	4	2	ND	29	9.16	2 (CREG)	**Yes**
Cyanide	4	1	ND	0.50	0.13	1,000 (RMEG)	No
Phenols	4	3	ND	5.4	1.40	2,000 (EMEG)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 21: Pre-Remedial Contaminants Detected in Subsurface Soil (1.75 feet) - Former Foam Basin Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Arsenic	1	1	12	12	12	0.5 (CREG) (a)	**Yes**
Beryllium	1	1	0.32	0.32	0.32	100 (EMEG) (b)	No
Cadmium	1	1	0.71	0.71	0.71	5 (EMEG)	No
Chromium	1	1	8.7	8.7	8.7	200 (RMEG) (c)	No
Copper	1	1	72	72	72	500 (RMEG)	No
Lead	1	1	79	79	79	400 (RSCC) (d)	No
Mercury	1	1	0.94	0.94	0.94	5.6 (SL R) (e)	No
Nickel	1	1	14	14	14	1,000 (RMEG)	No
Zinc	1	1	122	122	122	20,000 (RMEG)	No
Benzene	4	2	ND	0.02	0.01	10 (CREG)	No
Chloroform	4	2	ND	0.01	0.004	500 (EMEG)	No
Methylene Chloride	4	4	0.06	0.48	0.18	90 (CREG)	No
Toluene	4	2	ND	0.14	0.04	1,000 (EMEG)	No
Trichlorofluoromethane	4	1	ND	0.002	0.001	20,000 (RMEG)	No
Acenaphthylene	1	1	0.25	0.25	0.25	3,000 (RMEG)	No
Anthracene	1	1	0.22	0.22	0.22	20,000 (RMEG)	No
Benzo (a) Anthracene	1	1	0.38	0.38	0.38	0.15 (SL R)	**Yes**
Benzo (b) Fluoranthene	1	1	0.35	0.35	0.35	0.15 (SL R)	**Yes**
Benzo (k) Fluoranthene	1	1	0.35	0.35	0.35	1.5 (SL R)	No
Benzo (a) Pyrene	1	1	0.14	0.14	0.14	0.015 (SL R)	**Yes**
Chrysene	1	1	0.52	0.52	0.52	15 (SL R)	No
1,2-Dichlorobenzene	1	1	0.06	0.06	0.06	5,000 (RMEG)	No
Bis (2-ethylhexyl) phthalate	1	1	0.16	0.16	0.16	35 (SL R)	No

Table 21 - continued

Fluoranthene	1	1	0.99	0.99	0.99	2,300 (SL R)	No
Fluorene	1	1	0.26	0.26	0.26	2,300 (SL R)	No
2-Methylnaphthalene	1	1	0.50	0.50	0.50	200 (RMEG)	No
Napththalene	1	1	0.52	0.52	0.52	1,000 (RMEG)	No
Phenanthrene	1	1	1.6	1.6	1.6	0.015 (SL R)	**Yes**
Pyrene	1	1	1.3	1.3	1.3	1,700 (SL R)	No
1,2,4-Trichlorobenzene	1	1	0.08	0.08	0.08	500 (RMEG)	No
Chlordane	1	1	35	35	35	2 (CREG)	**Yes**
4,4'-DDD	1	1	210	210	210	3 (CREG)	**Yes**
4,4'-DDE	1	1	14	14	14	2 (CREG)	**Yes**
4,4'-DDT	1	1	600	600	600	2 (CREG)	**Yes**

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 22: Pre-Remedial Contaminants Detected in Surface Soil (0 - 0.25 feet) and Subsurface Soil (1.42 - 1.75 feet)
Former Stained Soil Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Surface Soil - Sampling Depth: 0 - 0.25'							
Arsenic	2	2	3.3	4.6	3.95	0.5 (CREG) (a)	**Yes**
Cadmium	2	2	1	1.3	1.15	5 (EMEG) (b)	No
Chromium	2	2	26	35	30.5	200 (RMEG) (c)	No
Copper	2	2	66	89	77.5	500 (RMEG)	No
Lead	2	2	130	150	140	400 (RSCC) (d)	No
Mercury	2	2	0.26	0.29	0.275	5.6 (SL R) (e)	No
Nickel	2	2	31	290	160.5	1,000 (RMEG)	No
Zinc	2	2	220	234	227	20,000 (RMEG)	No
β-BHC (beta - Hexachlorocyclohexane)	2	2	1.03	2.06	1.55	0.4 (CREG)	**Yes**
Chlordane	2	2	26	26	26	2 (CREG)	**Yes**
4,4'-DDD	2	2	3	6	4	3 (CREG)	**Yes**
4,4'-DDE	2	2	4	4	4	2 (CREG)	**Yes**
4,4'-DDT	2	2	3	4	3	2 (CREG)	**Yes**
Total Petroleum Hydrocarbons	2	2	1500	3200	2350	10,000 (RSCC)	No
Subsurface Soil - Sampling Depth: 1.42 - 1.75'							
Benzene	2	2	0.01	8.22	4.11	10 (CREG)	No
Methylene Chloride	2	2	0.05	3.04	1.54	90 (CREG)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential; ND - Not Detected

Table 23: Pre-Remedial Contaminants Detected in Subsurface Soil (1.08 - 4.08 feet) - Former Vent Overflow Area
Sample Data: April 1987
Former Penick/Penco Site

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Total Petroleum Hydrocarbons [(b)]	3	3	2100	19,300	8,167	10,000 (RSCC)	**Yes**

(a) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria

(b) Sample results available for 3 of 5 samples collected. The 2 unavailable samples were reportedly below the RSCC.

Table 24: Pre-Remedial Contaminants Detected in Surface Soil (0 - 2 feet) (f) - Random Site-Wide Sampling Areas
Sample Data: April - August 1987
Former Penick/Penco Site

Contaminant	**Number of Samples**	**Number of Detections**	**Concentration: milligrams/kilogram**				**Contaminant of Concern**
			Minimum	**Maximum**	**Average**	**Environmental Guideline Comparison Value**	
Antimony	14	4	ND	2.8	0.51	20 (RMEG)	No
Arsenic	43	42	ND	16	4.5	0.5 (CREG) (a)	**Yes**
Beryllium	43	30	ND	2.5	0.27	100 (EMEG) (b)	No
Cadmium	43	21	ND	500	12	5 (EMEG)	**Yes**
Chromium	43	43	3.2	47	13	200 (RMEG) (c)	No
Copper	43	43	3.1	3,930	146	500 (RMEG)	**Yes**
Lead	43	43	2.2	740	112	400 (RSCC) (d)	**Yes**
Mercury	43	33	ND	76	3.0	5.6 (SL R) (e)	**Yes**
Nickel	43	41	ND	157	15	1,000 (RMEG)	No
Selenium	24	9	ND	110	4.8	300 (EMEG)	No
Zinc	43	43	11	1,280	153	20,000 (RMEG)	No
Benzene	12	1	ND	0.02	0.002	10 (CREG)	No
Chlorobenzene	12	0	ND	0	0.0	1,000 (RMEG)	No
Chloroform	29	4	ND	0.003	0.0003	500 (EMEG)	No
Ethylbenzene	8	1	ND	0.60	0.07	5,000 (RMEG)	No
Methylene Chloride	43	37	ND	0.2	0.02	90 (CREG)	No
Toluene	12	2	ND	6.2	0.52	1,000 (EMEG)	No
1,1,2,2 Tetrachloroethane	11	1	ND	0.001	0.0001	0.56 (SL R)	No
Trichloroethylene	11	1	ND	0.003	0.0003	2.8 (SL R)	No
Acenaphthene	25	8	ND	1	0.09	3,400 (SL R)	No
Acenaphthylene	31	11	ND	1.3	0.10	3,000 (RMEG)	No
Anthracene	37	26	ND	3	0.30	20,000 (RMEG)	No
Benzo (a) Anthracene	42	35	ND	15	1.8	0.15 (SL R)	**Yes**

Table 24 - continued

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Benzo (b) Fluoranthene	41	33	ND	18	2.3	0.15 (SL R)	**Yes**
Benzo (k) Fluoranthene	39	22	ND	18	1.1	1.5 (SL R)	**Yes**
Benzo (g,h,i) Perylene	40	31	ND	4.7	0.7	380,000 (RSCC)	No
Benzo (a) Pyrene	42	33	ND	12	1.3	0.015 (SL R)	**Yes**
Butylbenzl phthalate	10	1	ND	0.05	0.01	10,000 (RMEG)	No
Chrysene	43	40	ND	19	2.3	15 (SL R)	**Yes**
Dibenzo (a,h) anthracene	42	19	ND	2.5	0.19	0.015 (SL R)	**Yes**
Dibenzofuran	29	4	ND	0.86	0.04	78 (SL R)	No
Di-n-butyl phthalate	29	7	ND	0.68	0.04	5,000 (RMEG)	No
Bis (2-ethylhexyl) phthalate	43	11	ND	7.0	0.21	35 (SL R)	No
Fluoranthene	43	38	ND	30	2.4	2,300 (SL R)	No
Fluorene	43	17	ND	2	0.10	2,300 (SL R)	No
Indeno (1,2,3-cd) Pyrene	43	29	ND	4.6	0.51	0.15 (SL R)	**Yes**
2-Methylnaphthalene	29	7	ND	0.9	0.05	200 (RMEG)	No
Napththalene	43	7	ND	0	0.02	1,000 (RMEG)	No
Phenanthrene	43	35	ND	16	1.7	0.015 (SL R)	**Yes**
Pyrene	43	38	ND	53	4.2	1,700 (SL R)	No
4-Nitrophenol	12	1	ND	0.36	0.03	NV	No
Aroclor 1254	15	1	ND	0.62	0.04	1 (EMEG)	No
α-BHC (alpha - Hexachlorocyclohexane)	10	1	ND	0.008	0.001	0.1 (CREG)	No
β-BHC (beta - Hexachlorocyclohexane)	4	1	ND	0.14	0.04	0.4 (CREG)	No
δ-BHC (delta - Hexachlorocyclohexane)	39	15	ND	0.23	0.03	0.27 (SL R)	No
γ-Lindane (gamma-Hexachlorocyclohexane)	4	1	ND	0.02	0.004	0.5 (EMEG)	No

Table 24 - continued

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram				Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	
Chlordane	43	21	ND	348	10.4	2 (CREG)	**Yes**
4,4'-DDD	43	25	ND	34	1.5	3 (CREG)	**Yes**
4,4'-DDE	43	32	ND	33	1.3	2 (CREG)	**Yes**
4,4'-DDT	43	29	ND	58	2.5	2 (CREG)	**Yes**
Dieldrin	10	1	ND	4.1	0.41	0.4 (CREG)	**Yes**
Endrin Aldehyde	10	1	ND	0.07	0.01	20 (RMEG)	No
Heptachlor	4	1	ND	0.02	0.004	0.2 (CREG)	No
Heptachlor Epoxide	20	6	ND	0.31	0.02	0.08 (CREG)	**Yes**
Cyanide	43	9	ND	0.5	0.06	1,000 (RMEG)	No
Phenols	43	18	ND	1.0	0.15	2,000 (EMEG)	No

(a) Cancer Risk Evaluation Guide; (b) Environmental Media Evaluation Guide; (c) Reference Media Evaluation Guide; (d) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (e) USEPA Regional Screening Levels - Residential;

(f) Note: As samples were collected from 0 - 2 feet, to be conservative of direct contact exposures they are considered surface samples.

ND - Not Detected; NV - No Value Available

Table 25: Summary of Soil Gas Results - Residences A through D
Sample Date: April 2009
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/cubic meter			Above GVISLG
			Minimum	Maximum	NJDEP GVISL (a)	
VOLATILE ORGANIC COMPOUNDS						
Acetone	4	0	ND	ND	160,000	No
Allyl chloride			ND	ND	NA	No
Benzene			ND	ND	16	No
Bromodichloromethane			ND	ND	34	No
Bromoform			ND	ND	80	No
Bromomethane			ND	ND	260	No
1,3-Butadiene			ND	ND	11	No
Chlorobenzene			ND	ND	2,600	No
Chloroethane			ND	ND	110	No
Chloroform			ND	ND	24	No
Chloromethane			ND	ND	4,700	No
Carbon disulfide			ND	ND	36,000	No
Carbon tetrachloride			ND	ND	31	No
2-Chlorotoluene			ND	ND	3,600	No
Cyclohexane		2	ND	13	310,000	No
Dibromochloromethane		0	ND	ND	43	No
1,2-Dibromoethane			ND	ND	38	No
1,2-Dichlorobenzene			ND	ND	7,300	No
1,3-Dichlorobenzene			ND	ND	550	No
1,4-Dichlorobenzene			ND	ND	30	No
Dichlorodifluoromethane			ND	ND	9,100	No
1,1-Dichloroethane			ND	ND	26,000	No
1,2-Dichloroethane			ND	ND	20	No
1,1-Dichloroethene			ND	ND	11,000	No
1,2-Dichloroethene (cis)			ND	ND	1,800	No
1,2-Dichloroethene (trans)			ND	ND	3,600	No
1,2-Dichloropropane			ND	ND	23	No
1,3-Dichloropropene (total)			ND	ND	31	No
1,2-Dichlorotetrafluoroethane			ND	ND	NA	No
1,4-Dioxane			ND	ND	NA	No
Ethylbenzene			ND	ND	53,000	No
4-Ethyltoluene			ND	ND	NA	No
n-Heptane		2	ND	25	NA	No
1,3-Hexachlorobutadiene		0	ND	ND	53	No
n-Hexane			ND	ND	36,000	No

Table 25 (continued): Summary of Soil Gas Results - Residences A through D
Sample Date: April 2009

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/cubic meter			Above GVISLG
			Minimum	Maximum	NJDEP GVISL [(a)]	
VOLATILE ORGANIC COMPOUNDS						
Isopropanol	4	4	1,900 J	4,700 J	NA	No
Methylene chloride		0	ND	ND	190	No
Methyl ethyl ketone			ND	ND	260,000	No
Methyl isobutyl ketone			ND	ND	160,000	No
Methyl methacrylate			ND	ND	NA	No
Methyl tert-butyl ether			ND	ND	78	No
Styrene			ND	ND	52,000	No
Tert-butyl alcohol			ND	ND	3,300	No
1,1,2,2-Tetrachloroethane			ND	ND	34	No
Tetrachloroethene			ND	ND	34	No
Tetrahydrofuran			ND	ND	NA	No
Toluene		1	ND	13	260,000	No
1,2,4-Trichlorobenzene		0	ND	ND	1,800	No
1,1,1-Trichloroethane			ND	ND	51,000	No
1,1,2-Trichloroethane			ND	ND	27	No
Trichloroethene			ND	ND	27	No
Trichlorofluoromethane			ND	ND	36,000	No
1,1,2-Trichloro-1,2,2-trifluoroethane			ND	ND	1,600,000	No
1,2,4-Trimethylbenzene			ND	ND	NA	No
1,3,5-Trimethylbenzene			ND	ND	NA	No
2,2,4-Trimethylpentane			ND	ND	NA	No
Vinyl bromide			ND	ND	NA	No
Vinyl chloride			ND	ND	13	No
Total Xylenes			ND	ND	110	No

(a) New Jersey Department of Environmental Protection Generic Vapor Intrusion Screening Levels for Soil Gas
ND - Not Detected
NA - No Screening Level

Table 26: Summary of Detected Contaminants in Indoor Air - Residence A
Sample Date: April 2009
Former Penick/Penco Site, Bergen County

Contaminant	**Number of Samples**	**Concentration: micrograms/cubic meter**						**Contaminant of Concern**
		Ambient Air	**Sub-Slab Soil Gas**	**Basement**	**First Floor**	**Environmental Guideline Comparison Value (CVs)**	**NJDEP IASL** [(a)]	
VOLATILE ORGANIC COMPOUNDS								
Acetone	1	ND	ND	33	14	30,000 (EMEG) [(b)]	3,300	No
Benzene		ND	ND	**3**	**1**	0.1 (CREG) [(c)]	2	**Yes**
Chloroform		ND	ND	**3**	**2**	0.04 (CREG)	2	**Yes**
Chloromethane		2	ND	2	2	90 (SL) [(d)]	95	No
Cyclohexane		ND	13	4	ND	6,000 (SL)	6,200	No
Dichlorodifluoromethane (Freon 12)		4	ND	4	4	200 (SL)	180	No
Ethylbenzene		ND	ND	7	1	1,000 (EMEG)	1,100	No
n-Heptane		ND	25	3	ND	NA	NA	No
n-Hexane		ND	ND	5	1	700 (SL)	730	No
Isopropyl Alcohol		ND	4,700 J	17	15	NA	NA	No
Methylene Chloride		ND	ND	2 J	2 J	2 (CREG)	4	No
Methyl Ethyl Ketone (2-Butanone)		ND	ND	8	2	5,000 (SL)	5,100	No
Styrene		ND	ND	1	ND	900 (EMEG)	1,000	No
Toluene		2	13	19	3	300 (EMEG)	5,100	No
Trichlorofluoromethane (Freon 11)		2	ND	3	2	700 (SL)	730	No
1,2,4-Trimethylbenzene		ND	ND	1	ND	7 (SL)	NA	No
Total Xylenes		ND	ND	14	3	100 (SL)	110	No

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level
(b) Environmental Media Evaluation Guidelines
(c) Cancer Risk Evaluation Guide
(d) USEPA Region 6 Human Health Media-Specific Screening Levels
ND - Not Detected
NA - No CV Available
Bolded numbers indicate exceedance of CV.

Table 27: Summary of Detected Contaminants in Indoor Air - Residence B
Sample Date: April 2009
Former Penick/Penco Site, Bergen County

Contaminant	**Number of Samples**	**Concentration: micrograms/cubic meter**						**Contaminant of Concern**
		Ambient Air	**Sub-Slab Soil Gas**	**Basement**	**First Floor**	**Environmental Guideline Comparison Value (CVs)**	**NJDEP IASL** [(a)]	
VOLATILE ORGANIC COMPOUNDS								
Acetone	1	ND	ND	45	71	30,000 (EMEG) [(b)]	3,300	No
Benzene		ND	ND	**2**	**1**	0.1 (CREG) [(c)]	2	**Yes**
Bromodichloromethane		ND	ND	ND	2	NA	3	No
Chloroform		ND	ND	ND	**9**	0.04 (CREG)	2	**Yes**
Chloromethane		2	ND	2	2	90 (SL) [(d)]	95	No
Cyclohexane		ND	8	ND	ND	6,000 (SL)	6,200	No
1,2-Dichloroethane		ND	ND	ND	**5**	0.04 (CREG)	2	**Yes**
Dichlorodifluoromethane (Freon 12)		4	ND	ND	3	200 (SL)	180	No
Ethylbenzene		ND	ND	1	1	1,000 (EMEG)	1,100	No
n-Heptane		ND	15	1	1	NA	NA	No
n-Hexane		ND	ND	1	1	700 (SL)	730	No
Isopropyl Alcohol		ND	2,900 JE	42	27	NA	NA	No
Methylene Chloride		ND	ND	2 J	**5 J**	2 (CREG)	4	**Yes**
Methyl Ethyl Ketone (2-Butanone)		ND	ND	3	4	5,000 (SL)	5,100	No
Toluene		2	ND	6	14	300 (EMEG)	5,100	No
Trichlorofluoromethane (Freon 11)		2	ND	3	2	700 (SL)	730	No
1,2,4-Trimethylbenzene		ND	ND	4	ND	7 (SL)	NA	No
1,3,5-Trimethylbenzene		ND	ND	2	ND	6 (SL)	NA	No
2,2,4-Trimethylpentane		ND	ND	ND	2	NA	NA	No
Total Xylenes		ND	ND	6	ND	100 (SL)	110	No

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level
(b) Environmental Media Evaluation Guidelines
(c) Cancer Risk Evaluation Guide
(d) USEPA Region 6 Human Health Media-Specific Screening Levels
ND - Not Detected
NA - No CV Available
Bolded numbers indicate exceedance of CV.

Table 28: Summary of Detected Contaminants in Indoor Air - Residence C
Sample Date: April 2009
Former Penick/Penco Site, Bergen County

Contaminant	**Number of Samples**	**Concentration: micrograms/cubic meter**						**Contaminant of Concern**
		Ambient Air	**Sub-Slab Soil Gas**	**Basement**	**First Floor**	**Environmental Guideline Comparison Value (CVs)**	**NJDEP IASL [(a)]**	
VOLATILE ORGANIC COMPOUNDS								
Acetone	1	ND	ND	26	31	30,000 (EMEG) [(b)]	3,300	No
Benzene		ND	ND	**4**	**2**	0.1 (CREG) [(c)]	2	**Yes**
Chloroform		ND	ND	ND	**1**	0.04 (CREG)	2	**Yes**
Chloromethane		2	ND	2	2	90 (SL) [(d)]	95	No
Cyclohexane		ND	ND	2	1	6,000 (SL)	6,200	No
Dichlorodifluoromethane (Freon 12)		4	ND	5	4	200 (SL)	180	No
Ethylbenzene		ND	ND	1	1	1,000 (EMEG)	1,100	No
n-Heptane		ND	ND	3	1	NA	NA	No
n-Hexane		ND	ND	6	3	700 (SL)	730	No
Isopropyl Alcohol		ND	1,900 JE	17	29	NA	NA	No
Methylene Chloride		ND	ND	2 J	ND	2 (CREG)	4	No
Methyl Ethyl Ketone (2-Butanone)		ND	ND	ND	2	5,000 (SL)	5,100	No
Toluene		2	ND	5	8	300 (EMEG)	5,100	No
Trichlorofluoromethane (Freon 11)		2	ND	4	2	700 (SL)	730	No
1,2,4-Trimethylbenzene		ND	ND	ND	1	7 (SL)	NA	No
Total Xylenes		ND	ND	3	2	100 (SL)	110	No

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level
(b) Environmental Media Evaluation Guidelines
(c) Cancer Risk Evaluation Guide
(d) USEPA Region 6 Human Health Media-Specific Screening Levels
ND - Not Detected
NA - No CV Available
Bolded numbers indicate exceedance of CV.

Table 29: Summary of Detected Contaminants in Indoor Air - Residence D
Sample Date: April 2009
Former Penick/Penco Site, Bergen County

Contaminant	Number of Samples	Concentration: micrograms/cubic meter						Contaminant of Concern
		Ambient Air	Sub-Slab Soil Gas	Basement	First Floor	Environmental Guideline Comparison Value (CVs)	NJDEP IASL [(a)]	
VOLATILE ORGANIC COMPOUNDS								
Acetone	1	ND	ND	26	40	30,000 (EMEG) [(b)]	3,300	No
Benzene		ND	ND	**5**	**2**	0.1 (CREG) [(c)]	2	**Yes**
1,3-Butadiene		ND	ND	**1**	**0.5**	0.03 (CREG)	1	**Yes**
Chloromethane		2	ND	2	2	90 (SL) [(d)]	95	No
Cyclohexane		ND	ND	5	ND	6,000 (SL)	6,200	No
1,4-Dichlorobenzene		ND	ND	ND	3	60 (EMEG)	3	No
Dichlorodifluoromethane (Freon 12)		4	ND	4	3	200 (SL)	180	No
Ethylbenzene		ND	ND	9	1	1,000 (EMEG)	1,100	No
4-Ethyltoluene		ND	ND	1	ND	NA	NA	No
n-Heptane		ND	ND	3	2	NA	NA	No
n-Hexane		ND	ND	5	1	700 (SL)	730	No
Isopropyl Alcohol		ND	1,900 JE	20	22	NA	NA	No
Methylene Chloride		ND	ND	**29 J**	**6 J**	2 (CREG)	4	**Yes**
Methyl Ethyl Ketone (2-Butanone)		ND	ND	6	2	5,000 (SL)	5,100	No
Styrene		ND	ND	1	ND	900 (EMEG)	1,000	No
Toluene		2	ND	34	10	300 (EMEG)	5,100	No
1,1,1-Trichloroethane		ND	ND	ND	2	7 (SL)	NA	No
Trichlorofluoromethane (Freon 11)		2	ND	3	2	700 (SL)	730	No
1,2,4-Trimethylbenzene		ND	ND	3	ND	6 (SL)	NA	No
2,2,4-Trimethylpentane		ND	ND	2	ND	NA	NA	No
Total Xylenes		ND	ND	16	4	100 (SL)	110	No

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level
(b) Environmental Media Evaluation Guidelines
(c) Cancer Risk Evaluation Guide
(d) USEPA Region 6 Human Health Media-Specific Screening Levels
ND - Not Detected
NA - No CV Available
Bolded numbers indicate exceedance of CV.

Table 30: Summary of Benzene Concentrations Detected in Indoor Air - 17 Study Residences (A - Q)
Sample Date: May/June 1989
Former Penick/Penco Site, Bergen County

Location	Number of Samples	Maximum Concentration: micrograms/cubic meter			Contaminant of Concern
		Basement	Environmental Guideline Comparison Value (CVs)	NJDEP IASL (a)	
BENZENE RESULTS					
Residence A	2	**10.2**	0.1 (CREG) (b)	2	**Yes**
Residence B	2	**80.8**			**Yes**
Residence C	1	**7.0**			**Yes**
Residence D	1	**42.5**			**Yes**
Residence E	1	**8.0**			**Yes**
Residence F	1	**36.7**			**Yes**
Residence G	1	**9.9**			**Yes**
Residence H	1	**7.3**			**Yes**
Residence I	2	**6.7**			**Yes**
Residence J	1	**7.7**			**Yes**
Residence K	1	**29.1**			**Yes**
Residence L	2	**54.3**			**Yes**
Residence M	1	**4.8**			**Yes**
Residence N	2	**3.2**			**Yes**
Residence O	1	ND			**Yes**
Residence P	2	**2.9**			**Yes**
Residence Q	1	**8.9**			**Yes**

Location	Number of Samples	Number of Homes Detected	Range of Concentrations	Average Concentration	Contaminant of Concern
Study Homes (N=17)	23	16	ND - 80.8	19.6	**Yes**
Control Homes (N=16)	26 (24) (c)	16 (15) (c)	0.32 - 50.8 (0.32 - 14.1) (c)	9.7 (6.3) (c)	**Yes**
Ambient Air (study area)	6	NA	0.2 - 6.1	3.6	NA
Ambient Air (control area)	7	NA	0.3 - 6.1	2.7	NA

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level - No value present at time of 1989 study
(b) Cancer Risk Evaluation Guide
(c) Adjusted values to reflect removal of one control home with two unusually high detections of benzene at 50.5 and 50.8 ug/m^3.
ND - Not Detected; NA - Not Applicable
Bolded numbers indicate exceedance of CV.

Table 31: Summary of Toluene Concentrations Detected in Indoor Air - 17 Study Residences (A - Q)
Sample Date: May/June 1989
Former Penick/Penco Site, Bergen County

Location	Number of Samples	Maximum Concentration: micrograms/cubic meter			Contaminant of Concern
		Basement	Environmental Guideline Comparison Value (CVs)	NJDEP IASL [a]	
TOLUENE RESULTS					
Residence A	2	56.0	300 (EMEG) [b]	5,100	No
Residence B	2	173.3			
Residence C	1	42.7			
Residence D	1	121.9			
Residence E	1	65.9			
Residence F	1	90.3			
Residence G	1	52.6			
Residence H	1	35.0			
Residence I	2	44.2			
Residence J	1	51.0			
Residence K	1	111.6			
Residence L	2	183.2			
Residence M	1	24.8			
Residence N	2	24.4			
Residence O	1	218.7			
Residence P	2	29.0			
Residence Q	1	48.0			

Location	Number of Samples	Number of Homes Detected	Range of Concentrations	Average Concentration	Contaminant of Concern
Study Homes (N=17)	23	17	2.6 - 80.8	77.7	No
Control Homes (N=16)	28	16	0.4 - 174.5	56.3	No
Ambient Air (study area)	6	NA	6.9 - 48.4	18.3	NA
Ambient Air (control area)	7	NA	1.5 - 50.7	13.3	NA

(a) New Jersey Department of Environmental Protection Indoor Air Screening Level - No value present at time of 1989 study
(b) Environmental Media Evaluation Guidelines
NA - Not Applicable

Table 32: Summary of Detected Volatile Organic Compounds in Groundwater Potentially Associated With Vapor Intrusion

Nine Monitoring Wells within Approximate 100 Foot Radius of Residential Area

Sample Data: June 1987 through July 2010

Former Penick/Penco Facility

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter				Contaminant of Concern
			Minimum	Maximum	Average	NJDEP GVISLG (a)	
Volatile Organic Compounds - Well Count 9							
Acetone	168	27	ND	150	7.9	1,900,000	No
Benzene	220	89	ND	88,700	1,693	15	**Yes**
Bromdichloromethane	52	0	ND	ND	ND	5	No
2-Butanone	2	0	ND	ND	ND	NV	No
Carbon Disulfide	131	1	ND	3	0.02	710	No
Carbon Tetrachloride	126	37	ND	1,800	159	1	**Yes**
Chlorobenzene	94	1	ND	0.20	0.002	640	No
Chloroform	220	39	ND	530	23.5	70	**Yes**
1,1-Dichloroethane	40	1	ND	1	0.0	3,600	No
1,1-Dichloroethene	54	1	ND	0.30	0.01	250	No
1,2-Dichloroethane	220	32	ND	17	0.6	2	**Yes**
1,2-Dichloroethene (cis)	218	4	ND	2	0.0	350	No
1,2-Dichloropropane	166	36	ND	13	1.2	1	**Yes**
Ethylbenzene	220	3	ND	1	0.01	61,000	No
Methylene chloride	220	6	ND	14	0.13	53	No
4-Methyl-2-Pentanone	2	0	ND	ND	ND	800,000	No
t-Butyl Alcohol	2	0	ND	ND	ND	170,000	No
Tetrachloroethylene	170	38	ND	73	3.2	1	**Yes**
Toluene	220	53	ND	11,000	113	310,000	No
Trichloroethylene	166	9	ND	7	0.1	1	**Yes**
Vinyl chloride	40	0	ND	ND	ND	1	No
Xylene (Total)	168	0	ND	ND	ND	7,000	No

(a) New Jersey Department of Environmental Protection Generic Vapor Intrusion Screening Level for Groundwater

Table 33 – Evaluated Exposure Pathways

Pathway	Pathway Exposure Pathway Elements					Pathway Classification
	Environmental Medium	Route of Exposure	Location	Exposed Population	Point of Exposure	
Soil	Surface Soil (0 – 6 inches)	Ingestion	On-site Former Penick/Penco Facility Property	Area Residents (Child and Adult)	Site-wide Areas on Property	Past, Present & Future – Eliminated (a)
Soil	Surface Soil (0 – 6 inches)	Ingestion	Off-Site Location	Area Residents (Child and Adult)	Former South Drainage Ditch	Past – Completed Present & Future – Eliminated (a)
Indoor Air	Indoor Air	Inhalation	16 Residences	Area Residents (Child and Adult)	Basement Interior	Past – Completed (b) Present & Future – Interrupted (c)
			1 Day-care Facility	Area Residents (Child and Adult)	Basement Interior	

(a) Past exposures are considered eliminated as there was a security fence surrounding the site to prevent unauthorized access. Future exposures considered eliminated through remedial actions completed in the 1990s and the placement of engineering controls via the deed notice to prevent contact to residual contamination.

(b) Review of historic groundwater investigations indicate the benzene groundwater plume leading into the area at the intersection of New York Avenue and Lafayette Avenue supporting the potential for vapor intrusion to have been present for nearby residences.

(c) Present and Future exposures are considered interrupted as groundwater is under active remediation. The New Jersey Department of Environmental Protection (NJDEP) is actively monitoring groundwater to determine whether the threat of vapor intrusion is posed to nearby residences in the future necessitating investigation and mitigation, if required.

Table 34: Comparison of Soil Ingestion and Dermal Absorbed Exposure Dose with Health Guideline Comparison Values. South Drainage Ditch Area - Surface Soil.
Former Penick/Penco Site

Contaminant Of Concern	Exposure Point Concentration (a) (mg/Kg)	Maximum Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)		Non-cancer Health Effects
		Child (b)	Adult (c)	ATSDR MRL (d)	USEPA RfD (e)	
METALS						
Arsenic	12	0.000017	0.000010	0.0003 C 0.005 A	0.0003	No
Cadmium	4	0.000004	0.000003	0.0002 C	0.001	No
Copper	279	0.000306	0.000197	0.01 I/A	0.04	No
Lead	604	0.000662	0.000426	NA	NA	No (f)
Mercury	8	0.000008	0.000005	NA	0.0003	No
SEMI-VOLATILE ORGANIC COMPOUNDS/POLYCYCLIC AROMATIC HYDROCARBONS						
Benzo(a)anthracene	19	0.000047	0.000022	NA	0.3	No
Benzo(b)fluoranthene	13	0.000032	0.000015	NA	0.04	No
Benzo(k)fluoranthene	15	0.000035	0.000016	NA	0.04	No
Benzo(a)pyrene	13	0.000031	0.000014	NA	0.03	No
Chrysene	25	0.000061	0.000028	NA	NA	No (g)
Indeno(1,2,3-cd)pyrene	22	0.000053	0.000025	NA	NA	No (g)
Phenanthrene	67	0.000162	0.000076	NA	NA	No (g)
SEMI-VOLATILE ORGANIC COMPOUNDS						
Aroclor 1254 (commercial mixture of PCBs)	25	0.00006	0.00003	0.00002 C	0.00002	**Yes** (i)
				0.00003 I		**Yes** (i)
Chlordane	18	0.000027	0.000015	0.0006 C	0.0005	No
4,4'-DDD	3.1	0.000004	0.000003	0.0005 I/A (h)	NA	No
4,4'-DDE	1.8	0.000003	0.000001	0.0005 I/A (h)	NA	No
4,4'-DDT	2.8	0.000004	0.000002	0.0005 I/A	0.0005	No
Phenols	3,924	0.004300	0.002764	1 A	0.3	No

(a) Exposure Point Concentrations derived using Pro UCL Version 4.00.02 (EPA, 2007).
(b) Child exposure assumptions: 6-18 yrs old, 5 days/week, 36 weeks/year; 45 kg body weight; 100 mg/day ingestion rate
(c) Adult exposure assumptions: 5 days/week, 36 weeks/year; 70 kg body weight; 100 mg/day ingestion rate
(d) Agency for Toxic Substances Disease Registry's Minimal Risk Level (A = Acute < 15 days, I = Intermediate 15-364 days, C= Chronic > 364 days)
(e) Reference Dose for chronic exposures
(f) As evaluated using the US EPA IEUBK Lead Model (see report for discussion)
(g) No value available. Comparison based on toxicity of benzo (a) pyrene, considered most toxic of the PAH compounds (see report for discussion).
(h) No MRL listed, however, identified as a known associated compound of DDT with similar or the same cancer slope factor.
(i) Contaminant could not be confirmed to originate from on-site source. Available data indicates Aroclor 1254 was present at a very low concentration in one soil sample.

Table 35: Comparison of Indoor Air Contaminant Concentrations with Health Guideline Comparison Values for Current and Future Non-Cancer Health Effects: 2009 Vapor Intrusion Investigations

Former Penick/Penco Site, Bergen County

Exposure Point Indoor Air	Contaminant of Concern	Exposure Point Concentration (µg/m3) (a,b)	Health-Based Comparison Values (µg/m^3)	Potential for Non-Cancer Health Effects
Residence A	Benzene	3	Benzene = 10 (C) (c) 1,3-Butadiene = 2 (d) Chloroform = 100 (C) (c) 1,2-DCA = 2,000 (C) (c) Methylene Chloride = 1,000 (C)(c)	No
	Chloroform	3		
Residence B	Benzene	2		
	Choroform	9		
	1,2-DCA	5		
	Methylene Chloride (e)	5 J		
Residence C	Benzene	4		
	Chloroform	1		
Residence D	Benzene	5		
	1,3-Butadiene	1		
	Methylene Chloride (e)	29 J		

(a) - micrograms per cubic meter.

(b) - Exposure Point Concentrations derived from data presented in Tables 26 through 29 based on maximum concentration detected for limited sampling data.
All detected compounds are considered to originate from background or consumer sources as these compounds were not detected in soil gas samples collected below each residence evaluated.

(c) - Agency for Toxic Substances and Disease Registry, Minimal Risk Level (I = Intermediate 15 - 365 days/year;
C = Chronic more than 365 days/year).

(d) - United States Environmental Protection Agency, Reference Concentration (RfC) (chronic inhalation).

(e) - Methylene Chloride is noted to be a common laboratory contaminant.

Table 36: Comparison of Historic Indoor Air Benzene Concentrations in Indoor Air for 17 Study Residences (A - Q) with Health Guideline Comparison Values for Past Non-Cancer Health Effects: 1989 Indoor Air Investigations

Former Penick/Penco Site, Bergen County

Location	Benzene Exposure Point Concentration (µg/m3) (a,b)	Benzene Health-Based Comparison Values (µg/m3)	Potential for Non-Cancer Health Effects
Residence A	**10.2**	10 (C) (c) (d) 20 (I) (c) 30 (A) (c)	**Yes**
Residence B	**80.8**		**Yes**
Residence C	7.0		No
Residence D	**42.5**		**Yes**
Residence E	8.0		No
Residence F	**36.7**		**Yes**
Residence G	9.9		No
Residence H	7.3		No
Residence I	6.7		No
Residence J	7.7		No
Residence K	**29.1**		**Yes**
Residence L	**54.3**		**Yes**
Residence M	4.8		No
Residence N	3.2		No
Residence O	ND		No
Residence P	2.9		No
Residence Q	8.9		No

(a) micrograms per cubic meter.

(b) Exposure Point Concentrations derived from data presented in Table 30 based on maximum concentration detected for limited sampling data.

(c) Agency for Toxic Substances and Disease Registry, Minimal Risk Level (A = Acute 14 days or less; I = Intermediate 15 - 365 days/year; C = Chronic more than 365 days/year).

(d) US EPA Reference Dose Concentration for chronic exposures.

Table 37: Calculated LECR with Contaminants in Surface Soil
South Drainage Ditch Area
Former Penick/Penco Site

Contaminant of Concern	DHHS Cancer Class [a]	Exposure Point Concentration (mg/Kg)	Potency Factor [f]	BaP Equiv. (mg/kg)	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day)		CSF [d] (mg/kg/d) $^{-1}$	LECR [e]	
						Child [b]	Adult [c]		Child	Adult
METALS										
Arsenic	1	12	-	-	-	4.90E-06	1.57E-06	1.5	7.35E-06	2.36E-06
Lead	2	604	-	-	-			NA		
SEMI-VOLATILE ORGANIC COMPOUNDS/POLYCYCLIC AROMATIC HYDROCARBONS										
Benzo(a)anthracene	2	19	0.1	1.9	19	7.64E-06	2.46E-06	7.3	5.58E-05	1.79E-05
Benzo(b)fluoranthene	2	13	0.1	1.3						
Benzo(k)fluoranthene	2	15	0.01	0						
Benzo(a)pyrene	2	13	1	13						
Chrysene	-	25	0.01	0.25						
Indeno(1,2,3-cd)pyrene	2	22	0.1	2.2						
Phenanthrene	-	67	-	-						

Table 37 - continued

SEMI-VOLATILE ORGANIC COMPOUNDS										
Aroclor 1254 (commercial mixture of PCBs)	2	25	-	-	-	1.02E-05	3.28E-06	2	2.04E-05	6.56E-06
Chlordane	-	18	-	-	-	7.44E-06	2.39E-06	0.35	2.61E-06	8.38E-07
4,4'-DDD	-	3.1	-	-	-	1.28E-06	4.11E-07	0.24	3.07E-07	9.86E-08
4,4'-DDE	-	1.8	-	-	-	7.51E-07	2.41E-07	0.34	2.55E-07	8.21E-08
4,4'-DDT	2	2.8	-	-	-	1.14E-06	3.67E-07	0.34	3.89E-07	1.25E-07
LECR SUM =									**8.71E-05**	**2.80E-05**

(a) Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified

(b) Child exposure assumptions: 5 days/week, 36 weeks/year, 13 year exposure duration (6 - 18 years); 34 kg body weight; 200 mg/day ingestion rate

(c) Adult faculty exposure assumptions: 3 days/week, 26 weeks/year, 30 year exposure duration; 70 kg body weight; 100 mg/day ingestion rate

(d) Cancer Slope Factor

(e) Lifetime Excess Cancer Risk

(f) Cancer potency factor relative to benzo[a]pyrene (BaP)

NA - Not Available

It is noted that the exposure point concentration for arsenic was below the NJDEP RDCSCC of 19 mg/kg for the South Drainage Ditch area. As arsenic exists naturally in the environment, concentrations detected for this area are considered to be within background concentrations with some contribution from site and non-site related sources. However, for the purposes of this PHA, contaminants, such as arsenic, which exceed an Environmental Guideline CV are established as COCs and are considered for further evaluation.

Table 38: Calculated Lifetime Excess Cancer Risk from Current and Future Inhalation Exposures to Indoor Air Contaminants: 2009 Vapor Intrusion Investigations

Former Penick/Penco Site, Bergen County

Exposure Point Indoor Air	Contaminant of Concern	Exposure Point Concentration (µg/m3) (a,b)	Exposure Duration (years) (c)	Exposed Population	USEPA IUR (d) (µg/m3)$^{-1}$	LECR	LECR Sum
Residence A (residence and daycare center)	Benzene	3	30 - Adult Resident (c2)	Adult/Child	Benzene = 7.8E-06 1,3-Butadiene = 3E-05 Chloroform = 2.3E-05 1,2-DCA = 2.6E-05 Methylene Chloride = 4.7E-07	1.00E-05	3.96E-05
	Chloroform	3				2.96E-05	
	Benzene	1.1	6 - Child in Daycare (c1)			7.14E-07	2.82E-06
	Chloroform	1.1				2.11E-06	
Residence B	Benzene	2	30 (c2)			6.69E-06	1.52E-04
	Choroform	9				8.87E-05	
	1,2-DCA	5				5.57E-05	
	Methylene Chloride (e)	5 J				1.01E-06	
Residence C	Benzene	4	30 (c2)			1.34E-05	2.32E-05
	Chloroform	1				9.86E-06	
Residence D	Benzene	5	30 (c2)			1.67E-05	3.54E-05
	1,3-Butadiene	1				1.29E-05	
	Methylene Chloride (e)	29 J				5.84E-06	

(a) - micrograms per cubic meter.

(b) Exposure Point Concentrations derived from data presented in Tables 26 through 29 based on maximum concentration detected for limited sampling data. Concentrations were adjusted based on the exposure scenario detailed in footnote C.

(c) - Current and future scenario based on EPA recommended length of residency for current residents at 30 years from time of 2009 NJDEP indoor air investigation verifying the absence of a source via soil gas sampling (see Table 25).

(c1) - Based on daycare operations. Exposure Assumptions: 260 days a year (5days/week) at a 12 hours/day exposure frequency, 70 years averaging time (USEPA 2002d, 2009).

(c2) - Based on EPA recommended length of residency for current residents. Exposure Assumptions: 365 days a year exposure frequency, 70 years averaging time (USEPA 2002d, 2009).

(d) - Inhalation Unit Risk (cancer slope factor) for human inhalation exposure.

Table 39: Calculated Lifetime Excess Cancer Risk from Past Inhalation Exposures to Benzene for 17 Study Residences (A - Q): 1989 Indoor Air Investigations

Former Penick/Penco Site, Bergen County

Exposure Point Indoor Air	Exposure Point Concentration (µg/m3) [a,b]	Exposure Duration (years) [c]	Exposed Population	USEPA Benzene IUR [d] (µg/m3)$^{-1}$	LECR
Residence A (residence and daycare facility)	10.2	30 - Adult Resident [c2]	Adult/Child	7.80E-06	3.42E-05
	3.6	6 - Child in Daycare [c1]			2.43E-06
Residence B	80.8	30 [c2]			2.70E-04
Residence C	7.0				2.35E-05
Residence D	42.5				1.42E-04
Residence E	8.0				2.67E-05
Residence F	36.7				1.23E-04
Residence G	9.9				3.31E-05
Residence H	7.3				2.46E-05
Residence I	6.7				2.24E-05
Residence J	7.7				2.56E-05
Residence K (residence and former daycare facility)	29.1	30 - Adult Resident [c2]			9.72E-05
	10.4	6 - Child in Daycare [c1]			6.92E-06
Residence L	54.3	30 [c2]			1.82E-04
Residence M	4.8				1.60E-05
Residence N	3.2				1.07E-05
Residence O	ND				NA
Residence P	2.9				9.61E-06
Residence Q	8.9				2.99E-05

(a) - micrograms per cubic meter.

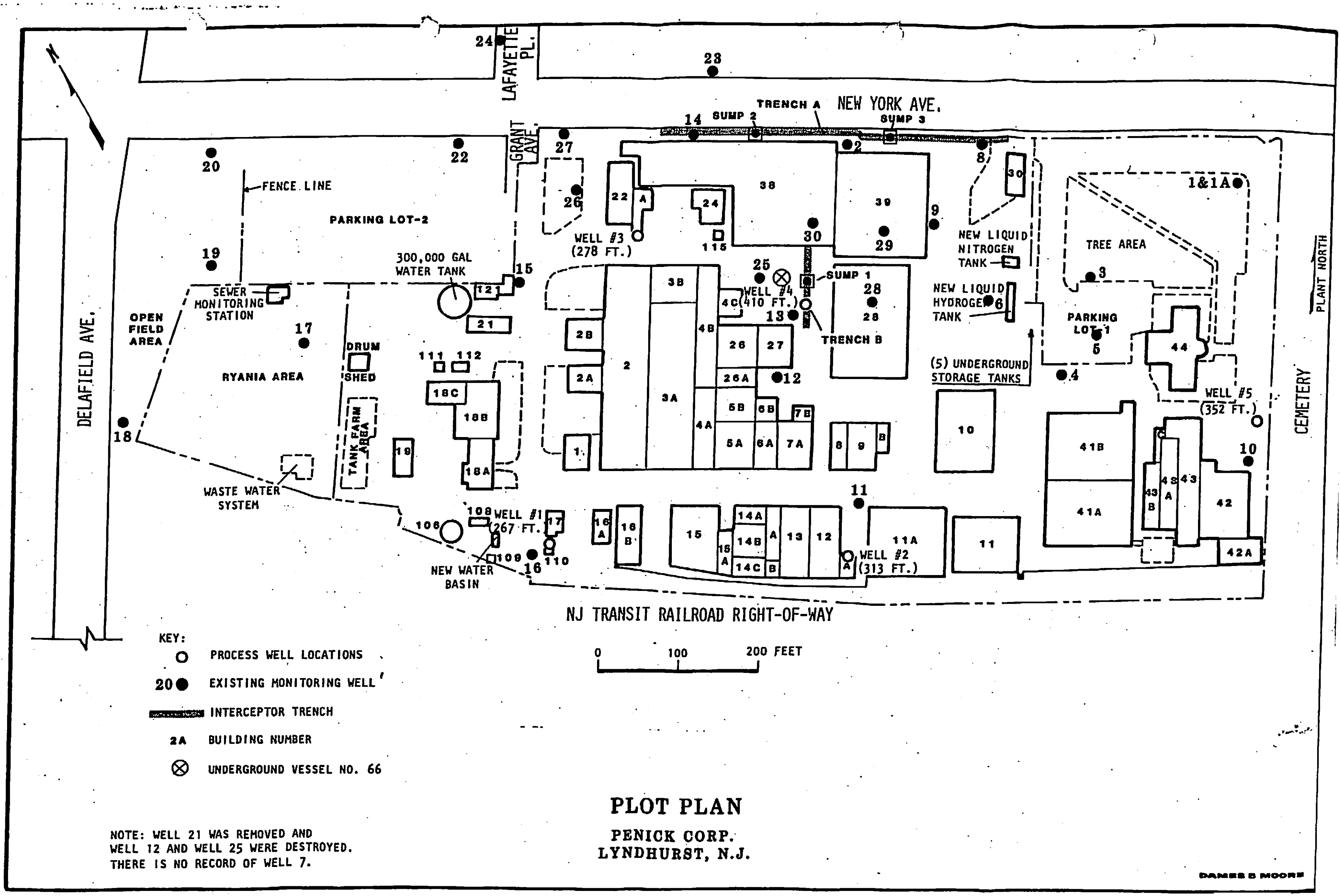
(b) Exposure Point Concentrations derived from data presented in Table 30 based on maximum concentration detected for limited sampling data.

(c) - Based on EPA recommended length of residency for current residents and estimated from time from 1980 discovery of spill to 2009 NJDEP indoor air investigation verifying the absence of a source via soil gas sampling (see Table 25).

(c1) - Based on daycare operations. Exposure Assumptions: 260 days a year (5days/week) at a 12 hours/day exposure frequency, 70 years averaging time (USEPA 2002d, 2009).

(c2) - Based on EPA recommended length of residency for current residents. Exposure Assumptions: 365 days a year exposure frequency, 70 years averaging time (USEPA 2002d, 2009).

(d) - Inhalation Unit Risk (cancer slope factor) for human inhalation exposure to benzene.



NOTE: WELL 21 WAS REMOVED AND
WELL 12 AND WELL 25 WERE DESTROYED.
THERE IS NO RECORD OF WELL 7.

PLOT PLAN
PENICK CORP.
LYNDHURST, N.J.

Figure 2: Former Penick Corporation site layout depicting building numbers and locations.

WELL No.	Casing Elevation above MSL	Depth to Water from Top of Casing (ft)	Ground Water Elevation (ft)
MW-2	45.67	8.79	36.88
MW-6A	48.83	5.88	42.95
MW-8	50.52	13.12	37.40
MW-9	48.80	4.67	44.13
MW-13	47.21	5.36	41.85
MW-22	41.29	3.50	37.79
MW-23	41.59	3.66	37.93
MW-24	38.95	3.43	35.52
MW-26	43.43	6.11	37.32
MW-27	43.33	5.68	37.65
MW-29	49.00	5.81	43.19
MW-33	39.71	2.62	37.09
MW-34	37.94	3.28	34.66
MW-47A	43.44	6.67	36.77
MW-48	39.70	5.96	33.74
MW-50	48.66	5.17	43.49
MW-51	48.81	5.68	43.13
MW-52	50.23	7.21	43.02
MW-53	41.76	3.00	38.76
MW-A	42.24	3.22	39.02
MW-B	43.46	4.45	39.01
MW-C	45.10	5.62	39.48
MW-D	46.50	8.06	38.44
BMW-2	46.05	7.58	38.47
BMW-4	47.11	9.43	37.68
TMW-2	39.28	2.85	36.43
TMW-4	44.98	7.11	37.87
TMW-5	46.42	11.61	34.81
TMW-6	43.90	3.81	40.09
P-1	41.01	4.01	37.00
P-2	44.83	4.68	40.15
P-3A	45.63	6.49	39.14
P-4	45.17	8.67	36.50
P-5	47.23	4.51	42.72
P-6	47.84	4.92	42.92
P-7	50.01	6.57	43.44
P-8	49.91	6.81	43.10
P-9	50.30	7.10	43.20
P-10	49.60	6.15	43.45

LEGEND:

⊕	**-MW = MONITORING WELL SCREENED IN ALLUVIUM**
⊕	**-TMW = MONITORING WELL SCREENED IN TILL**
⊕	**-BMW = MONITORING WELL SCREENED IN BEDROCK**
⊕	**-P = PIEZOMETER**
●	**-CO = CLEANOUT**
→	**- GROUNDWATER FLOW DIRECTION**
----------	**-GALLERY**
— 35 —	**-GROUNDWATER CONTOUR**
(39.30)	**-GROUNDWATER ELEVATION**

Langan
Engineering and
Environmental Services

River Drive Center 1
Elmwood Park, NJ 07407
Phone: (201) 794-6900
Fax: (201) 794-0366
langan.com

- Doylestown, PA
- Miami, FL
- New Haven, CT
- New York, NY
- Philadelphia, PA

Project
FORMER PENICK FACILITY
LYNDHURST NEW JERSEY

Drawing Title
GROUNDWATER ELEVATION CONTOUR MAP
17 JULY 2009

Job No.	2042602
Date	1/23/2009
Scale	1"=40'
Drn. By	KRM
Chkd. By	BYK
Drawing No.	

Figure 3: Groundwater contour map showing recovery system trenches and infiltration galleries

Filename: G:\Data6\2042601\Cadd Data - 2042601\G.W. ELEV. CONTOUR MAP July 2009.dwg Date: 10/13/2009 Time: 11:13 User: kmcpartland Style Table: Langan.stb Layout: E Size Sheet (Side)

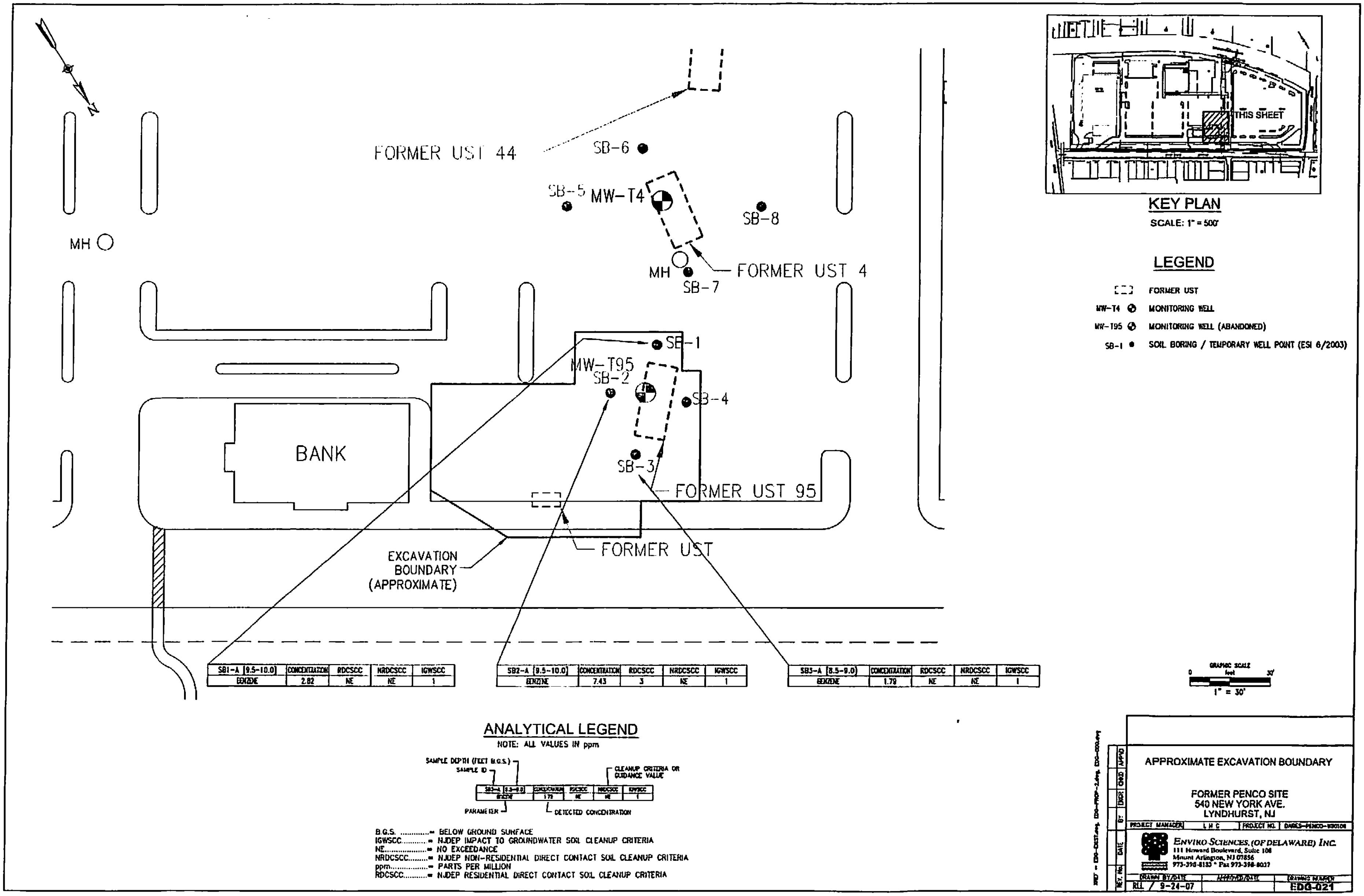


Figure 4: Former Underground Storage Tank No. 95 area near bank location.

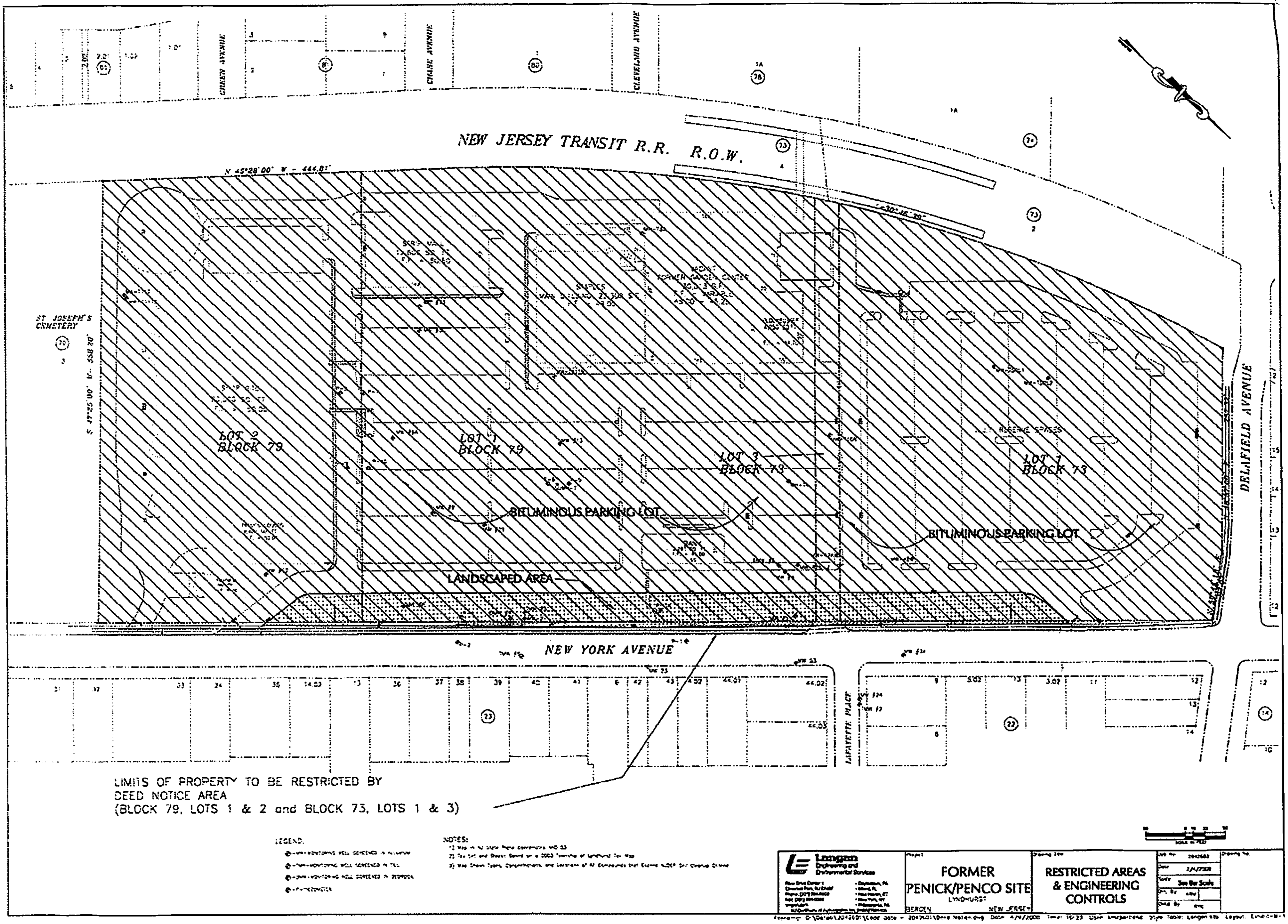
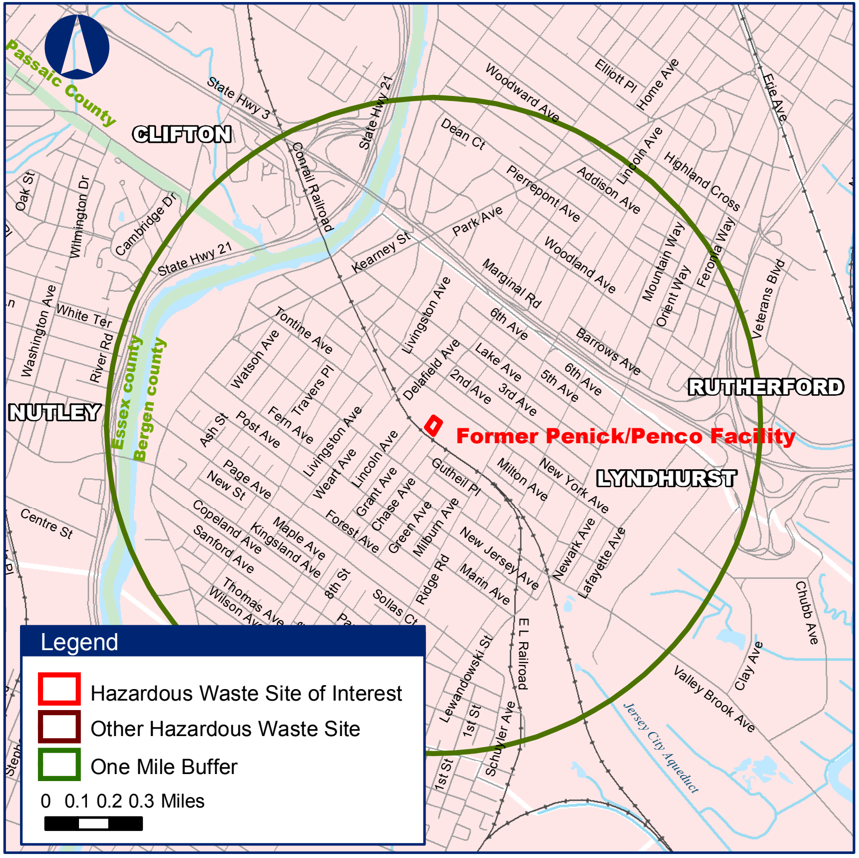


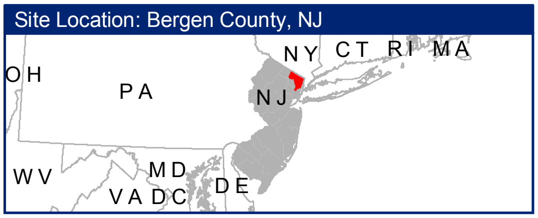
Figure 5: Deed Notice for former Penick/Penco Site encompassing Block 79, Lots 1 & 2; Block 73, Lots 1 & 3

Penick Corporation
Lyndhurst, NJ

EPA Facility ID: NJD081894842



Site Location: Bergen County, NJ



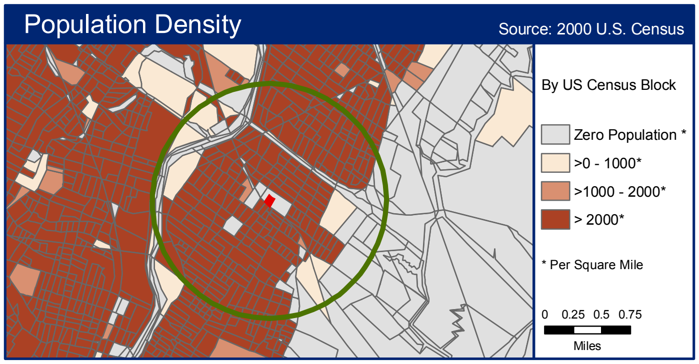
Demographic Statistics
Within One Mile of Site*

Total Population	25,241
White Alone	22,510
Black Alone	167
Am. Indian & Alaska Native Alone	11
Asian Alone	1,540
Native Hawaiian & Other Pacific Islander Alone	1
Some Other Race Alone	519
Two or More Races	493
Hispanic or Latino**	2,237
Children Aged 6 and Younger	1,848
Adults Aged 65 and Older	4,270
Females Aged 15 to 44	5,411
Total Housing Units	10,225

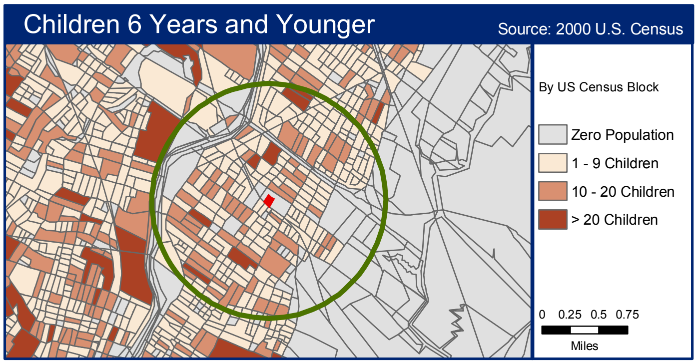
Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

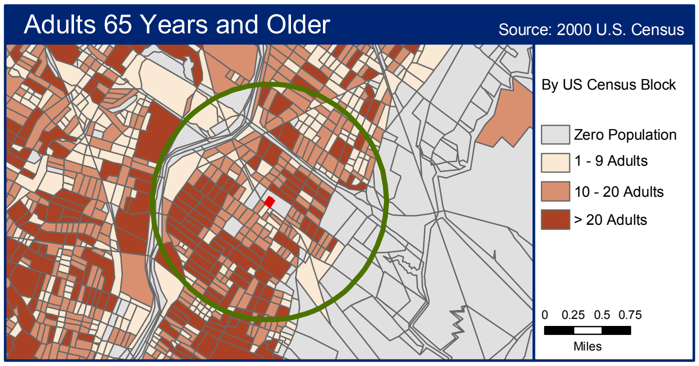
Population Density
Source: 2000 U.S. Census



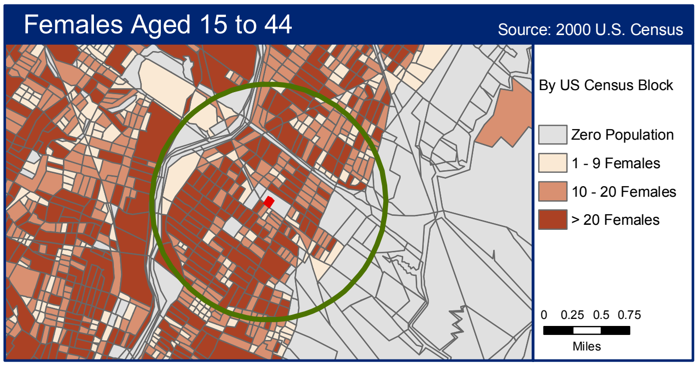
Children 6 Years and Younger
Source: 2000 U.S. Census



Adults 65 Years and Older
Source: 2000 U.S. Census



Females Aged 15 to 44
Source: 2000 U.S. Census



<project=03704><userid=IXA0><geo=Bergen County, NJ><keywords=NJD081894842, Penick, Corporation>

Figure 6: Demographics information for the former Penick/Penco site based on 2000 census data.

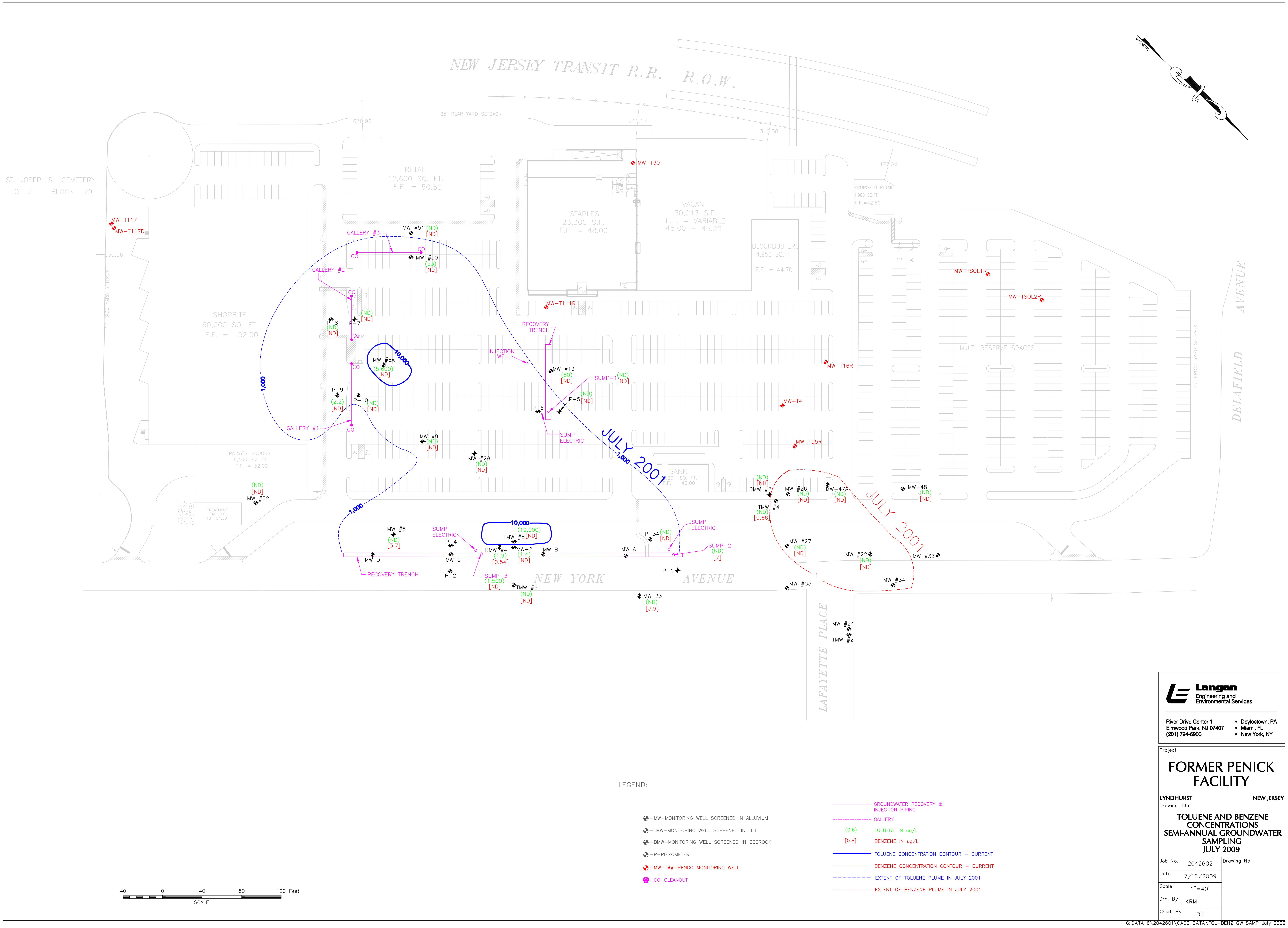


Figure 7: Isopleth of Benzene and Toluene Groundwater Plumes

Depicts current groundwater plumes as of July 2009 and past groundwater plumes as of July 2001

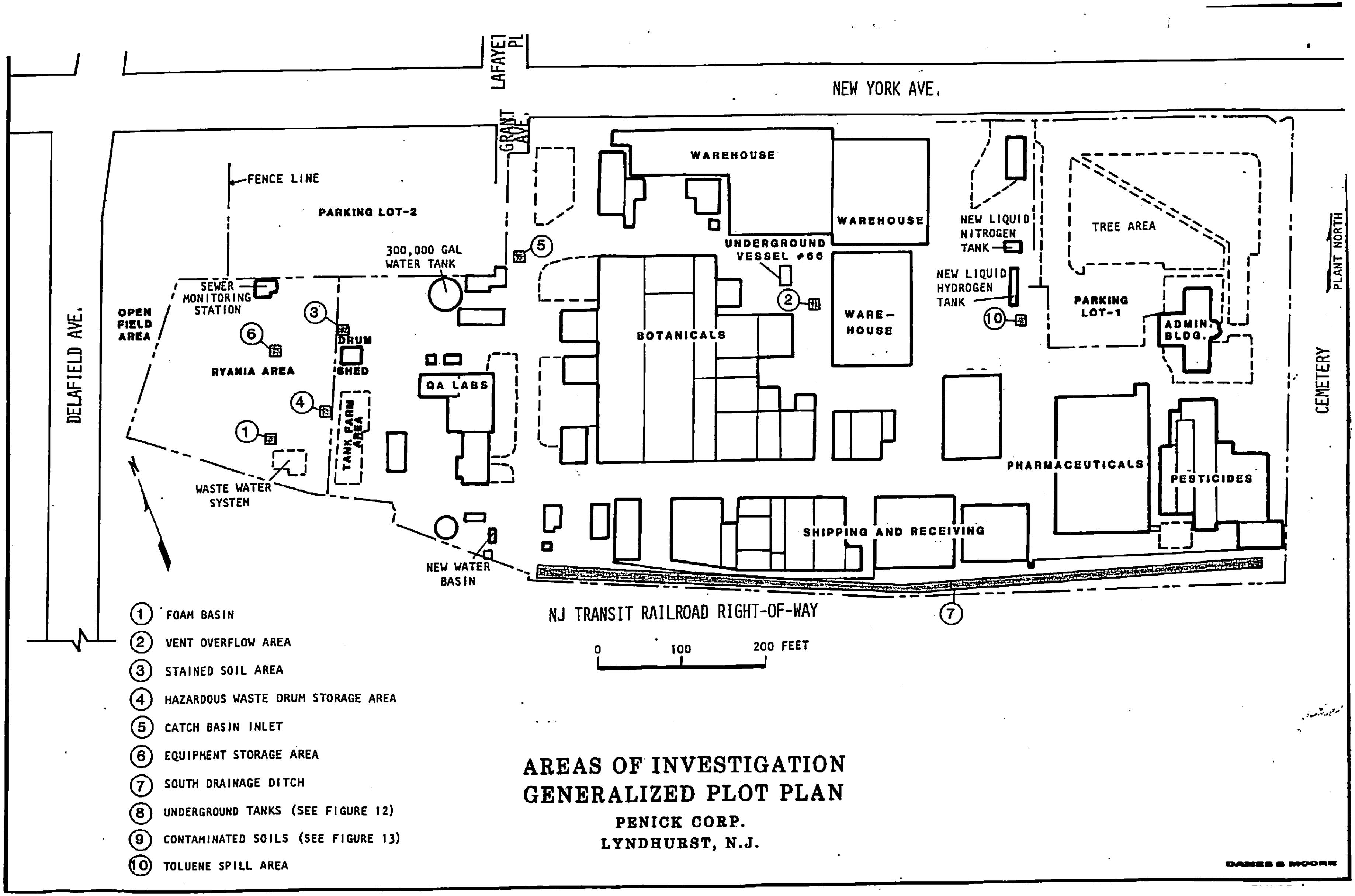


Figure 8: Former Penick Corporation - various areas of investigation.

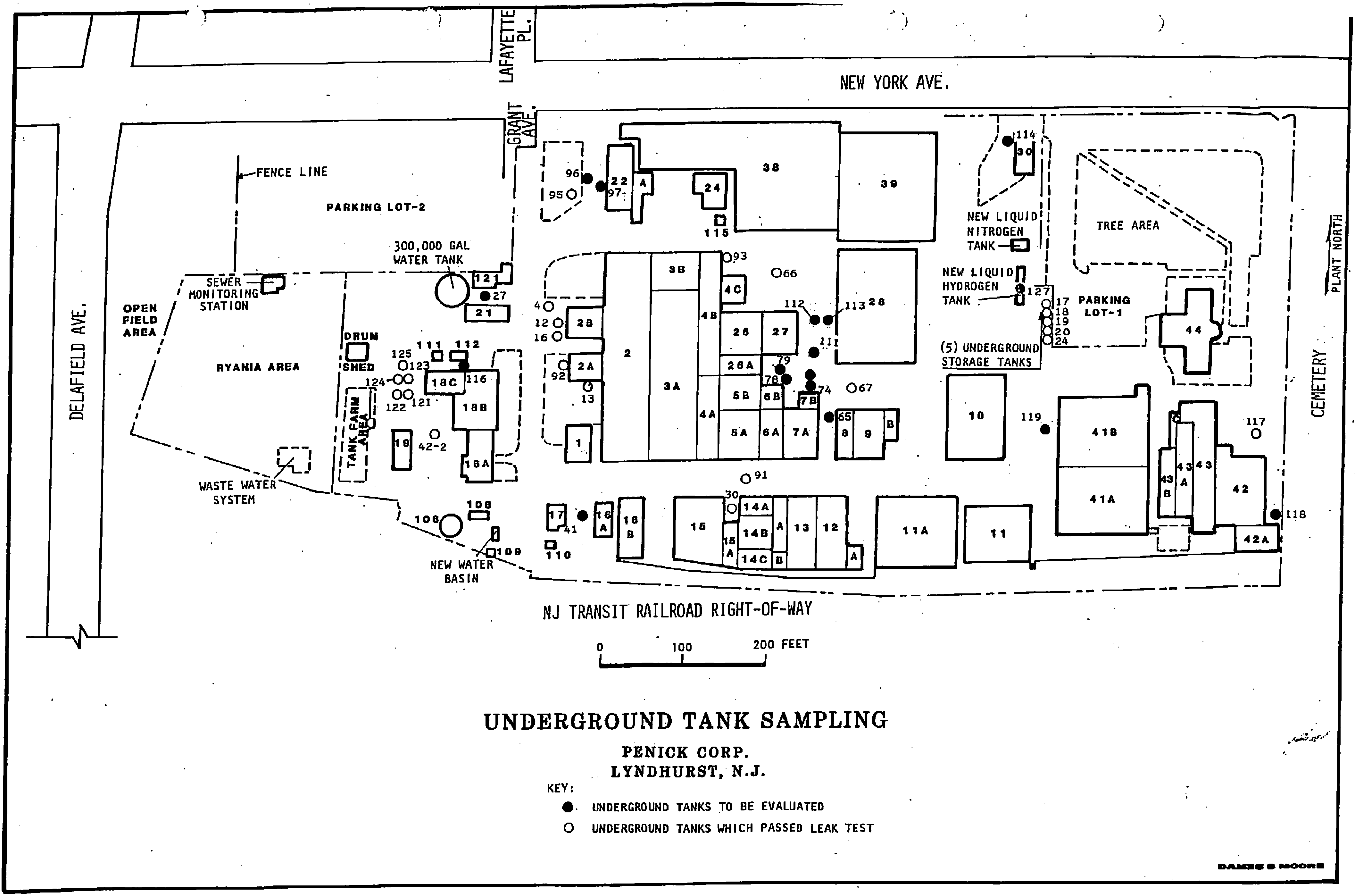


Figure 9: Former Penick Corporation site depicting locations of underground storage tanks.

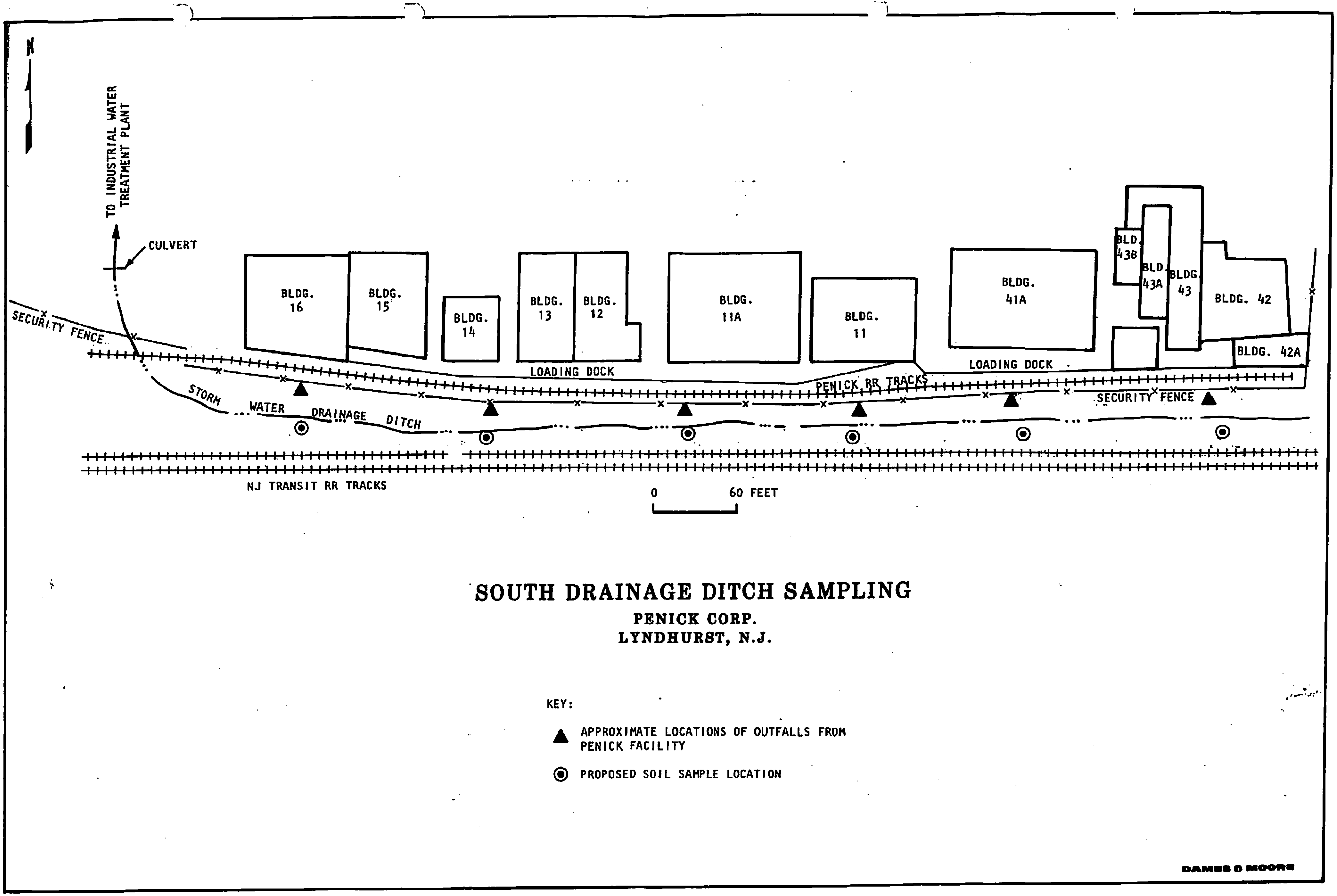
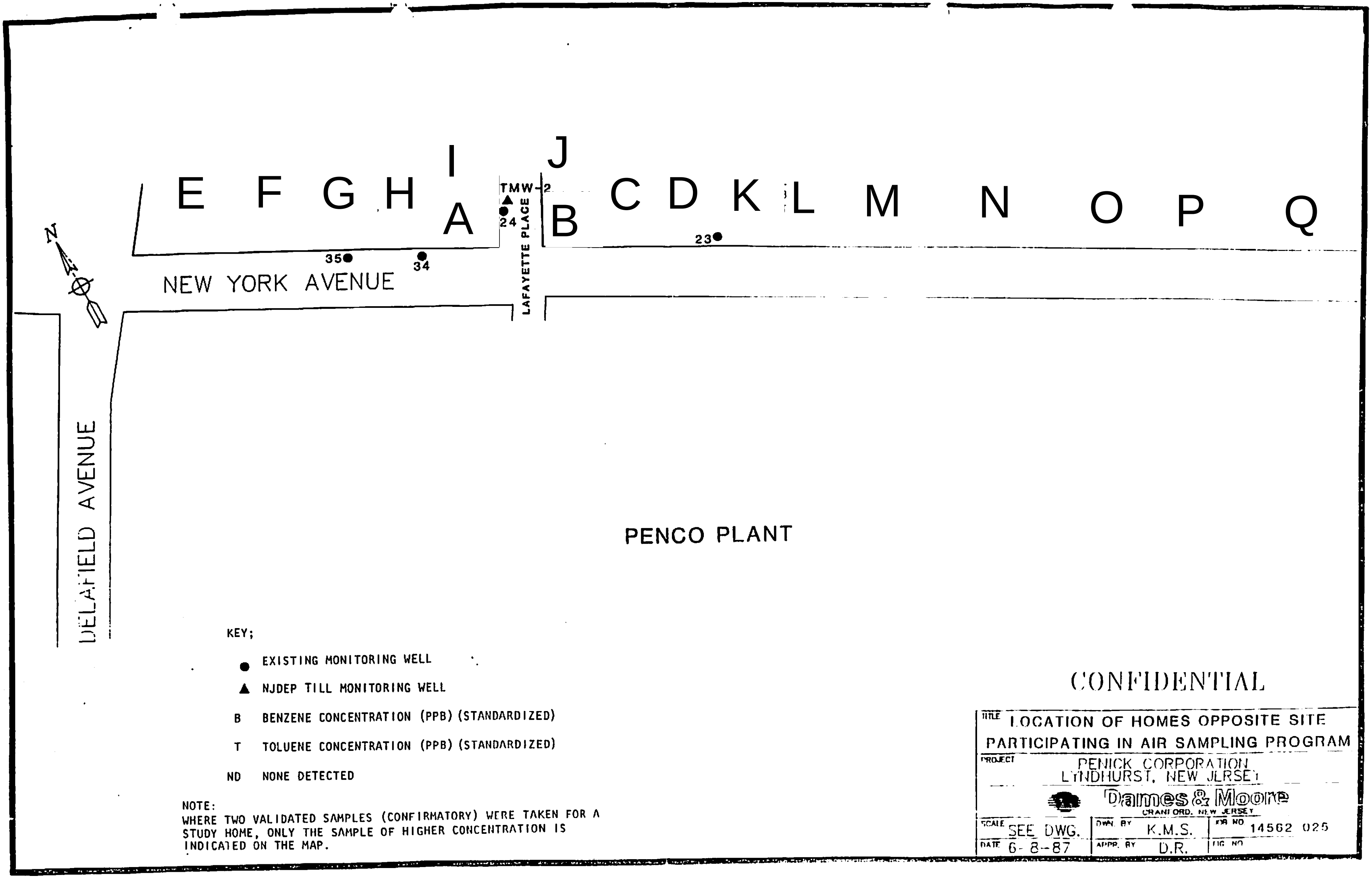


Figure 10: Former Penick Corporation - location of South Drainage Ditch and sample locations.



KEY;

- ● EXISTING MONITORING WELL
- ▲ NJDEP TILL MONITORING WELL
- B BENZENE CONCENTRATION (PPB) (STANDARDIZED)
- T TOLUENE CONCENTRATION (PPB) (STANDARDIZED)
- ND NONE DETECTED

NOTE:
WHERE TWO VALIDATED SAMPLES (CONFIRMATORY) WERE TAKEN FOR A STUDY HOME, ONLY THE SAMPLE OF HIGHER CONCENTRATION IS INDICATED ON THE MAP.

CONFIDENTIAL

TITLE LOCATION OF HOMES OPPOSITE SITE PARTICIPATING IN AIR SAMPLING PROGRAM

PROJECT PENICK CORPORATION
LYNDHURST, NEW JERSEY

Dames & Moore
CRANFORD, NEW JERSEY

SCALE SEE DWG.	DWN. BY K.M.S.	JOB NO 14562 025
DATE 6-8-87	APPR. BY D.R.	FIG NO

Figure 11: Residence locations under indoor air investigations completed in 1989 and 2009.

Figure 12a
Benzene Plume Concentrations in Groundwater (ug/L)
9 Wells within 100-foot Radius of New York Avenue Residential Properties
Annual Data Series

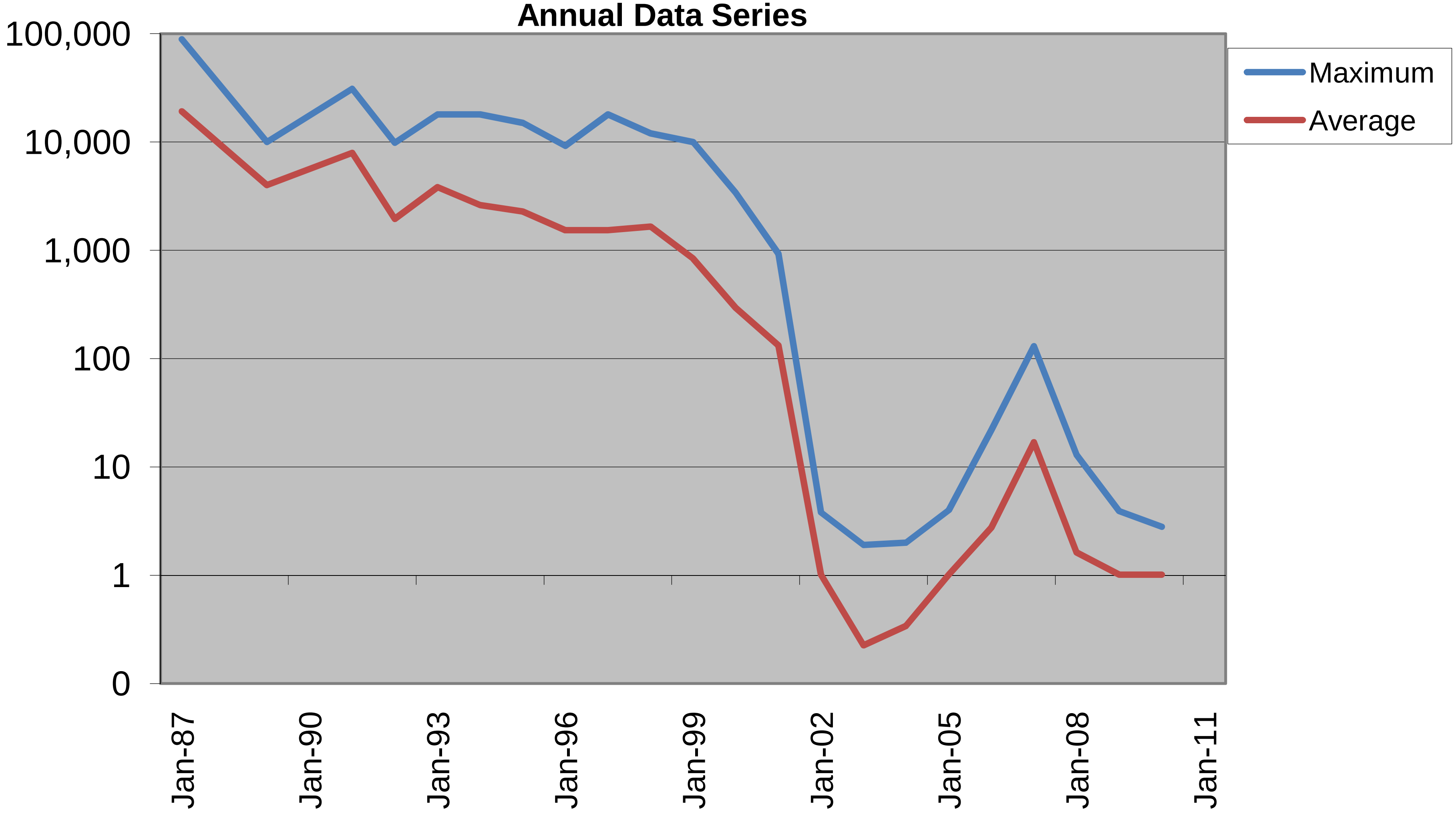


Figure 12b

Toluene Plume Concentrations in Groundwater (ug/L)
9 Wells within 100-foot Radius of New York Avenue Residential Properties
Annual Data Series

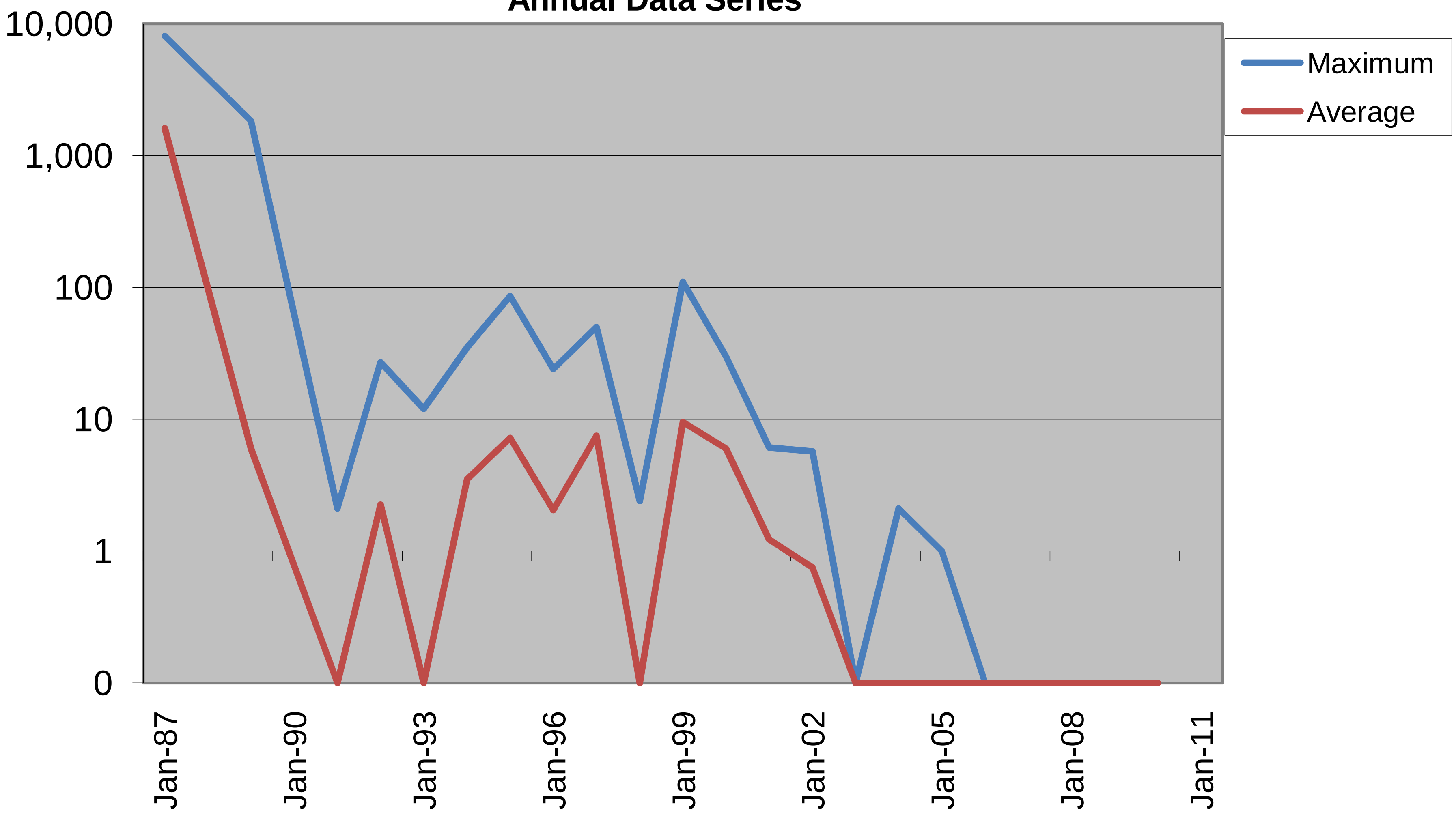


Figure 12c
Benzene Plume Concentrations in Groundwater (ug/L)
7 Wells Closest to New York Avenue Residential Properties
Annual Data Series

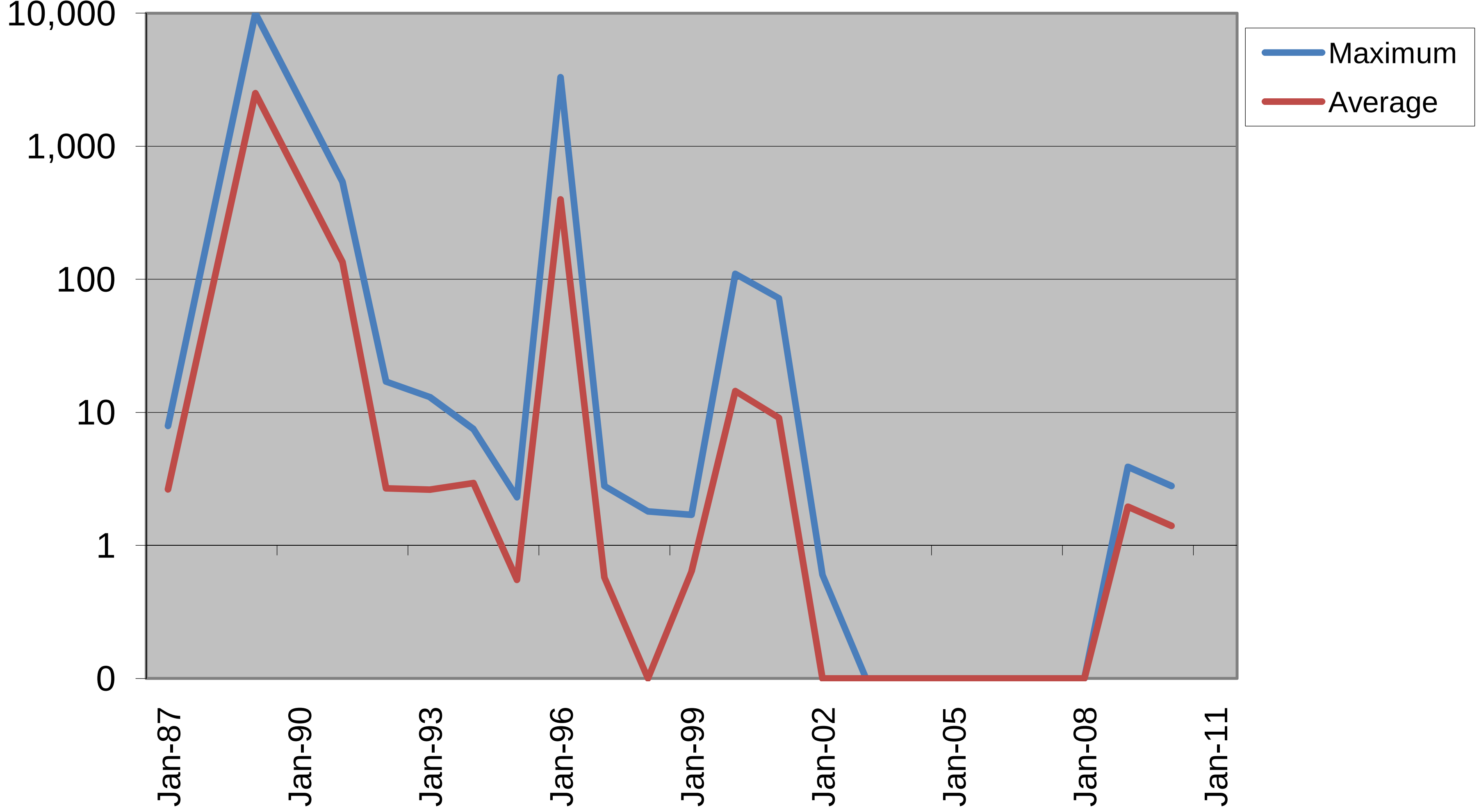
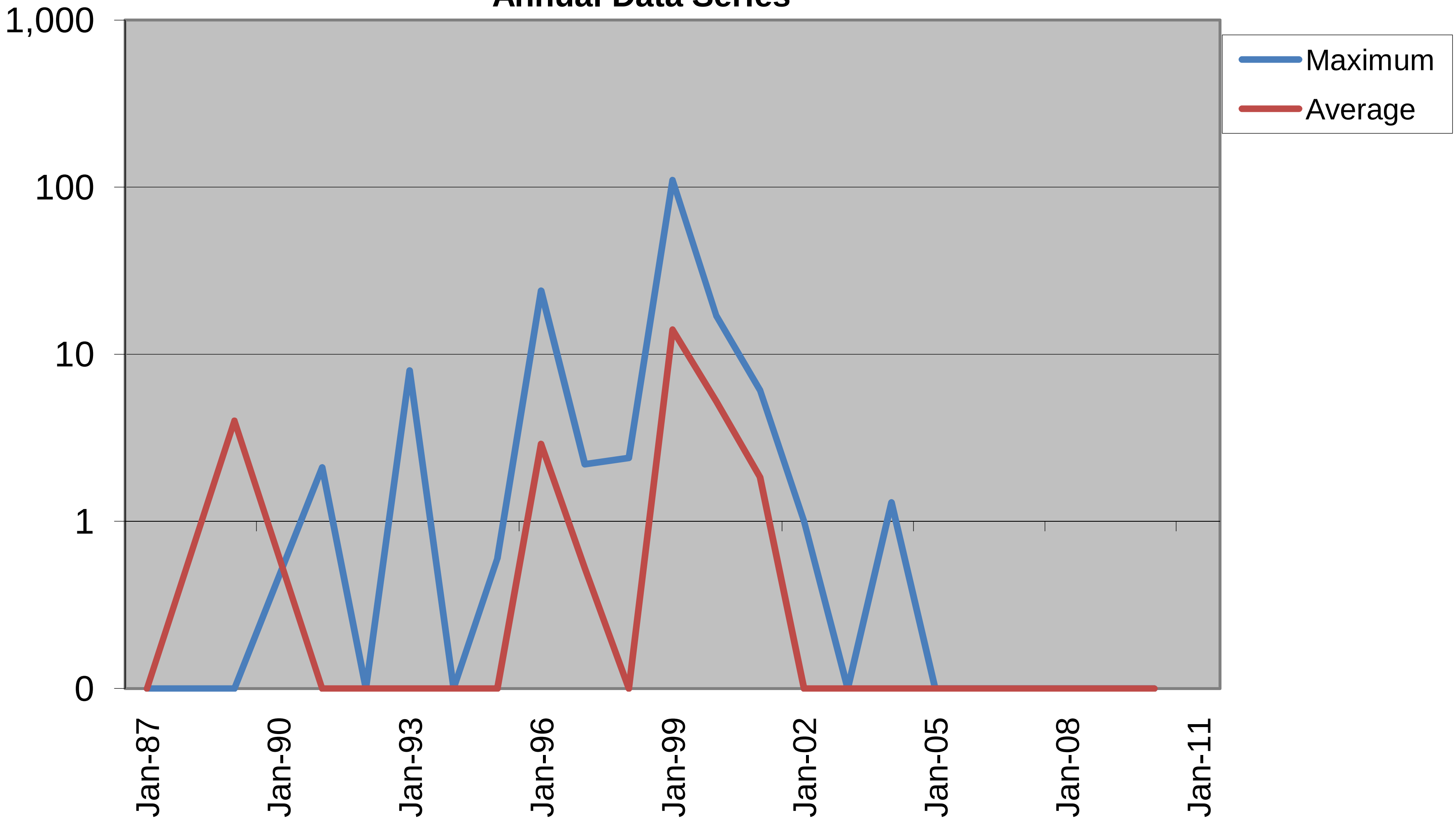


Figure 12d
Toluene Plume Concentrations in Groundwater (ug/L)
7 Wells Closest to New York Avenue Residential Properties
Annual Data Series



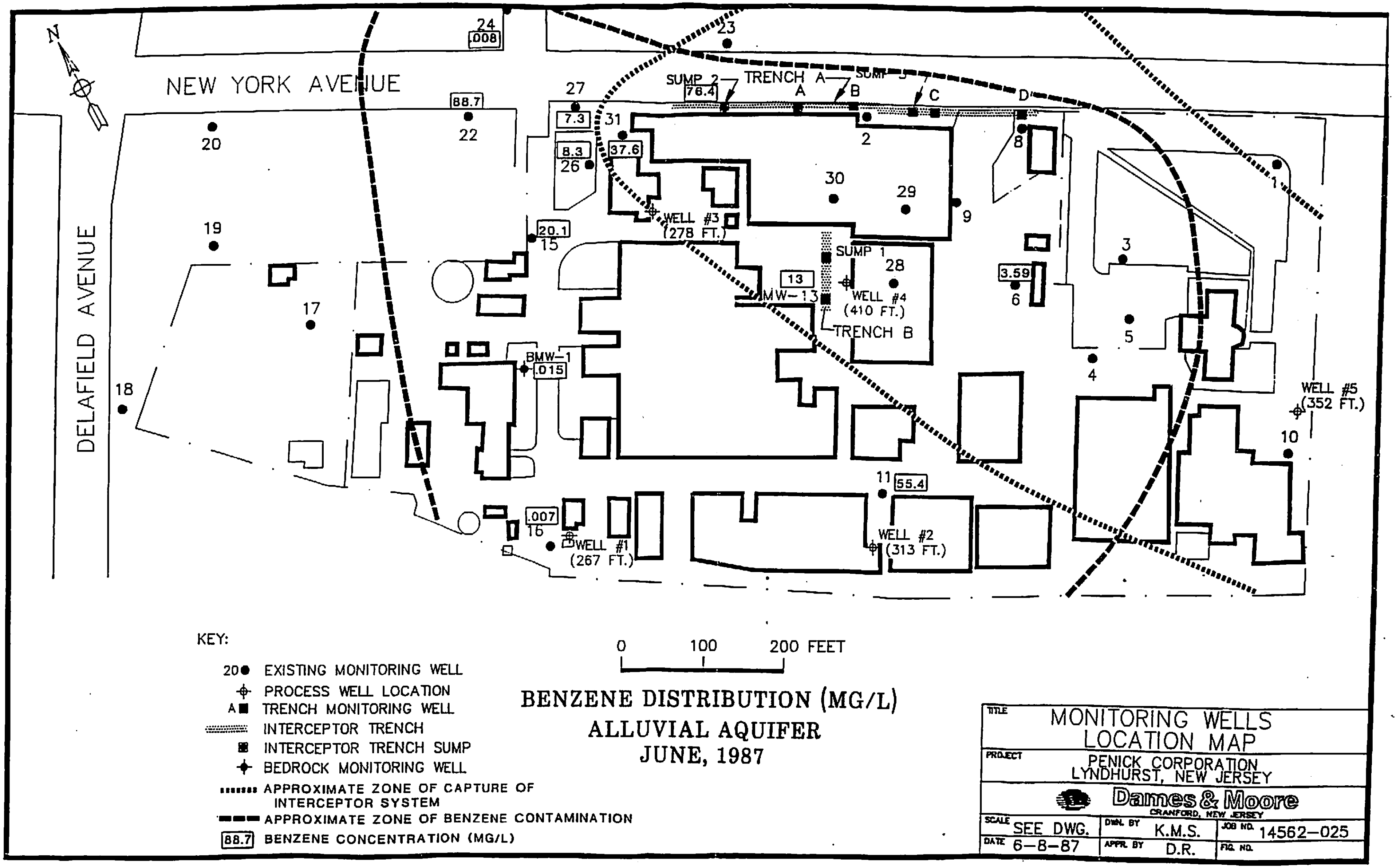


Figure 13: June 1987 isopleth of benzene groundwater plume depicting boundary extending into residential area.

Appendix A

New Jersey Department of Health & Senior Services
Cancer Epidemiology Services
Standardized Incidence Ratio Analyses, Lyndhurst, New Jersey

State of New Jersey
DEPARTMENT OF HEALTH AND SENIOR SERVICES
PO BOX 360
TRENTON, N.J. 08625-0360

JON S. CORZINE
Governor

www.nj.gov/health

HEATHER HOWARD
Commissioner

September 5, 2008

Ms. Joyce Jacobson
Health Administrator
Lyndhurst Township Health Department
253 Stuyvesant Avenue
Lyndhurst, New Jersey 07071-1832

Dear Ms. Jacobson:

This letter is a follow-up to your recent discussion with Pamela Agovino of my staff regarding continued community concerns about the number of cancers among former and current Lyndhurst residents and known contaminated sites in the township. I hope the following information will be helpful to you and everyone in the community. Please feel free to share it with them.

As a result of the continued concern, Cancer Epidemiology Services (CES) has completed a standardized incidence ratio (SIR) analysis for all cancers combined and multiple myeloma. An SIR analysis can tell us if the number of observed cancer cases in a particular geographic area is higher or lower than expected given the population and age distribution for that area. SIRs are the analysis method most often used by the New Jersey State Department of Health and Senior Services and the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services to determine if cancer is elevated. Please refer to the attached fact sheet on the Lyndhurst SIR analysis. The results of the Lyndhurst SIR analysis indicate that the number of all malignant cancers combined and the number of multiple myeloma cancers are not statistically significantly elevated.

As you are aware, CES was provided with a list of cancer cases compiled by the community. Our program searched the NJSCR for each of the multiple myeloma cases on the list and were able to locate all of the individuals in the NJSCR. Some of the cases identified on the list, were either 1) not residents of Lyndhurst at the time of diagnosis or 2) diagnosed outside of the analysis period (1990-2005) or 3) diagnosed with a cancer other than multiple myeloma and therefore, according to standard practice across the country, cannot be included as a case in the SIR analysis for multiple myeloma in Lyndhurst. It should be noted that the Lyndhurst SIR analysis for all cancers combined does include this last group of non multiple myeloma cases in the all cancers combined analysis.

One of the concerns raised was that the multiple myeloma cases in Lyndhurst are being diagnosed at ages younger than would be expected. According the American Cancer Society (ACS), 34% of all multiple myelomas are diagnosed in individuals younger than 65 and 66% are diagnosed among individuals 65 or older, which is consistent with New Jersey data from 1990-2005. A review of the Lyndhurst multiple myeloma cases from the NJSCR for the same time period, revealed that 19% of the cases were diagnosed in residents younger than 65, indicating a lower proportion of younger individuals affected with multiple myeloma in Lyndhurst. This age distribution is not consistent with the community's concern that multiple myeloma is disproportionately affecting younger residents.

Another concern mentioned was the occurrence of a case of Neurilemoma (referred to as an epithelium schwannoma on the list provided to us) in a woman in her early thirties who was a former resident of Lyndhurst. The concern raised was that this cancer is very rare and is not typically diagnosed in this age group. CES reviewed the Neurilemoma data in the NJSCR and found about 130 cases diagnosed in New Jersey from 1990-2005. About 21% of the neurilomomas were diagnosed under the age of 35 and a little over 50% occurred among females. Although this is a rare cancer, the occurrence of a single case in a woman in this age group does not indicate an elevated number.

Because of the continued community concern, we will continue to monitor the NJSCR for multiple myeloma cases and all cancers combined in Lyndhurst when more years of data are complete. Presently, NJSCR data are complete through 2005, and we will review the complete years of Lyndhurst data for 2006 and 2007. We will update you on a yearly basis via letter.

Additional concerns have been raised about the number of known contaminated sites located in Lyndhurst. As you are aware these concerns have been forwarded to Ms. Sharon Kubiak with the New Jersey Department of Health & Senior Services - Consumer and Environmental Health Program.

Please feel free to call Cancer Epidemiology Services Monday through Friday between 9:00 AM and 5:00 PM at (609) 588-3500 with any other information or questions you may have.

Sincerely,

Christina G. Tan, M.D.
Acting Deputy Commissioner/Acting State Epidemiologist
Public Health Services Branch

Enclosure

c: Hansel F. Asmar, MS, MAS
Director/Health Officer, Bergen County Department of Health Services

The Honorable Richard J. DiLascio
Mayor, Township of Lyndhurst

Carl Rathjen
Deputy Chief of Staff, NJDHSS

Betsy A. Kohler
Director, Cancer Epidemiology Services/ NJDHSS

Pamela Agovino
Research Scientist, Cancer Epidemiology Services/ NJDHSS

Celeste Andriot-Wood
Assistant Commissioner, Division of Family Health Services/ NJDHSS

Jerald Fagliano
Program Manager, Consumer and Environmental Health / NJDHSS

Sharon Kubiak
Program Specialist, Consumer and Environmental Health / NJDHSS

James Brownlee
Assistant Commissioner,
Epidemiology, Environmental and Occupational Health / NJDHSS

Analysis of Cancer Incidence in Lyndhurst Borough (1990-2005)

Cancer Epidemiology Services (CES) used the New Jersey State Cancer Registry (NJSCR) to examine the occurrence of all malignant cancers combined and multiple myeloma in Lyndhurst Borough for the time period from 1990-2005, as well as three consecutive time periods (1990-1994, 1995-1999 and 2000-2005) to examine trends. US and NJ data have not yet been published for 2006-present because they are incomplete. Males and females were evaluated separately. It should be noted that information on cancer risk factors, such as genetics, personal behaviors or occupational history, is not part of the required data collected by the NJSCR.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in the study area (Kelsey et al. 1986; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases from the NJSCR by the expected number of cancers for the surveyed population over the time period 1990 to 2005, assuming that the cancer rates of the state would be what was expected.

The expected number was derived by multiplying a comparison population's age-sex-specific cancer incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1990 to 2005 and for the three included time periods mentioned above. The study area's age-sex-specific population was determined from the 1990 and 2000 U.S. Census data (Census 1990, 2000). Each analysis used 18 age-specific population groups.

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases than expected are observed.

The number of cases (observed cases) was obtained from the New Jersey State Cancer Registry (NJSCR). The NJSCR has been awarded the North American Association of Central Cancer Registries (NAACCR) Gold Standard, the highest standard possible, for the quality of data since the inception of this award many years ago. Some of the criteria used to judge the quality of the data include timeliness and completeness of cancer case ascertainment. A "case" is defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in Lyndhurst. This case selection criteria is standard practice used to tally cases for national cancer statistics.

Random fluctuations may account for some SIRs being higher or lower than 1.0. The statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution (Breslow and Day 1987; Checkoway et al. 1989). If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0. The results of the Lyndhurst SIR analysis indicate that all cancers combined or multiple myeloma are not statistically significantly elevated.

References

Breslow NE, Day NE. 1987. Statistical methods in cancer research: Vol II. The design and analysis of cohort studies. IARC Scientific Publication No. 82. Lyon: International Agency for Research on Cancer.

Checkoway H, Pearce NE, Crawford-Brown DJ. 1989. Research methods in occupational epidemiology (Monographs in epidemiology and biostatistics, vol. 13). Oxford: Oxford University Press.

Kelsey JL, Thompson WD, Evans AS. 1986. Methods in observational epidemiology (Monographs in epidemiology and biostatistics, vol. 10). Oxford: Oxford University Press.

US Census Bureau. 1990. Population census report, general population characteristics. Washington, DC: US Department of Commerce.

US Census Bureau. 2000. Population census report, general population characteristics. Washington, DC: US Department of Commerce.

Standardized Incidence Ratio Analysis - Lyndhurst vs. New Jersey:

All Cancers Combined						
		Observed	**Expected**	**SIR**	***Lower**	***Upper**
1990-2005	Male	1026	1031.04	1.00	0.94	1.06
	Female	1007	995.03	1.01	0.95	1.08
1990-1994	Male	316	332.04	0.95	0.85	1.06
	Female	329	305.63	1.08	0.96	1.20
1995-1999	Male	348	325.09	1.07	0.96	1.19
	Female	304	313.17	0.97	0.86	1.09
2000-2005	Male	362	374.49	0.97	0.87	1.07
	Female	374	376.22	0.99	0.90	1.10

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

Multiple Myeloma						
		Observed	**Expected**	**SIR**	***Lower**	***Upper**
1990-2005	Male	13	11.83	1.10	0.58	1.88
	Female	14	12.09	1.16	0.63	1.94
1990-1994	Male	0	3.46	-	-	-
	Female	6	3.67	1.63	0.60	3.55
1995-1999	Male	6	3.69	1.63	0.59	3.54
	Female	3	3.69	0.81	0.16	2.37
2000-2005	Male	7	4.66	1.50	0.60	3.10
	Female	5	4.74	1.05	0.34	2.46

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

State of New Jersey
DEPARTMENT OF HEALTH AND SENIOR SERVICES
PO BOX 360
TRENTON, N.J. 08625-0360
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CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

POONAM ALAIGH, MD, MSHCPM, FACP
Commissioner

August 20, 2010

Ms. Joyce Jacobson
Health Administrator
Lyndhurst Township Health Department
253 Stuyvesant Avenue
Lyndhurst, NJ 07071-1832

Dear Ms. Jacobson:

This letter is a follow-up to our previous correspondence dated September 5, 2008, in which we promised to update the Lyndhurst Standardized Incidence Ratio (SIR) analysis from 1990-2005 with the additional years of data 2006 and 2007 as they become available from the New Jersey State Cancer Registry (NJSCR). This updated SIR analysis includes all invasive cancers and invasive multiple myeloma cancers by gender diagnosed among Lyndhurst residents from 1990-2007. Please feel free to share this information with the community members or other interested parties as you feel appropriate.

An SIR analysis can tell us if the number of observed cancer cases in a particular geographic area during a specified time is higher or lower than expected numbers given the population and age distribution for that area. SIRs are the analysis method most often used by the New Jersey State Department of Health and Senior Services and the Center for Disease Control and Prevention's (CDC) Agency for Toxic Substances and Disease Registry (ATSDR) to determine if cancer rates are elevated. Please refer to the attached fact sheet for the previous Lyndhurst SIR analysis.

Lyndhurst Standardized Incidence Ratio (SIR) Analysis

Invasive Cancers, 1990-2007

		Observed	Expected	SIR	*Lower	*Upper
All Cancers	Male	1133	1160.02	0.98	0.92	1.04
	Female	1111	1124.14	0.99	0.93	1.05
Multiple Myeloma	Male	15	13.33	1.12	0.63	1.86
	Female	14	13.67	1.02	0.56	1.72

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.
None of the SIRs are statistically significantly elevated.

As in the previous analysis, completed in 2008, this analysis indicates that there is not a statistically significant elevation for either "all invasive cancers combined" or "invasive multiple myeloma" within the town of Lyndhurst for the time period from 1990-2007.

The North American Association of Central Cancer Registries, Inc. (NAACCR), has awarded the NJSCR the Gold Standard, the highest standard possible, for the quality of data since the inception of this award several years ago. The criteria used to judge the quality of the data are timeliness, completeness of cancer case ascertainment, completeness of specific information on the cancer cases, percent of death certificate only cases, percent of duplicate cases, in addition to passing the data through a stringent edit program.

Please feel free to call Cancer Epidemiology Services Monday through Friday between 9:00 AM and 5:00 PM at (609) 588-3500 with any other information or questions you may have.

Sincerely,

Christina Tan

Christina G. Tan, M.D., MPH
State Epidemiologist/Assistant Commissioner
Public Health Services

encl.

cc: Hansel F. Asmar, MS, MAS
Director/Health Officer, Bergen County Department of Health Services

The Honorable Richard J. DiLascio
Mayor, Township of Lyndhurst

John Graff, MS, Ph.D.
Director, Cancer Epidemiology Services/ NJDHSS

Pamela Agovino, MPH
Research Scientist, Cancer Epidemiology Services/ NJDHSS

Jerald Fagliano, MPH, PhD
Program Manager, Consumer, Environmental and Occupational Health Services / NJDHSS

0817 Follow-up

Analysis of Cancer Incidence in Lyndhurst Borough (1990-2005)

Cancer Epidemiology Services (CES) used the New Jersey State Cancer Registry (NJSCR) to examine the occurrence of all malignant cancers combined and multiple myeloma in Lyndhurst Borough for the time period from 1990-2005, as well as three consecutive time periods (1990-1994, 1995-1999 and 2000-2005) to examine trends. US and NJ data have not yet been published for 2006-present because they are incomplete. Males and females were evaluated separately. It should be noted that information on cancer risk factors, such as genetics, personal behaviors or occupational history, is not part of the required data collected by the NJSCR.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in the study area (Kelsey et al. 1986; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases from the NJSCR by the expected number of cancers for the surveyed population over the time period 1990 to 2005, assuming that the cancer rates of the state would be what was expected.

The expected number was derived by multiplying a comparison population's age-sex-specific cancer incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1990 to 2005 and for the three included time periods mentioned above. The study area's age-sex-specific population was determined from the 1990 and 2000 U.S. Census data (Census 1990, 2000). Each analysis used 18 age-specific population groups.

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases than expected are observed.

The number of cases (observed cases) was obtained from the New Jersey State Cancer Registry (NJSCR). The NJSCR has been awarded the North American Association of Central Cancer Registries (NAACCR) Gold Standard, the highest standard possible, for the quality of data since the inception of this award many years ago. Some of the criteria used to judge the quality of the data include timeliness and completeness of cancer case ascertainment. A "case" is defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in Lyndhurst. This case selection criteria is standard practice used to tally cases for national cancer statistics.

Random fluctuations may account for some SIRs being higher or lower than 1.0. The statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution (Breslow and Day 1987; Checkoway et al. 1989). If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0. The results of the Lyndhurst SIR analysis indicate that all cancers combined or multiple myeloma are not statistically significantly elevated.

References

Breslow NE, Day NE. 1987. Statistical methods in cancer research: Vol II. The design and analysis of cohort studies. IARC Scientific Publication No. 82. Lyon: International Agency for Research on Cancer.

Checkoway H, Pearce NE, Crawford-Brown DJ. 1989. Research methods in occupational epidemiology (Monographs in epidemiology and biostatistics, vol. 13). Oxford: Oxford University Press.

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Standardized Incidence Ratio Analysis - Lyndhurst vs. New Jersey:

All Cancers Combined

		Observed	Expected	SIR	*Lower	*Upper
1990-2005	Male	1026	1031.04	1.00	0.94	1.06
	Female	1007	995.03	1.01	0.95	1.08
1990-1994	Male	316	332.04	0.95	0.85	1.06
	Female	329	305.63	1.08	0.96	1.20
1995-1999	Male	348	325.09	1.07	0.96	1.19
	Female	304	313.17	0.97	0.86	1.09
2000-2005	Male	362	374.49	0.97	0.87	1.07
	Female	374	376.22	0.99	0.90	1.10

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

Multiple Myeloma

		Observed	Expected	SIR	*Lower	*Upper
1990-2005	Male	13	11.83	1.10	0.58	1.88
	Female	14	12.09	1.16	0.63	1.94
1990-1994	Male	0	3.46	-	-	-
	Female	6	3.67	1.63	0.60	3.55
1995-1999	Male	6	3.69	1.63	0.59	3.54
	Female	3	3.69	0.81	0.16	2.37
2000-2005	Male	7	4.66	1.50	0.60	3.10
	Female	5	4.74	1.05	0.34	2.46

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

State of New Jersey
DEPARTMENT OF HEALTH AND SENIOR SERVICES
DIVISION OF EPIDEMIOLOGY, ENVIRONMENTAL AND OCCUPATIONAL HEALTH
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CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

MARY E. O'DOWD, M.P.H.
Commissioner

October 27, 2011

Ms. Joyce Jacobson
Health Administrator
Lyndhurst Township Health Department
253 Stuyvesant Avenue
Lyndhurst, NJ 07071-1832

Dear Ms. Jacobson:

This letter is a follow-up to our correspondence dated September 4, 2008 (attached), in which we presented a Standardized Incidence Ratio (SIR) cancer analysis for Lyndhurst 1990-2005. At the time of that analysis, 2005 was the New Jersey State Cancer Registry's (NJSCR) most recent year of complete data.

Since our last correspondence, the duties of cancer surveillance have moved to the Department's Environmental and Occupational Health Surveillance Program. Staff here have taken the opportunity to update the SIR analysis to include cancer data from 1990-2008. Additionally, this analysis has been updated to take into account population data from the 2010 U.S. Census.

The updated SIR analysis was completed for 1990-2008 as well as for early and late time periods (1990-1999 and 2000-2008). The analysis was performed for males and females separately, for all malignant cancers combined and multiple myeloma.

The results of the analysis show that none of the SIRs performed for Lyndhurst Borough are statistically significantly elevated. We have attached an updated Fact Sheet entitled '***Analysis of Cancer Incidence in Lyndhurst Borough (1990-2008)***', which includes the SIR results and supporting documentation. This updated SIR analysis will be incorporated into the ***Public Health Assessment for the Former Penick Corporation/Penco of Lyndhurst Facility*** expected to be released in the near future.

Please feel free to distribute this letter, the enclosed ***Analysis of Cancer Incidence in Lyndhurst Borough (1990-2008)*** and the ***Explanation of Standardized Incidence Ratios*** Fact Sheets to the community if you believe it will be helpful.

Please feel free to call me Monday through Friday between 9:00 am and 5:00 pm at (609) 826-4984 if you have additional questions about this analysis.

Pamela K. Agovino, MPH
Pamela K. Agovino
Research Scientist
Cancer Surveillance Unit

encl.

cc: Irene Jessie-Hunte, Acting Health Officer
Bergen County Department of Health Services

Glenn Pulliam, Occupational Health Consultant
Environmental and Occupational Health Surveillance/ NJDHSS

Jerald Fagliano, Program Manager
Environmental and Occupational Health Surveillance / NJDHSS

Analysis of Cancer Incidence in Lyndhurst Borough (1990-2008)

The Cancer Surveillance Unit of the Environmental & Occupational Health Surveillance Program of the New Jersey Department of Health and Senior Services used the New Jersey State Cancer Registry (NJSCR) to examine the occurrence of all malignant cancers combined and multiple myeloma in Lyndhurst Borough for the time period from 1990-2008, as well as for two consecutive time periods (1990-1999 and 2000-2008) to examine trends. At the time of this analysis, 2008 data were the most complete year of cancer data for both N.J. and the U.S. Males and females were evaluated separately.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in the study area (Kelsey et al. 1986; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases from the NJSCR by the expected number of cancers for the surveyed population over the time period 1990 to 2008.

The expected number was derived by multiplying a comparison population's age-sex-specific cancer incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1990 to 2008 and for the two included time periods mentioned above. The study area's age-sex-specific population was determined from the 1990, 2000 and 2010 U.S. Census data (Census 1990, 2000, 2010). Each analysis used 18 age-specific population groups.

The number of cases (observed cases) was obtained from the New Jersey State Cancer Registry (NJSCR). The NJSCR has been awarded the North American Association of Central Cancer Registries (NAACCR) Gold Standard, the highest standard possible, for the quality of data since the inception of this award many years ago. Some of the criteria used to judge the quality of the data include timeliness and completeness of cancer case ascertainment. A "case" is defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in Lyndhurst. This case selection criteria is standard practice used to tally cases for national cancer statistics. It should be noted that information on cancer risk factors, such as genetics, personal behaviors or occupational history, is not part of the required data collected by the NJSCR.

The results of the analysis show that none of the SIRs performed for Lyndhurst Borough are statistically significantly elevated.

Background

Cancer is more common than many people realize.

According to the American Cancer Society, about 1 out of 2 men and 1 out of 3 women in the United States will develop cancer over their lifetime. As a result, over the years, cancer will affect most households. Because public health and medicine have conquered many infectious diseases, cancer has become the second leading cause of death in the U.S., following heart disease. Given these statistics, it is not surprising to know several people in one's neighborhood or workplace who have cancer.

Cancer is not just one disease.

Cancers are a group of more than 100 diseases that all start with uncontrolled growth and spread of abnormal cells. Different types of cancers have different rates of occurrence and different causes. We cannot assume that all the different types of cancers in a community or workplace share a common cause.

The risk of having cancer is related to age.

While cancers occur in people of all ages, incidence rates (the number of newly diagnosed cases of cancer in a specific population during a specific time period) for most types of cancers rise sharply among people who are over 45 years of age. When a community, neighborhood, or workplace consists primarily of people over the age of 45, and particularly over the age of 60, we see many more cancers there than in a community, neighborhood or workplace with more young people.

Multiple Myeloma

Scientists still do not know exactly what causes most cases of multiple myeloma.
Known risk factors for multiple myeloma include older age, being black (multiple myeloma is almost twice as common among black Americans as white Americans), family history of multiple myeloma and being male. Possible risk factors include exposure to radiation, occupational exposures in certain petroleum-related industries, obesity and certain plasma cell diseases. For more detailed information on multiple myeloma, please visit the American Cancer Society's document on multiple myeloma at
http://www.cancer.org/acs/groups/cid/documents/webcontent/003121-pdf.pdf

References

Breslow NE, Day NE. 1987. Statistical methods in cancer research: Vol II. The design and analysis of cohort studies. IARC Scientific Publication No. 82. Lyon: International Agency for Research on Cancer.

Checkoway H, Pearce NE, Crawford-Brown DJ. 1989. Research methods in occupational epidemiology (Monographs in epidemiology and biostatistics, vol. 13). Oxford: Oxford University Press.

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US Census Bureau. 2010. Population census report, general population characteristics. Washington, DC: US Department of Commerce.

Standardized Incidence Ratio Analysis - Lyndhurst vs. New Jersey:

All Cancers Combined						
		Observed	Expected	SIR	*Lower	*Upper
1990-2008	Male	1214	1215.8	1.00	0.94	1.06
	Female	1190	1161.0	1.02	0.97	1.08
1990-1999	Male	670	645.9	1.04	0.96	1.12
	Female	638	604.2	1.06	0.98	1.14
2000-2008	Male	544	570.8	0.95	0.87	1.04
	Female	552	557.2	0.99	0.91	1.08

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

Multiple Myeloma						
		Observed	Expected	SIR	*Lower	*Upper
1990-2008	Male	15	14.4	1.04	0.58	1.72
	Female	15	14.0	1.07	0.60	1.76
1990-1999	Male	6	7.0	0.86	0.31	1.87
	Female	9	7.1	1.27	0.58	2.40
2000-2008	Male	9	7.4	1.21	0.55	2.30
	Female	6	6.9	0.87	0.32	1.89

* 95% Confidence Interval: lower and upper limits.
Note: Intercensal population years are interpolated.

New Jersey Department of Health & Senior Services
Cancer Epidemiology Services
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(609) 588-3500
www.state.nj.us/health

Fact Sheet: Explanation of Standardized Incidence Ratios

The Standardized Incidence Ratio (SIR)

A Standardized Incidence Ratio (SIR) is used to determine if the occurrence of cancer in a relatively small population is high or low. An SIR analysis can tell us if the number of observed cancer cases in a particular geographic area is higher or lower than expected, given the population and age distribution for that community.

The SIR is obtained by dividing the observed number of cases of cancer by the "expected" number of cases. The expected number is the number of cases that would occur in a community if the disease rate in a larger reference population (usually the state or country) occurred in that community. Since cancer rates increase strongly with age, the SIR takes into account whether a community's population is older or younger than the reference population.

How an SIR Is Calculated

The expected number is calculated by multiplying each age-specific cancer incidence rate of the reference population by each age-specific population of the community in question and then adding up the results. If the observed number of cancer cases equals the expected number, the SIR is 1. If more cases are observed than expected, the SIR is greater than 1. If fewer cases are observed than expected, the SIR is less than 1.

Examples:

60 observed cases / 30 expected cases: the SIR is 60/30 = 2.0
Since 2.0 is 100% greater than 1.0, the SIR indicates an excess of 100%.

45 observed cases / 30 expected cases: the SIR is 45/30 = 1.5
Since 1.5 is 50% greater than 1.0, the SIR indicates an excess of 50%.

30 observed cases / 30 expected cases: the SIR is 30/30 = 1.0
A SIR of 1 would indicate no increase or decrease.

15 observed cases / 30 expected cases: the SIR is 15/30 = 0.5
Since 0.5 is 50% less than 1.0, a SIR=0.5 would indicate a decrease of 50%.

Testing if the Difference Between Observed and Expected is Due to Chance

Differences between the observed and expected number of cases may be due to random fluctuations in disease occurrence. The farther the observed number is from the expected number, the less likely it is that chance variation can explain the difference.

A confidence interval (CI) is calculated around an SIR to determine how likely it is that the number of observed number of cases is high or low by chance. If the confidence interval includes 1.0, then the difference between the observed and expected number of cases is likely to have occurred by chance (i.e. to be due to random fluctuations in the data). If the confidence interval does not include 1.0, then the difference between the observed and expected number of cases is not very likely to have occurred by chance.

Examples:

SIR=1.15; 95% CI=0.95, 1.35
One can be 95% confident that the true SIR falls between 0.94 and 1.19. Since the 95% CI contains 1, this estimate of the SIR is not statistically significantly elevated.

SIR=1.11; 95% CI=1.03, 1.19
One can be 95% confident that the true SIR falls between 1.04 and 1.19. Since the 95% CI does not contain 1, this estimate is statistically significantly elevated. One can be 95% confident that the true SIR is at least 1.04, which represents at least a 4% increase.

Statistics, such as SIRs, generated with higher numbers are more likely to show a statistically significant increase or decrease if a true difference does in fact exist. In contrast, small numbers make it particularly difficult for statistical analyses to yield useful or valid information.

Example:

A 20% increase in an SIR derived from Observed =12 and Expected =10 is not statistically significant (SIR=1.2, 95% CI=0.62-2.10)

A 20% increase in an SIR derived from Observed =12,000 and Expected =10,000 is statistically significant (SIR=1.2, 95% CI=1.8-2.2)

The 95% CI as a test for statistical significance may still lead to results that that are due to chance alone. By definition, if a SIR is statistically significantly elevated with 95% confidence, there is still a five percent chance that the increase is due to chance alone. If multiple analyses are done, we further increase the likelihood that some statistically significant results are due to random variation. For example, if a SIR analysis was performed for 20 cancer sites among 5 geographic areas, (20 X 5=100 analyses), we could expect that 5 out of the 100 specific results might be statistically significantly high or low due to chance alone.

Appendix B

Indoor Air Quality Information Sources

The following sources of information are provided as a reference to homeowners and business owners regarding actions and preventative measures on how to help improve the quality of indoor air within their homes or workplace.

“Healthy Indoor Air for America’s Homes – Indoor Air Hazards Every Homeowner Should Know About.” USEPA. EPA 402-K-98-002. June 2002 available at: http://www.montana.edu/wwwcxair/

“The Inside Story – A Guide to Indoor Air Quality.” USEPA. EPA 402-K-93-007. April 1995 available at:
http://www.epa.gov/iaq/pubs/index.html

“Health Buildings, Health People: A Vision for the 21st Century.” USEPA. EPA 402-K-01-003. October 2001 available at:
http://www.epa.gov/iaq/pubs/index.html

“Indoor Air Pollution: An Introduction for Health Professionals.” USEPA. EPA 402-R-94-007. 1994 available at:
http://www.epa.gov/iaq/pubs/index.html

“What You Should Know About Using Paint Strippers.” Consumer Product Safety Commission. CPSC Publication # F-747-F-95-002. February, 1995 available at:
www.cpsc.gov/cpscpub/pubs/423.html

“Healthy Indoor Painting Practices.” USEPA. EPA 744-F-00-001. May 2000 available at:
www.cpsc.gov/cpscpub/pubs/456.pdf

Many of these sources are available in print through the website contact or through:

New Jersey Department of Health and Senior Services
Indoor Environments Program
PO Box 369
Trenton, NJ 08625-0369
609-631-6749
Access on line at:http://www.state.nj.us/health/eoh/tsrp/index.html

Appendix B: Uses and Typical U.S. Background Concentrations of Typical Contaminants Detected in Residential Vapor Intrusion Investigations

Chemical	Usage[a]	Sources of Common Exposure[b]	Background Concentrations (μg/m^3)[c]
Acetone	Solvent; paint strippers; rubber cement; cleaning fluids; nail polish remover.	See Usage.	2 - 80[d]; 16[g]; 19 (indoor)[g]
Benzene	Solvents, gasoline, resins and plastics; nylon; paints; adhesives (especially carpet); printing; pesticides; detergents/disinfectants; dyes; photographic processing	Gasoline emissions; cigarette smoke; paints and adhesives; particle board and wood composites; wood smoke	1 – 18 (mean average range) Various New Jersey cities[b]
1,3-Butadiene	Intermediate (potential impurity) in many plastics and polymers; fungicides; latex paint; acrylics; fuel formulations	Vehicle emissions; tobacco smoke; wood fires; waste incinerators; electric wire coatings; thermal degradation of plastics	0.38 (indoor) 14 (cigarette smoke)[d]
Chloroform	Refrigerant manufacturing; raw material for polytetrafluoroethylene plastics; insecticidal fumigant; solvent; cleansing agent in fire extinguishers; by-product in chlorination of potable water; former use in cough syrup, toothpastes, and toothache compounds..	Bathroom showers using chlorinated water; see Usage.	10-500 (10 min shower)[d]; 0.5 - 4 [d]; 0.1 - 2 [g]
1,4 - Dichlorobenzene	Deodorant; pesticide; resins and plastics; solvent; dyes; degreaser; wood preservative; motor oils; paint	Mothballs; toilet deodorants; air fresheners; tobacco smoke; pesticide application	3.45 (indoor non-smoker)[d]; 10.22(indoor smoker)[d]; 1 - 4 (average outdoor)[d] 0.08-240 (indoor - study)[g]
1,2 - Dichloroethane	Manufacture of vinyl chloride; formerly used in varnish, paints, finish removers, adhesives, soaps, degreasing agent	Fugitive emissions from industries, treatment plants, hazardous waste sites; landfills; occupational settings; ambient air	0.3 (indoor non-smoker avg)[f]; 0.03 (indoor non-smoker avg)[f]; 0.04-0.4 (outdoor - study)[f]
Ethylbenzene	Production of synthetic rubber; general and resin solvent; gasoline additive.	Self-serve gasoline fill-ups; vehicle emissions; painting; new or remodel construction.	1 - 12 (outdoor - average) [d]
n-Hexane	Gasoline; rubber cement; typing correction fluid; perfume aerosols; cleaning agent; paint diluent; alcohol denaturant; solvent in extraction of soybean oil, cottonseed oil and other seed oils. Constituent in natural gas.	Combustion of motor fuels, heating oil fuels or other petroleum products; natural gas; glues, stains, paints, varnishes, adhesives, and cleaning agents.	14 (average outdoor) [d]; 7 [g]
Methylene Chloride	Industrial solvent; hairspray; paint strippers; spray paint; rug cleaners; insecticides; furniture polish.	See Usage	Less than 10[d] ; 0.17 (average)[g]
Methyl t-Butyl Ether (MTBE)	Used as an octane booster in gasoline (gasoline refinement)	Automobile gasoline refueling; inside automobiles when driving; refueling lawn mowers; chain-saws; or other gasoline-powered equipment	3.6 (median) [d] ; Less than 1 (estimated average)[f]

Appendix A: (Cont'd.)

Chemical	Usage[a]	Sources of Common Exposure[b]	Background Concentrations (µg/m^3)[c]
Tetrachloroethylene (PCE)	Solvent; degreaser; dry cleaning and textile production; water repellants; pharmaceuticals; pesticides; refrigerants; insulating fluids; correction fluid (e.g., white out) and inks; adhesives	Dry cleaned garments; paint removers; fabric cleaning products (e.g., stain removers, etc.); lubricants; wood products	1-4 (average)[d]; 7 (average)[g]
Trichloroethylene (TCE)	Solvent; degreaser; dry cleaning and textile production; adhesives, paint removers; correction fluid (e.g., white out) and spot removers	Present main use as a metal degreaser; dry cleaned garments; paint removers; fabric cleaning products (e.g., stain removers, etc.)	0.2-4 (ambient average)[f]
1,2,4-Trimethylbenzene	Dyes, fragrances, and plastics; solvent and paint thinner; sterilizing agent; degreaser; gasoline additive; synthetic wood products.	Self-serve gasoline fill-ups; indoor painting or printing	10-12 (indoor)[d] 2.8 - 5.9 (outdoor)[f]
1,3,5-Trimethylbenzene	Building materials; Dyes; UV inhibitor in plastics; solvent and paint thinner; gasoline additive.	Self-serve gasoline fill-ups; indoor painting or printing; new or remodel construction.	3-8 (indoor)[d] 3-15 (outdoor) [d]
Toluene	Manufacture of benzoic acid, explosives, dyes, artificial leather, perfumes; solvent for paints, lacquers, gums, and resins; printing inks; gasoline additive; spot removers; cosmetics; antifreeze; adhesive solvent in plastic toys and model airplanes.	Self-serve gasoline fill-ups; vehicle emissions; cigarette smoke; consumer products; nail polish; indoor painting; new or remodel construction (carpets).	3 - 140 (outdoor) [d] 42 (outdoor - average) [d] 20 – 60 µg/cigarette [d]
Xylenes (Total)	Manufacture of benzoic acid; dyes, hydrogen peroxide, perfumes, insect repellants, epoxy resins, pharmaceuticals, paints, varnishes, general solvent for adhesives and paints; gasoline additive; used in leather industry.	Self-serve gasoline fill-ups; vehicle emissions; indoor painting; new or remodel construction.	17 (outdoor - average) [d]

[a] National Library of Medicine's (NLM) Hazardous Substances Data Bank (HSDB)

[b] ATSDR Toxicological Profile

[c] The background concentrations presented are not specific to Lyndhurst, New Jersey in particular, but are presented to provide the homeowner some perspective as to levels typically found in U.S. homes.

[d] HSDB, 2002, at www.toxnet.nlm.nih.gov

[e] Chemical profiles at www.scorecard.org

[f] EPA, 1988

[g] Tox Profile at www.atsdr.cdc.gov

[h] EPA, 1999

Appendix C

Toxicological Summaries of Contaminants of Concern

The toxicological summaries provided in this appendix are based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html). Health effects are summarized in this section for the chemicals of concern found off-site in area private wells and in indoor air of evaluated residences and occupied buildings. The health effects described in the section are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Alluminum. Antimony Aluminum is the most abundant metal in the earth's crust. It is always found combined with other elements such as oxygen, silicon, and fluorine. Aluminum as the metal is obtained from aluminum-containing minerals. Small amounts of aluminum can be found dissolved in water. Aluminum metal is light in weight and silvery-white in appearance. Aluminum is used for beverage cans, pots and pans, airplanes, siding and roofing, and foil. Aluminum is often mixed with small amounts of other metals to form aluminum alloys, which are stronger and harder. Aluminum compounds are also found in consumer products such as antacids, astringents, buffered aspirin, food additives, cosmetics, and antiperspirants.

Only very small amounts of aluminum that you may inhale, ingest, or have skin contact with will enter the bloodstream. Exposure to aluminum is usually not harmful, but exposure to high levels can affect your health. Workers who breathe large amounts of aluminum dusts can have lung problems, such as coughing or abnormal chest X-rays. Some workers who breathe aluminum dusts or aluminum fumes have decreased performance in some tests that measure functions of the nervous system.

Some people with kidney disease store a lot of aluminum in their bodies and sometimes develop bone or brain diseases which may be caused by the excess aluminum. Some studies show that people exposed to high levels of aluminum may develop Alzheimer's disease, but other studies have not found this to be true. We do not know for certain whether aluminum causes Alzheimer's disease.

Studies in animals show that the nervous system is a sensitive target of aluminum toxicity. Obvious signs of damage were not seen in animals after high oral doses of aluminum. However, the animals did not perform as well in tests that measured the strength of their grip or how much they moved around. We do not know if aluminum will affect reproduction in people. Aluminum does not appear to affect fertility in animals.

The Department of Health and Human Services (DHHS) and the EPA have not evaluated the carcinogenic potential of aluminum in humans. Aluminum has not been shown to cause cancer in animals.

Children with kidney problems who were given aluminum in their medical treatments developed bone diseases. It does not appear that children are more sensitive to aluminum than adults. We do not know if aluminum will cause birth defects in people. Birth defects have not been seen in animals. Aluminum in large amounts has been shown to be harmful to unborn and developing animals because it can cause delays in skeletal and neurological development. Aluminum is found in breast milk, but only a small amount of this aluminum will enter the infant's body through breastfeeding.

Antimony. Antimony is a silvery-white metal that is found in the earth's crust. Antimony ores are mined and then mixed with other metals to form antimony alloys or combined with oxygen to form antimony oxide. As alloys, it is used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, and pewter. Antimony oxide is added to textiles and plastics as fire retardant. It is also used in paints, ceramics, and fireworks, and as enamels for plastics, metal, and glass.

Antimony is released to the environment from natural sources and from industry. In the air, antimony is attached to very small particles that may stay in the air for many days. Most antimony particles settle in soil, where it attaches strongly to particles that contain iron, manganese, or aluminum.

Breathing high levels for a long time can irritate eyes and lungs and can cause heart and lung problems, stomach pain, diarrhea, vomiting, and stomach ulcers. In short-term studies, animals that breathed very high levels of antimony died. Animals that breathed high levels had lung, heart, liver, and kidney damage. In long-term studies, animals that breathed very low levels of antimony had eye irritation, hair loss, lung damage, and heart problems. Problems with fertility were also noted. In animal studies, fertility problems were observed when rats breathed very high levels of antimony for a few months.

Ingesting large doses of antimony can cause vomiting. Other effects of ingesting antimony are unknown. Long-term animal studies have reported liver damage and blood changes when animals ingested antimony. Antimony can irritate the skin if it is left on it.

Lung cancer has been observed in some studies of rats that breathed high levels of antimony. No human studies are available. The DHHS, the International Agency for Research on Cancer, and the EPA have not classified antimony as to its human carcinogenicity.

Arsenic. Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs. Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling.

Organic arsenic compounds are used as pesticides, primarily on cotton plants. Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as those caused by inorganic arsenic.

Several studies have shown that inorganic arsenic can increase the risk of lung cancer, skin cancer, bladder cancer, liver cancer, kidney cancer, and prostate cancer. The World Health Organization (WHO), the DHHS, and the EPA have determined that inorganic arsenic is a human carcinogen

Benzene. Benzene is a widely used chemical formed from both natural processes and human activities. Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities. Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke. Industrial processes are the main source of benzene in the environment.

Once benzene enters the environment:

- It can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.
- Benzene in the air can attach to rain or snow and be carried back down to the ground.
- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

People can be exposed to benzene from several sources. Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions. Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, are sources of exposure. Air around hazardous waste sites or gas stations will contain higher levels of benzene. Exposures can also occur when working in industries that make or use benzene.

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the bloodforming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults. Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

Beryllium. Beryllium is a hard, grayish metal naturally found in mineral rocks, coal, soil, and volcanic dust. Beryllium compounds are commercially mined, and the beryllium is purified for use in nuclear weapons and reactors, aircraft and space vehicle structures, instruments, x-ray machines, and mirrors.

Beryllium dust enters the air from burning coal and oil. This beryllium dust will eventually settle over the land and water. Most beryllium in soil does not dissolve in water and remains bound to soil. Beryllium does not accumulate in the food chain.

The general population is exposed to normally low levels of beryllium in air, food, and water. People working in industries where beryllium is mined, processed, machined, or converted into metal, alloys, and other chemicals may be exposed to high levels of beryllium. People living near these industries may also be exposed to higher than normal levels of beryllium in air. People living near uncontrolled hazardous waste sites may be exposed to higher than normal levels of beryllium.

Beryllium can be harmful if you breathe it. If beryllium air levels are high enough (greater than 1000 $\mu g/m^3$), an acute condition can result. This condition resembles pneumonia and is called acute beryllium disease. Occupational and community air standards are effective in preventing most acute lung damage.

Some people (1-15%) become sensitive to beryllium. These individuals may develop an inflammatory reaction in the respiratory system. This condition is called chronic beryllium disease (CBD), and can occur many years after exposure to higher than normal levels of beryllium (greater than 0.5 $\mu g/m^3$). This disease can make you feel weak and tired, and can cause difficulty in breathing. It can also result in anorexia, weight loss, and may also lead to right side heart enlargement and heart disease in advanced cases. Some people who are sensitized to beryllium may not have any symptoms. The general population is unlikely to develop acute or chronic beryllium disease because ambient air levels of beryllium are normally very low (0.00003-0.0002 $\mu g/m^3$).

Swallowing beryllium has not been reported to cause effects in humans because very little beryllium is absorbed from the stomach and intestines. Ulcers have been seen in dogs ingesting beryllium in the diet. Beryllium contact with skin that has been scraped or cut may cause rashes or ulcers.

Long term exposure to beryllium can increase the risk of developing lung cancer in people. The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have determined that beryllium is a human carcinogen. The EPA has determined that beryllium is a probable human carcinogen. EPA has estimated that lifetime exposure to 0.04 $\mu g/m^3$ beryllium can result in a one in a thousand chance of developing cancer.

There are no studies on the health effects of children exposed to beryllium. It is likely that the health effects seen in children exposed to beryllium will be similar to the effects seen in adults. We do not know whether children differ from adults in their susceptibility to beryllium. We do not know if exposure to beryllium will result in birth defects or other developmental effects in people. The studies on developmental effects in animals are not conclusive.

1,3-Butadiene. 1,3-Butadiene is a chemical made from the processing of petroleum. It is a colorless gas with a mild gasoline-like odor. Recent production volumes are not available. About 60% of the manufactured 1,3-butadiene is used to make synthetic rubber. Synthetic rubber is widely used for tires on cars and trucks. 1,3-Butadiene is also used to make plastics including acrylics. Small amounts are found in gasoline.

In the environment it quickly evaporates to the air as a gas from leaks during production, use, storage, transport, or disposal. Half of the 1,3-butadiene that enters into air is expected to be broken down in 6 hours. It evaporates very quickly from water and soil. Since it evaporates so easily, it is not expected to be found in water or soil, but adequate tests are not available to measure the amounts. 1,3-Butadiene may be broken down by microorganisms in the soil. It is not expected to accumulate in fish.

People can become exposed by:

- Breathing urban and suburban air, but these levels are generally very low except in polluted cities or near chemical, plastic, and rubber facilities that use it.
- Breathing contaminated workplace air where it is manufactured or used.
- Breathing contaminated air from car and truck exhaust, waste incineration, or wood fires.
- Breathing cigarette smoke.
- Drinking contaminated water near production or waste sites.
- Ingesting foods contained in plastic or rubber food containers, but levels are generally very low or not present at all.
- Skin contact with gasoline and breathing gasoline fumes, but levels are low.

Breathing high levels of 1,3-butadiene for a short time may cause nausea, dry mouth and nose, headache, and decreased blood pressure and pulse rate. In laboratory animals, 1,3-butadiene causes inflammation of nasal tissues, changes to lung, heart, and reproductive tissues, neurological effects, and blood changes.

The Department of Health and Human Services (DHHS), IARC, and EPA have determined that 1,3-butadiene is a human carcinogen. Studies have shown that workers exposed to 1,3-butadiene may have an increased risk of cancers of the stomach, blood, and lymphatic system. Animal studies found increases in a variety of tumor types from exposure to 1,3-butadiene.

It is likely that health effects seen in children exposed to high amounts of 1,3-butadiene will be similar to the effects seen in adults. We do not know if exposure to 1,3-butadiene will result in birth defects or other developmental effects in people. Animal studies showed that breathing 1,3-butadiene during pregnancy can increase the number of birth defects.

Cadmium: Cadmium is a natural element in the earth's crust. All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics. Exposure to high levels of cadmium severely damages the lungs and can cause death. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage and fragile bones. Skin contact with cadmium is not known to cause health effects in humans or animals.

Carbon tetrachloride. Carbon tetrachloride is a manufactured chemical that does not occur naturally. It is a clear liquid with a sweet smell that can be detected at low levels. Carbon tetrachloride is most often found in the air as a colorless gas. It is not flammable and does not dissolve in water very easily. It was used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. Because of its harmful effects, these uses are now banned and it is only used in some industrial applications.

Carbon tetrachloride moves very quickly into the air upon release, so most of it is in the air. It evaporates quickly from surface water. Only a small amount sticks to soil particles; the rest evaporates or moves into the groundwater. It is very stable in air (lifetime 30-100 years). It can be broken down or transformed in soil and water within several days. When it does break down, it forms chemicals that can destroy ozone in the upper atmosphere. It does not build up in animals. We do not know if it builds up in plants.

People can be exposed by breathing contaminated air near manufacturing plants or waste sites, breathing workplace air where the compound used, and drinking contaminated water near manufacturing plants and waste sites. Other sources of exposure include breathing contaminated air and skin contact with water while showering or cooking with contaminated water, swimming or bathing in contaminated water and contact with or ingesting contaminated soil at or near waste sites.

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects can occur after ingestion or breathing carbon tetrachloride, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it enlarges and cells are damaged or destroyed. Kidneys also are damaged, causing a build up of wastes in the blood. If exposure is low and brief, the liver and kidneys can repair the damaged cells and function normally again. Effects of carbon tetrachloride are more severe in persons who drink large amounts of alcohol.

If exposure is very high, the nervous system, including the brain, is affected. People may feel intoxicated and experience headaches, dizziness, sleepiness, and nausea and vomiting. These effects may subside if exposure is stopped, but in severe cases, coma and even death may occur. There have been no studies of the effects of carbon tetrachloride on reproduction in humans, but studies in rats showed that long-term inhalation may cause decreased fertility.

Studies in humans have not been able to determine whether or not carbon tetrachloride can cause cancer because usually there has been exposure to other chemicals at the same time. Swallowing or breathing carbon tetrachloride for years caused liver tumors in animals. Mice that breathed carbon tetrachloride also developed tumors of the adrenal gland. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that carbon tetrachloride is possibly carcinogenic to humans, whereas the EPA determined that carbon tetrachloride is a probable human carcinogen.

The health effects of carbon tetrachloride have not been studied in children, but they are likely to be similar to those seen in adults exposed to the chemical. We do not know whether children differ from adults in their susceptibility to carbon tetrachloride.

A few survey-type studies suggest that maternal drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects. Studies in animals showed that carbon tetrachloride can cause early fetal deaths, but did not cause birth defects. A study with human breast milk in a test tube suggested that it would be possible for carbon tetrachloride to pass from the maternal circulation to breast milk, but there is no direct demonstration of this occurring.

Chlordane. Chlordane is a manufactured chemical that was used as a pesticide in the United States from 1948 to 1988. Technical chlordane is not a single chemical, but is actually a mixture of pure chlordane mixed with many related chemicals. It doesn't occur naturally in the environment. It is a thick liquid whose color ranges from colorless to amber. Chlordane has a mild, irritating smell. Some of its trade names are Octachlor and Velsicol 1068. Until 1983, chlordane was used as a pesticide on crops like corn and citrus and on home lawns and gardens. Because of concern about damage to the environment and harm to human health, the Environmental Protection Agency (EPA) banned all uses of chlordane in 1983 except to control termites. In 1988, EPA banned all uses.

Chlordane entered the environment when it was used as a pesticide on crops, on lawns and gardens, and to control termites. Chlordane sticks strongly to soil particles at the surface and is not likely to enter groundwater. It can stay in the soil for over 20 years. Most chlordane leaves soil by evaporation to the air. It breaks down very slowly and doesn't dissolve easily in water. Chlordane builds up in the tissues of fish, birds, and mammals.

People can be exposed to chlordane by eating crops grown in soil that contains chlordane, eating fish or shellfish caught in water that is contaminated by chlordane, breathing air or touching soil near homes treated for termites with chlordane, and by breathing air or by touching soil near waste sites or landfills.

Chlordane affects the nervous system, the digestive system, and the liver in people and animals. Headaches, irritability, confusion, weakness, vision problems, vomiting, stomach cramps, diarrhea, and jaundice have occurred in people who breathed air containing high concentrations of chlordane or accidentally swallowed small amounts of chlordane. Large amounts of chlordane taken by mouth can cause convulsions and death in people.

Japanese workers who used chlordane over a long period of time had minor changes in liver function. Animals given high levels of chlordane by mouth for short periods died or had convulsions. Long-term exposure caused harmful effects in the liver of test animals.

We do not know whether chlordane affects the ability of people to have children or whether it causes birth defects. Animals exposed before birth or while nursing developed behavioral effects later.

The International Agency for Research on Cancer has determined that chlordane is not classifiable as to its carcinogenicity to humans. Studies of workers who made or used chlordane do not show that exposure to chlordane is related to cancer, but the information is not sufficient to know for sure. Mice fed low levels of chlordane in food developed liver cancer.

Chlorobenzene. Chlorobenzene is a colorless, flammable liquid with an aromatic, almond-like odor. Some of it will dissolve in water, but it readily evaporates into air. It does not occur naturally in the environment. Chlorobenzene production in the United States has declined by more than 60% from its peak in 1960. It was used in the past to make other chemicals, such as phenol and DDT. Now chlorobenzene is used as a solvent for some pesticide formulations, to degrease automobile parts, and as a chemical intermediate to make several other chemicals.

Chlorobenzene released to air is slowly broken down by reactions with other chemicals and sunlight or can be removed by rain. In water, chlorobenzene will rapidly evaporate to the air and/or be broken down by bacteria. When released to soil, it is broken down rapidly by bacteria, but some will evaporate to the air and some may filter into the groundwater. Chlorobenzene does not build up in the food chain.

People can be exposed to chlorobenzene if they work where chlorobenzene is made or used you could be exposed by breathing air with chlorobenzene vapors or by spilling or splashing chlorobenzene on your skin. Other sources of exposure include living near waste sites where drinking contaminated groundwater, breathing vapors released to the air, or getting contaminated soil on their skin could occur. People can also be exposed by eating food contaminated with chlorobenzene but there is not enough information to determine how often this occurs.

Workers exposed to high levels of chlorobenzene in the air complained of headaches, nausea, sleepiness, numbness, and vomiting. We cannot be certain that all of these effects were due to chlorobenzene exposure because the workers may have been exposed to other chemicals.

Animal studies indicate that the liver, kidney, and central nervous system are affected by exposure to chlorobenzene. Effects on the central nervous system from breathing chlorobenzene include unconsciousness, tremors, restlessness, and death. Longer exposure has caused liver and kidney damage. The limited data available indicate that chlorobenzene does not cause birth defects or infertility.

It is not known whether chlorobenzene causes cancer in people. Although chlorobenzene did not produce cancer in animal studies with rats and mice, liver nodules which can lead to cancer were produced in male rats. The EPA has determined that chlorobenzene is not classifiable as to human carcinogenicity based on inadequate evidence in both humans and animals.

Exposure to chlorobenzene can be determined by measuring it or its metabolites in urine, exhaled air, blood, and body fat, but these tests cannot be used to predict whether harmful health effects will occur. These tests are not usually done in the doctors' office because special equipment is needed.

Chloroethane. Chloroethane is a colorless gas at room temperature and pressure. It has a characteristically sharp smell. It is a liquid when stored in pressurized containers; however, the liquid evaporates quickly when exposed to room air. It was used in leaded gasoline, but strict new government regulations have reduced that use dramatically. It is used in the production of cellulose, dyes, medicinal drugs, and other commercial products, and as a solvent and refrigerant. It is also used to numb the skin before medical procedures such as ear piercing and skin biopsies and as a treatment in sports injuries.

Most chloroethane exists as a gas in the atmosphere where it breaks down fairly rapidly (about half disappears within 40 days) by reacting with other substances in the air. Small amounts can enter groundwater by filtering through the soil. In groundwater, chloroethane is slowly changed into a simpler form by reaction with water. Some types of bacteria in water may break it down to smaller compounds.

Sources of exposure to people include:

- Chloroethane can be released to air from factories that manufacture or use it.
- It can evaporate from landfills.
- It can be released during its use as a solvent, refrigerant, and anesthetic.
- Chloroethane may be present in drinking water as a result of chlorination.
- People may be exposed through skin contact if it is used in a medical procedure.
- Workers who may be exposed include doctors, nurses, mechanics, plumbers, and painters.

Brief exposure to high levels can produce temporary feelings of drunkenness. At higher levels, it can cause lack of muscle coordination and unconsciousness. It can also cause stomach cramps, nausea, vomiting, and eye irritation. Chloroethane is sometimes applied to the skin as a numbing agent before surgery. If it is applied for too long, frostbite can result. Some people had allergic reactions to it, and others experienced mild pain after being sprayed for 10 seconds.

Laboratory tests in animals have shown that long-term exposure can cause cancer in mice. It is not known whether it causes cancer in humans. The International Agency for Research on Cancer (IARC) has concluded that chloroethane is not classifiable as to its carcinogenicity in humans.

We don't know whether chloroethane exposure can affect development in people. In animal studies, the babies of mice exposed to chloroethane during pregnancy had delayed development. It is not known whether children differ from adults in their susceptibility to chloroethane.

Chloroform. Chloroform is a colorless liquid with a pleasant, nonirritating odor and a slightly sweet taste. It will burn only when it reaches very high temperatures. In the past, chloroform was used as an inhaled anesthetic during surgery, but it isn't used that way today. Today, chloroform is used to make other chemicals and can also be formed in small amounts when chlorine is added to water. Other names for chloroform are trichloromethane and methyl trichloride.

Chloroform evaporates easily into the air. Most of the chloroform in air breaks down eventually, but it is a slow process. The breakdown products in air include phosgene and hydrogen chloride, which are both toxic. It doesn't stick to soil very well and can travel through soil to groundwater. Chloroform dissolves easily in water and some of it may break down to other chemicals. Chloroform lasts a long time in groundwater. Chloroform doesn't appear to build up in great amounts in plants and animals.

People can become exposed through drinking water or beverages made using water containing chloroform, breathing indoor or outdoor air containing it, especially in the workplace, eating contaminated food, and skin contact with water that contains it, such as in swimming pools.

Breathing about 900 parts of chloroform per million parts air (900 ppm) for a short time can cause dizziness, fatigue, and headache. Breathing air, eating food, or drinking water containing high levels of chloroform for long periods of time may damage your liver and kidneys. Large amounts of chloroform can cause sores when chloroform touches your skin. It isn't known whether chloroform causes reproductive effects or birth defects in people.

Animal studies have shown that miscarriages occurred in rats and mice that breathed air containing 30 to 300 ppm chloroform during pregnancy and also in rats that ate chloroform during pregnancy. Offspring of rats and mice that breathed chloroform during pregnancy had birth defects. Abnormal sperm were found in mice that breathed air containing 400 ppm chloroform for a few days.

The Department of Health and Human Services (DHHS) has determined that chloroform may reasonably be anticipated to be a carcinogen. Rats and mice that ate food or drank water with chloroform developed cancer of the liver and kidneys.

Chromium Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium is present in the environment in several different forms: chromium (0), chromium (III), and chromium (VI). No taste or odor is associated with chromium compounds. The metal chromium, which is the chromium (0) form, is used for making steel. Chromium (VI) and chromium (III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Chromium enters the air, water, and soil mostly in the chromium (III) and chromium (VI) forms. In air, chromium compounds are present mostly as fine dust particles which eventually settle over land and water. Chromium can strongly attach to soil and only a small amount can dissolve in water and move deeper in the soil to underground water. Fish do not accumulate much chromium from water.

Breathing high levels of chromium (VI) can cause nasal irritation, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium (VI) compounds can cause skin ulcers. Allergic reactions consisting of severe redness and swelling of the skin have been noted.

Several studies have shown that chromium (VI) compounds can increase the risk of lung cancer. Animal studies have also shown an increased risk of cancer. The WHO has determined that chromium (VI) is a human carcinogen. The DHHS has determined that certain chromium (VI) compounds are known to cause cancer in humans. The EPA has determined that chromium (VI) in air is a human carcinogen.

It is unknown whether exposure to chromium will result in birth defects or other developmental effects in people. Birth defects have been observed in animals exposed to chromium(VI). It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

Copper. High levels of copper can be harmful. Breathing high levels of copper can cause irritation of nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to liver and kidneys, and can even cause death.

Exposure to high levels of copper will result in the same type of effects in children and adults. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that the young children may have more severe effects than adults, but we don't know if this would also be true in humans. There are a very small percentage of infants and children who are unusually sensitive to copper.

Birth defects or other developmental effects of copper in humans are unknown. Animal studies suggest that high levels of copper may cause a decrease in fetal growth.

The most likely human exposure pathway is through drinking water, especially if the water is corrosive and copper pipes are used for plumbing. One of the most effective ways to reduce copper exposure is to let the water run for at least 15 seconds first thing in the morning before drinking or using it. This reduces the levels of copper in tap water dramatically.

Copper is found throughout the body; in hair, nails, blood, urine, and other tissues. High levels of copper in these samples can show copper exposures. However, these tests can not predict occurrence of harmful effects. Tests to measure copper levels in the body require special equipment.

Human carcinogenicity of copper is unknown. The EPA has determined that copper is not classifiable as to human carcinogenicity.

Dieldrin and Aldrin. Aldrin and dieldrin are insecticides with similar chemical structures. They are discussed together in this fact sheet because aldrin quickly breaks down to dieldrin in the body and in the environment. Pure aldrin and dieldrin are white powders with a mild chemical odor. The less pure commercial powders have a tan color. Neither substance occurs naturally in the environment

From the 1950s until 1970, aldrin and dieldrin were widely used pesticides for crops like corn and cotton. Because of concerns about damage to the environment and potentially to human health, EPA banned all uses of aldrin and dieldrin in 1974, except to control termites. In 1987, EPA banned all uses.

Sunlight and bacteria change aldrin to dieldrin so that we mostly find dieldrin in the environment. These compounds bind tightly to soil and slowly evaporate to the air. Dieldrin in soil and water breaks down very slowly. Plants take in and store aldrin and dieldrin from the soil. Aldrin rapidly changes to dieldrin in plants and animals. In humans and animals, dieldrin is stored in the fat and leaves the body very slowly.

Dieldrin is everywhere in the environment, but at very low levels. People can be exposed by eating food like fish or shellfish from lakes or streams contaminated with either chemical, or contaminated root crops, dairy products, or meats. Other sources of exposure include air, surface water, or soil near waste sites may contain higher levels and living in homes that were once treated with aldrin or dieldrin to control termites.

People who intentionally or accidentally ingested large amounts of aldrin or dieldrin suffered convulsions and some died. Health effects may also occur after a longer period of exposure to smaller amounts because these chemicals build up in the body. Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements. Workers removed from the source of exposure rapidly recovered from most of these effects.

Animals exposed to high amounts of aldrin or dieldrin also had nervous system effects. In animals, oral exposure to lower levels for a long period also affected the liver and decreased their ability to fight infections. We do not know whether aldrin or dieldrin affect the ability of people to fight disease. Studies in animals have given conflicting results about whether aldrin and dieldrin affect reproduction in male animals and whether these chemicals may damage the sperm. We do not know whether aldrin or dieldrin affect reproduction in humans.

There is no conclusive evidence that aldrin or dieldrin cause cancer in humans. Aldrin and dieldrin have shown to cause liver cancer in mice. The International Agency for Research on Cancer (IARC) has determined that aldrin and dieldrin are not classifiable as to human carcinogenicity. The EPA has determined that aldrin and dieldrin are probable human carcinogens.

Children can be exposed to aldrin and dieldrin in the same way as adults. There are no known unique exposure pathways for children. Children who swallowed amounts of aldrin or dieldrin much larger than those found in the environment suffered convulsions and some died, as occurred in adults. However, we do not know whether children are more susceptible than adults to the effects of aldrin or dieldrin.

We do not know whether aldrin or dieldrin cause birth defects in humans. Pregnant animals that ingested aldrin or dieldrin had some babies with low birth weight and some with alterations in the skeleton. Dieldrin has been found in human breast milk, therefore, it can be passed to suckling infants.

DDT, DDE, DDT. DDT (dichlorodiphenyltrichloroethane) is a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. DDT is a white, crystalline solid with no odor or taste. Its use in the U.S. was banned in 1972 because of damage to wildlife, but is still used in some countries.

DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloroethane) are chemicals similar to DDT that contaminate commercial DDT preparations. DDE has no commercial use. DDD was also used to kill pests, but its use has also been banned. One form of DDD has been used medically to treat cancer of the adrenal gland.

DDT entered the environment when it was used as a pesticide; it still enters the environment due to current use in other countries. DDE enters the environment as contaminant or breakdown product of DDT; DDD also enters the environment as a breakdown product of DDT. DDT, DDE, and DDD in air are rapidly broken down by sunlight. Half of what's in air breaks down within 2 days. These compounds stick strongly to soil; most DDT in soil is broken down slowly to DDE and DDD by microorganisms; half the DDT in soil will break down in 2-15 years, depending on the type of soil. Only a small amount will go through the soil into groundwater; they do not dissolve easily in water. DDT, and especially DDE, build up in plants and in fatty tissues of fish, birds, and other animals.

People can be exposed to these compounds by eating contaminated foods, such as root and leafy vegetable, fatty meat, fish, and poultry, but levels are very low. Other pathways include eating contaminated imported foods from countries that still allow the use of DDT to control pests, breathing contaminated air or drinking contaminated water near waste sites and landfills that may contain higher levels of these chemicals, infants who are fed on breast milk from mothers who have been exposed, and breathing or swallowing soil particles near waste sites or landfills that contain these chemicals.

DDT affects the nervous system. People who accidentally swallowed large amounts of DDT became excitable and had tremors and seizures. These effects went away after the exposure stopped. No effects were seen in people who took small daily doses of DDT by capsule for 18 months.

A study in humans showed that women who had high amounts of a form of DDE in their breast milk were unable to breast feed their babies for as long as women who had little DDE in the breast milk. Another study in humans showed that women who had high amounts of DDE in breast milk had an increased chance of having premature babies.

In animals, short-term exposure to large amounts of DDT in food affected the nervous system, while long-term exposure to smaller amounts affected the liver. Also in animals, short-term oral exposure to small amounts of DDT or its breakdown products may also have harmful effects on reproduction.

Studies in DDT-exposed workers did not show increases in cancer. Studies in animals given DDT with the food have shown that DDT can cause liver cancer.

The Department of Health and Human Services (DHHS) determined that DDT may reasonable be anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) determined that DDT may possibly cause cancer in humans. The EPA determined that DDT, DDE, and DDD are probable human carcinogens.

There are no studies on the health effects of children exposed to DDT, DDE, or DDD. We can assume that children exposed to large amounts of DDT will have health effects similar to the effects seen in adults. However, we do not know whether children differ from adults in their susceptibility to these substances.

There is no evidence that DDT, DDE, or DDD cause birth defects in people. A study showed that teenage boys whose mothers had higher DDE amounts in the blood when they were pregnant were taller than those whose mothers had lower DDE levels. However, a different study found the opposite in preteen girls. The reason for the discrepancy between these studies is unknown.

Studies in rats have shown that DDT and DDE can mimic the action of natural hormones and in this way affect the development of the reproductive and nervous systems. Puberty was delayed in male rats given high amounts of DDE as juveniles. This could possibly happen in humans. A study in mice showed that exposure to DDT during the first weeks of life may cause neurobehavioral problems later in life.

1,2-Dichloroethane. 1,2-Dichloroethane, also called ethylene dichloride, is a manufactured, colorless liquid with a pleasant smell and sweet taste. It is primarily used in the production of vinyl chloride which is used to make a variety of plastic and vinyl products.

Breathing high levels of 1,2-dichloroethane can cause nervous system disorders, liver and kidney diseases, and affect the lungs and immune system. Livers, kidneys and lungs were the target organs in chronic exposures studies in animals. Studies have not been conclusive that 1,2-dichloroethane causes cancer in humans. In animal studies, increases in stomach, mammary gland, liver, lung, and endometrium cancers have been seen following inhalation, oral and dermal exposures. Exposure to 1,2-dichloroethane has not been shown to affect fertility in people or animals. The US Environmental Protection Agency (EPA) has determined that 1,2-dichloroethane is a probably human carcinogen and the International Agency for Cancer Research (IARC) considers it to be a possible human carcinogen.

1,2-Dichloroethene. 1,2-Dichloroethene, also called 1,2-dichloroethylene, is a highly flammable, colorless liquid with a sharp, harsh odor. It is used to produce solvents and in chemical mixtures. You can smell very small amounts of 1,2-dichloroethene in air (about 17 parts of 1,2-dichloroethene per million parts of air [17 ppm]).

Breathing high levels of 1,2-dichloroethene can make you feel nauseous, drowsy, and tired; breathing very high levels can kill you. When animals breathed high levels of *trans*-1,2-dichloroethene for short or longer periods of time, their livers and lungs were damaged and the effects were more severe with longer exposure times. Animals that breathed very high levels of *trans*-1,2-dichloroethene had damaged hearts. Animals that ingested extremely high doses of *cis*- or *trans*-1,2-dichloroethene died. Lower doses of *cis*-1,2-dichloroethene caused effects on the blood, such as decreased numbers of red blood cells, and also effects on the liver.

The long-term (365 days or longer) human health effects after exposure to low concentrations of 1,2-dichloroethene aren't known. One animal study suggested that an exposed fetus may not grow as quickly as one that hasn't been exposed.

Exposure to 1,2-dichloroethene hasn't been shown to affect fertility in people or animals.

The EPA has determined that *cis*-1,2-dichloroethene is not classifiable as to its human carcinogenicity. No EPA cancer classification is available for *trans*-1,2-dichloroethene.

Heptachlor. Heptachlor is a manufactured chemical and doesn't occur naturally. Pure heptachlor is a white powder that smells like camphor (mothballs). The less pure grade is tan. Trade names include Heptagran®, Basaklor®, Drinox®, Soleptax®, Termide®, Gold Crest H-60®, and Velsicol 104®. Heptachlor was used extensively in the past for killing insects in homes, buildings, and on food crops. These uses stopped in 1988. Currently it can only be used for fire ant control in underground power transformers. Heptachlor epoxide is also a white powder. Bacteria and animals break down heptachlor to form heptachlor epoxide. The epoxide is more likely to be found in the environment than heptachlor.

Heptachlor doesn't dissolve easily in water; heptachlor epoxide dissolves more easily. It sticks strongly to soil particles and evaporates slowly to air. Heptachlor epoxide can stay in the soil and water for many years. Plants can take up heptachlor from the soil. Levels of heptachlor and heptachlor epoxide can build up in the tissues of fish and cattle.

Sourced of exposure include eating fish, dairy products, and fatty meats from animals exposed to heptachlor in their food, breast milk from mothers who had high exposures can expose breastfed infants, and drinking water, breathing air, or touching soil at waste sites that contain these substances.

There is no reliable information on health effects in humans. Liver damage, excitability, and decreases in fertility have been observed in animals ingesting heptachlor. The effects are worse when the exposure levels were high or when exposure lasted many weeks. Although there is very little information on heptachlor epoxide, it is likely that similar effects would also occur after exposure to this compound.

Lifetime exposure to heptachlor resulted in liver tumors in animals. The International Agency for Research on Cancer (IARC) and the EPA have classified heptachlor as a possible human carcinogen. EPA also considers heptachlor epoxide as a possible human carcinogen.

Animals exposed to heptachlor during gestation and infancy may be very sensitive to heptachlor and heptachlor epoxide. Changes in nervous system and immune function were found in these animals. Exposure to higher doses of heptachlor in animals can also result in decreases in body weight and death in newborn animals.

Hexachlorocyclohexane. Hexachlorocyclohexane (HCH) is a manufactured chemical that exists in eight chemical forms called isomers. One of these forms, gamma-HCH (or γ-HCH, commonly called lindane) is produced and used as an insecticide on fruit, vegetables, and forest crops. It is a white solid that may evaporate into the air as a colorless vapor with a slightly musty odor. It is also available as a prescription (lotion, cream, or shampoo) to treat head and body lice, and scabies. Lindane has not been produced in the United States since 1976, but is imported for insecticide use.

Technical-grade HCH was used as an insecticide in the United States and typically contained 10-15% ã-HCH as well as the alpha (α), beta (β), delta (δ), and epsilon (ε) forms of HCH. Virtually all the insecticidal properties resided in γ-HCH. Technical-grade HCH has not been produced or used in the United States in over 20 years.

The components of technical-grade HCH have been found in soil and surface waters near hazardous waste sites. In the air, the different forms of HCH can exist as a vapor or attached to small particles such as soil and dust. The particles may be removed from the air by rain or degraded by other compounds in the atmosphere. HCH can remain in the air for long periods of time and travel great distances. In soil, sediments, and water, HCH is broken down to less toxic substances by algae, fungi, and bacteria, but this process can take a long time. HCH can accumulate in the fatty tissue of fish.

People can become exposed by eating food or drinking water contaminated with HCH, breathing air contaminated with HCH in or near factories where products using γ-HCH are made, and through the skin when applied as a lotion or shampoo to treat lice or scabies. Occupational exposure can occur to workers involved in the formulation or application of products containing γ-HCH may be exposed to higher concentrations.

Some people who breathed contaminated workplace air during manufacturing of pesticides, including γ-HCH, had blood disorders, dizziness, headaches, and changes in the levels of sex hormones. Some people who swallowed large amounts had seizures and sometimes died.

Animals fed γ- and α-HCH have had convulsions, and animals fed β-HCH have become comatose. All isomers can produce liver and kidney effects. Reduced ability to fight infection was reported in animals fed γ-HCH, and injury to the ovaries and testes was reported in animals given γ-HCH or β-HCH.

Long-term oral administration of α-HCH, β-HCH, γ-HCH, or technical-grade HCH to laboratory rodents produced liver cancer. The Department of Health and Human Services (DHHS) has determined that HCH (all isomers) may reasonably be anticipated to cause cancer in humans. The International Agency for Research on Cancer (IARC) has classified HCH (all isomers) as possibly carcinogenic to humans. The EPA has determined that there is suggestive evidence that lindane (γ-HCH) is carcinogenic, but the evidence is not sufficient to assess its human carcinogenic potential. The EPA has additionally classified technical HCH and α-HCH as probable human carcinogens, β-HCH as a possible human carcinogen, and δ- and ε-HCH as not classifiable as to human carcinogenicity.

Health effects observed in adults should also be of potential concern in children. Children can experience convulsions from exposure to γ-HCH. Accidentally eating high amounts of γ-HCH can kill a child. We do not know whether children are more susceptible than adults to health effects from exposure to γ-HCH. However, a study performed on rabbits showed that young animals had higher death rates and greater sensitivity than adults when γ-HCH was applied to the skin.

We do not know whether HCH causes birth defects in humans. Technical grade and γ-HCH do not cause serious birth defects in animals. HCH has been shown to cross the placenta in pregnant women. HCH has been detected in human breast milk, suggesting that it can be transferred to infants from women who nurse.

Lead. Lead is a naturally occurring metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing. Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. People may be exposed to lead by eating food or drinking water that contains lead, spending time in areas where lead-based paints have been used and are deteriorating, and by working in a job or engaging in a hobby where lead is used. Small children are more likely to be exposed to lead by swallowing house dust or soil that contains lead, eating lead-based paint chips or chewing on objects painted with lead-based paint.

Lead can affect many organs and systems in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain.

Children are more vulnerable to lead poisoning than adults. A child, who swallows large amounts of lead, for example by eating old paint chips, may develop blood anemia, severe stomachache, muscle weakness, and brain damage. A large amount of lead might get into a child's body if the child ate small pieces of old paint that contained large amounts of lead. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, however, lead can affect a child's mental and physical growth. Exposure to lead is more dangerous for young children and fetuses. Fetuses can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead.

The DHHS has determined that two compounds of lead (lead acetate and lead phosphate) may reasonably be anticipated to be carcinogens based on studies in animals. There is inadequate evidence to clearly determine whether lead can cause cancer in people.

Manganese. Manganese is a naturally occurring metal that is found in many types of rocks. Pure manganese is silver-colored, but does not occur naturally. Manganese occurs naturally in most foods and may be added to some foods. Manganese is used principally in steel production to improve hardness, stiffness, and strength. It may also be used as an additive in gasoline to improve the octane rating of the gas.

Manganese can be released to the air, soil, and water from the manufacture, use, and disposal of manganese-based products. Manganese cannot break down in the environment. It can only change its form or become attached to or separated from particles.

The primary way you can be exposed to manganese is by eating food or manganese-containing nutritional supplements. Vegetarians who consume foods rich in manganese such as grains, beans and nuts, as well as heavy tea drinkers, may have a higher intake of manganese than the average person. Certain occupations like welding or working in a factory where steel is made may increase your chances of being exposed to high levels of manganese. Manganese is routinely contained in groundwater, drinking water, and soil at low levels. Drinking water containing manganese or swimming or bathing in water containing manganese may expose you to low levels of this chemical.

Manganese is an essential nutrient, and eating a small amount of it each day is important to stay healthy.

The most common health problems in workers exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as "manganism". Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations in the work place.

The EPA concluded that existing scientific information cannot determine whether or not excess manganese can cause cancer.

Studies in children have suggested that extremely high levels of manganese exposure may produce undesirable effects on brain development, including changes in behavior and decreases in the ability to learn and remember. We do not know for certain that these changes were caused by manganese alone. We do not know if these changes are temporary or permanent. We do not know whether children are more sensitive than adults to the effects of manganese, but there is some indication from experiments in laboratory animals that they may be. Studies of manganese workers have not found increases in birth defects or low birth weight in their offspring. No birth defects were observed in animals exposed to manganese.

Mercury. Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas. Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants. It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity. Methylmercury may be formed in water and soil by small organisms called bacteria.

Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

People can be exposed to mercury by eating fish or shellfish contaminated with methylmercury, breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels, release of mercury from dental work and medical treatments, breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury), and practicing rituals that include mercury.

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also can pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

Methylene chloride. Methylene chloride is a colorless liquid with a mild, sweet odor. Another name for it is dichloromethane. Methylene chloride does not occur naturally in the environment. Methylene chloride is used as an industrial solvent and as a paint stripper. It may also be found in some aerosol and pesticide products and is used in the manufacture of photographic film.

Methylene chloride is mainly released to the environment in air. About half of the methylene chloride in air disappears in 53 to 127 days. Methylene chloride does not easily dissolve in water, but small amounts may be found in drinking water. We do not expect methylene chloride to build up in plants or animals.

The most likely way to be exposed to methylene chloride is by breathing contaminated air. Breathing the vapors given off by products containing methylene chloride. Exposure to high levels of methylene chloride is likely if methylene chloride or a product containing it is used in a room with inadequate ventilation.

If you breathe in large amounts of methylene chloride you may feel unsteady, dizzy, and have nausea and a tingling or numbness of your finger and toes. A person breathing smaller amounts of methylene chloride may become less attentive and less accurate in tasks requiring hand-eye coordination. Skin contact with methylene chloride causes burning and redness of the skin.

We do not know if methylene chloride can cause cancer in humans. An increased cancer risk was seen in mice breathing large amounts of methylene chloride for a long time. The World Health Organization (WHO) has determined that methylene chloride may cause cancer in humans. The Department of Health and Human Services (DHHS) has determined that methylene chloride can be reasonably anticipated to be a cancer-causing chemical. The EPA has determined that methylene chloride is a probable cancer-causing agent in humans.

It is likely that health effects seen in children exposed to high amounts of methylene chloride will be similar to the effects seen in adults. We do not know if methylene chloride can affect the ability of people to have children or if it causes birth defects. Some birth defects have been seen in animals inhaling very high levels of methylene chloride.

Nickel. Nickel is a very abundant natural element. Pure nickel is a hard, silvery-white metal. Nickel can be combined with other metals, such as iron, copper, chromium, and zinc, to form alloys. These alloys are used to make coins, jewelry, and items such as valves and heat exchangers. Most nickel is used to make stainless steel. Nickel compounds are used for nickel plating, to color ceramics, to make some batteries, and as substances known as catalysts that increase the rate of chemical reactions. Nickel is found in all soil and is emitted from volcanoes. Nickel is also found in meteorites and on the ocean floor. Nickel and its compounds have no characteristic odor or taste.

Nickel is released into the atmosphere by industries that make or use nickel, nickel alloys, or nickel compounds. It is also released into the atmosphere by oil-burning power plants, coal-burning power plants, and trash incinerators. In the air, it attaches to small particles of dust that settle to the ground or are taken out of the air in rain or snow; this usually takes many days. Nickel released in industrial waste-water ends up in soil or sediment where it strongly attaches to particles containing iron or manganese. Nickel does not appear to accumulate in fish or in other animals used as food.

People can be exposed to nickel by eating food containing nickel, which is the major source of exposure for most people. People can also be exposed by skin contact with soil, bath or shower water, or metals containing nickel, as well as by handling coins or touching jewelry containing nickel. Other pathways include drinking water that contains small amounts of nickel, breathing air or smoking tobacco containing nickel, and working in industries that process or use nickel.

The most common harmful health effect of nickel in humans is an allergic reaction. The most common reaction is a skin rash at the site of contact. The skin rash may also occur at a site away from the site of contact. People working in nickel refineries or nickel-processing plants have experienced chronic bronchitis and reduced lung function. These persons breathed amounts of nickel much higher than levels found normally in the environment. Workers who drank water containing high amounts of nickel had stomach ache and suffered adverse effects to their blood and kidneys. Damage to the lung and nasal cavity has been observed in rats and mice breathing nickel compounds. Eating or drinking large amounts of nickel has caused lung disease in dogs and rats and has affected the stomach, blood, liver, kidneys, and immune system in rats and mice, as well as their reproduction and development.

Cancers of the lung and nasal sinus have resulted when workers breathed dust containing high levels of nickel compounds while working in nickel refineries or nickel processing plants. The Department of Health and Human Services (DHHS) has determined that nickel metal may reasonably be anticipated to be a carcinogen and that nickel compounds are known human carcinogens. The International Agency for Research on Cancer (IARC) has determined that some nickel compounds are carcinogenic to humans and that metallic nickel may possibly be carcinogenic to humans. The EPA has determined that nickel refinery dust and nickel subsulfide are human carcinogens.

It is likely that the health effects seen in children exposed to nickel will be similar to those seen in adults. We do not know whether children differ from adults in their susceptibility to nickel. Human studies that examined whether nickel can harm the fetus are inconclusive. Animal studies have found increases in newborn deaths and decreased newborn weight after ingesting very high amounts of nickel. Nickel can be transferred from the mother to an infant in breast milk and can cross the placenta.

Polycyclic Aromatic Hydrocarbons (PAHs) Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd0pyrene, phenanthrene, and naphthalene

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides. Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

The DHHS has determined that some PAHs may reasonably be expected to be carcinogens. Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Polychlorinated biphenyls. Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs. PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators. PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil. PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

People can be exposed to PCBs from old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure. Eating contaminated food are the main dietary sources of PCB exposure which include fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products. Other sources of exposure include breathing air near hazardous waste sites and drinking contaminated well water. In the workplace, exposures can occur during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects. High levels of toluene may affect your kidneys.

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

1,1,2,2-Tetrachloroethane. 1,1,2,2-Tetrachloroethane is a manufactured, colorless, dense liquid that does not burn easily. It is volatile and has a sweet odor. In the past, it was used in large amounts to produce other chemicals, as an industrial solvent to clean and degrease metals, and as an ingredient in paints and pesticides. Commercial production of 1,1,2,2-tetrachloroethane for these uses has stopped in the United States. It presently is used only as a chemical intermediate in the production of other chemicals.

In the environment most 1,1,2,2-tetrachloroethane released to the environment eventually moves to the air or ground water. It does not attach to soil particles when released to land. When released to surface water, much of it will evaporate to the air while the rest may break down in the water. Breakdown of the chemical in the environment is slow; it takes about 1 year for half of the chemical to disappear from groundwater and 2 months in air. 1,1,2,2-Tetrachloroethane does not build up significantly in the bodies of fish or other organisms.

People can become exposed through the following pathways:

- The general public is not expected to be exposed to significant amounts of 1,1,2,2-tetrachloroethane. It is not commonly found in drinking water, soil, or food.
- Higher concentrations have been found occasionally in private well water that may have been used for drinking.
- You may be exposed to 1,1,2,2-tetrachloroethane if you live near a hazardous waste site that contains it or near an industrial building where the chemical is used.
- Since production of the chemical has stopped, most workers would not be exposed to it.
- If spills or accidents occur at work, exposure will likely be by breathing in vapors or through skin contact.

Most of the 1,1,2,2-tetrachlooethane that you may ingest or inhale will enter the bloodstream. Breathing very high concentrations of 1,1,2,2 tetra¬chloro¬ethane can rapidly cause drowsiness, dizziness, nausea, and vomiting. Most people recover from these effects once they are in fresh air. Breathing high levels of 1,1,2,2 tetra-chloro-ethane for a long time can cause liver damage. Drinking very large amounts of 1,1,2,2-tetrachloroethane can cause shallow breathing, faint pulse, decreased blood pressure, and possibly unconsciousness. Liver damage has been observed in animals orally exposed to lower doses for a long time.

It is not known whether 1,1,2,2-tetrachloroethane causes cancer in humans. In a long-term study, 1,1,2,2-tetrachloroethane caused an increase in liver tumors in mice, but not in rats. The International Agency for Research on Cancer (IARC) has determined that 1,1,2,2-tetrachloroethane cannot be classified as to its ability to cause cancer in humans, while the EPA has determined that it is a possible human carcinogen.

Exposure of children to large amounts of 1,1,2,2-tetra¬chloroethane will probably cause the same effects observed in adults (i.e., fatigue, vomiting, dizziness, liver damage, stomachache). It is not known whether children are more or less susceptible to the effects of 1,1,2,2-tetra¬chloroethane than adults. Some effects have been observed in animals born to females exposed to 1,1,2,2-tetrachloroethane during pregnancy. This occurred at exposure levels that were also toxic to the mothers. A very small number of studies in animals do not suggest that 1,1,2,2-tetrachloroethane is a developmental toxin.

Tetrachloroethylene (PCE). PCE is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell PCE when it is present in the air at a level of approximately 7,000 micrograms per cubic meter or more, although some can smell it at even lower levels. People are commonly exposed to PCE when they bring clothes from the dry cleaners.

High concentrations of PCE can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with it. These symptoms occur almost entirely in work (or hobby) environments when people have been exposed to high concentrations. In industry, most workers are exposed to levels lower than those causing obvious nervous system effects, although more subtle neurological effects are possible at the lower levels. The health effects of breathing in air or drinking water with low levels of PCE are not known. Results from some studies suggest that women who work in dry cleaning industries where exposures to PCE can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that PCE can cause liver and kidney damage. Exposure to very high levels of PCE can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant.

The U.S. Department of Health and Human Services (USDHHS) has determined that PCE may reasonably be anticipated to be a carcinogen. PCE has been shown to cause liver tumors in mice and kidney tumors in male rats.

Toluene. Toluene is a clear, colorless liquid with a distinctive smell. Toluene occurs naturally in crude oil and in the tolu tree. It is also produced in the process of making gasoline and other fuels from crude oil and making coke from coal. Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes.

Toluene enters the environment when you use materials that contain it. It can also enter surface water and groundwater from spills of solvents and petrolieum products as well as from leasking underground storage tanks at gasoline stations and other facilities. When toluene-containing products are placed in landfills or waste disposal sites, the toluene can enter the soil or water near the waste site. Toluene does not concentrate or buildup to high levels in animals.

People can become exposed by breathing contaminated workplace air or automobile exhaust, working with gasoline, kerosene, heating oil, paints, and lacquers, drinking contaminated well-water, and living near uncontrolled hazardous waste sites containing toluene products.

Toluene may affect the nervous system. Low to moderate levles can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite, and hearing and color vision loss. These symptoms usually disappear when exposure is stopped. Inhaling High levels of toluene in a short time can make you feel light-headed, dizzy, or sleepy. It can also cause unconsciousness, and even death. High levels of toluene may affect your kidneys.

Studies in humans and animals generally indicate that toluene does not cause cancer. The EPA has determined that the carcinogenicity of toluene can not be classified.

It is likely that health effects seen in children exposed to toluene will be similar to the effects seen in adults. Some studies in animals suggest that babies may be more sensitive than adults. Breathing very high levels of toluene during pregnancy can result in children with birth defects and retard mental abilities, and growth. We do not know if toluene harms the unborn child if the mother is exposed to low levels of toluene during pregnancy.

Trichloroethylene (TCE). TCE is a nonflammable, colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers. TCE dissolves a little in water, and can remain in groundwater for a long time. It quickly evaporates from water, so it is commonly found as a vapor in the air. People can be exposed to TCE by breathing air in and around the home which has been contaminated with TCE vapors from shower water or household products, or by drinking, swimming, or showering in water that has been contaminated with TCE. Breathing small amounts of TCE may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage. Drinking large amounts of TCE may cause nausea, liver damage, unconsciousness, impaired heart function, or death. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Skin contact with TCE for short periods may cause skin rashes.

Some studies with mice and rats have suggested that high levels of TCE may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of TCE in drinking water or in workplace air have found evidence of increased cancer. The National Toxicology Program has determined that TCE is “reasonably anticipated to be a human carcinogen,” and the International Agency for Research on Cancer (IARC) has determined that trichloroethylene is “probably carcinogenic to humans.”

Thallium. Thallium is a bluish-white metal that is found in trace amounts in the earth's crust. It is used mostly in manufacturing electronic devices, switches, and closures, primarily for the semiconductor industry. It also has limited use in the manufacture of special glass and for certain medical procedures. Thallium enters the environment primarily from coal-burning and smelting, in which it is a trace contaminant of the raw materials. Exposure to thallium may occur through eating food contaminated with thallium, breathing workplace air in industries that use thallium, smoking cigarettes, or contact with contaminated soils, water or air.

Exposure to high levels of thallium can result in harmful health effects. A study on workers exposed on the job over several years reported nervous system effects, such as numbness of fingers and toes, from breathing thallium. Studies in people who ingested large amounts of thallium over a short time have reported vomiting, diarrhea, temporary hair loss, and effects on the nervous system, lungs, heart, liver, and kidneys. High exposures can cause death. It is not known what the reproductive effects are from breathing or ingesting low levels of thallium over a long time. Studies in rats exposed to high levels of thallium showed adverse reproductive effects, but such effects have not been seen in people. Animal data suggest that the male reproductive system may be susceptible to damage by low levels of thallium.

The DHHS, IARC, and the EPA have not classified thallium as to its human carcinogenicity. No studies are available in people or animals on the carcinogenic effects of breathing, ingesting, or touching thallium.

Vinyl chloride. Vinyl chloride is a colorless gas. It has a mild, sweet odor. It is a manufactured substance that does not occur naturally. It can be formed when other substances such as trichloroethane, trichloroethylene, and tetrachloroethylene are broken down. Vinyl chloride is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products, including pipes, wire and cable coatings, and packaging materials. Vinyl chloride is also known as chloroethene, chloroethylene, and ethylene monochloride.

Liquid vinyl chloride evaporates easily. Vinyl chloride in water or soil evaporates rapidly if it is near the surface. Vinyl chloride in the air breaks down in a few days to other substances, some of which can be harmful. Small amounts of vinyl chloride can dissolve in water. Vinyl chloride is unlikely to build up in plants or animals that you might eat.

People can become exposed by breathing vinyl chloride that has been released from plastics industries, hazardous waste sites, and landfills, breathing vinyl chloride in air or during contact with your skin or eyes in the workplace, and drinking water from contaminated wells.

Breathing high levels of vinyl chloride can cause you to feel dizzy or sleepy. Breathing very high levels can cause you to pass out, and breathing extremely high levels can cause death.

Some people who have breathed vinyl chloride for several years have changes in the structure of their livers. People are more likely to develop these changes if they breathe high levels of vinyl chloride. Some people who work with vinyl chloride have nerve damage and develop immune reactions. The lowest levels that produce liver changes, nerve damage, and immune reaction in people are not known. Some workers exposed to very high levels of vinyl chloride have problems with the blood flow in their hands. Their fingers turn white and hurt when they go into the cold.

The effects of drinking high levels of vinyl chloride are unknown. If you spill vinyl chloride on your skin, it will cause numbness, redness, and blisters.

Animal studies have shown that long-term exposure to vinyl chloride can damage the sperm and testes.

The U.S. Department of Health and Human Services has determined that vinyl chloride is a known carcinogen. Studies in workers who have breathed vinyl chloride over many years showed an increased risk of liver, brain, lung cancer, and some cancers of the blood have also been observed in workers.

It has not been proven that vinyl chloride causes birth defects in humans, but studies in animals suggest that vinyl chloride might affect growth and development. Animal studies also suggest that infants and young children might be more susceptible than adults to vinyl chloride-induced cancer.

Zinc. Zinc is a naturally occurring element. Zinc has many commercial uses as coatings to prevent rust, in dry cell batteries, and mixed with other metals to make alloys like brass, and bronze. Acute health effects associated with ingesting large doses are stomach cramps, nausea, and vomiting. Low level chronic exposures to zinc can cause anemia and decrease the levels of good cholesterol. Effect of zinc on human reproductive system is unknown; infertility was observed in animal studies at large doses,

Inhaling large amounts of zinc (as dusts or fumes) can cause a specific short-term disease called metal fume fever. Chronic effects of breathing high levels of zinc are unknown. Zinc can cause skin irritation. The DHHS and the IARC have not classified zinc for carcinogenicity. Based on incomplete information from human and animal studies, the EPA has determined that zinc is not classifiable as to its human carcinogenicity.

Appendix D

ATSDR Glossary of Terms

ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-422-ATSDR (1-888-422-8737).
The glossary can be accessed online at http://www.atsdr.cdc.gov/glossary.html

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
Office of Policy and External Affairs
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, N.E. (MS E-60)
Atlanta, GA 30333
Telephone: (404) 498-0080

Appendix E

Response to Public Comments

Response to Public Comments
Former Penick Corporation/Penco of Lyndhurst Facility
Bergen County, New Jersey
May 2014

The New Jersey Department of Health (NJDOH) and the Agency for Toxic Substances and Disease Registry (ATSDR) had received public comments regarding the Draft Public Health Assessment for the Former Penick Corporation/Penco of Lyndhurst Facility in October 2012.

Comment	Comments/Responses
1	**Comment:** Why weren't former residents of Lyndhurst included in the SIR study? My sister was one of those residents who grew up in Lyndhurst, but lived out of state when diagnosed. She and several others from the list of 19 [now 20…] are not included. So the percentage of cases the SIR released in 2008 showed 19% of cases younger than 65 would be incorrect if not every person were diagnosed while living in Lyndhurst. **Response:** The protocol for a SIR analysis requires that cases are obtained from the state cancer registry and selected if the individual lived in the area of analysis when the diagnosis occurred. The analysis assumes that people who have moved out of the geographic area compared to those people who moved into the area have the same risk. Because the case counts need to be matched to population counts, it is important for this type of analysis to follow this criterion for case selection. Including past residents diagnosed with cancer in the analysis, would artificially inflate the SIR statistic, because the population would be underestimated. Despite having some limitations, the SIR analysis is the method most often used by the CDC for investigating community cancer concerns and is a valuable tool in showing if a particular geographic area has higher or lower than expected rates of cancer.

Comment	Comments/Responses
2	**Comment:** To take a look at the high incidence of MM and blood cancers in Lyndhurst, couldn't size of town and population be taken into consideration? **Response:** The population of Lyndhurst (obtained by the US Census) was used to calculate the expected number of cases. Additionally, the Lyndhurst population 5 year age groups were used in order to age-adjust the SIR.

Comment	Comments/Responses
3	**Comment:** Since contamination to the soil was still found beyond 100 feet of the site in the 1990's and several years ago when reevaluated, I feel the NJDEP has the responsibility to test soil and air at the sites where all persons diagnosed with MM lived. **Response:** Following the New Jersey Administrative Code (N.J.A.C) 7:26E Technical Requirements for Site Remediation, any type of contamination originating from a site and released to the environment must be addressed to ensure actions taken are protective of public health and safety and of the environment. These requirements include delineation of contaminated media, including soil, to a boundary where contaminants are below the established remedial cleanup criterion. NJDEP oversight of investigation and remedial actions taken at the Penick/Penco site indicate these measures were completed for soil, including off-site contamination at the South Drainage Ditch area described within the PHA. Part of these measures included the removal of contaminated soil (see Table 5a) and the implementation of a deed notice to address remaining areas of contamination on the property. Regarding testing soil and air at sites where persons diagnosed with multiple myeloma resided, there needs to be a basis for the testing. For indoor air to become contaminated due to vapor intrusion there needs to be verification that a source is present. Based on the results of the April 2009 soil gas vapor intrusion investigations conducted by the NJDEP, a soil gas source was not present below the four residences tested which were closest but still outside the groundwater plume from the Penick/Penco site. As the contaminated groundwater plume is under hydraulic control via the groundwater intercept trench and does not extend past New York Avenue, a vapor intrusion source originating from the groundwater plume associated with the Penick/Penco site would not occur in other areas of Lyndhurst. Further, the operation of the groundwater intercept trench by 1982 prevented migration of the groundwater contaminant plume which remained localized to the area below the Penick/Penco site and the area along New York Avenue.

Comment	Comments/Responses
4	**Comment:** I just heard again that someone in one of the well-known oncologist's office treating MM and other blood cancers said they couldn't believe how many people from Lyndhurst have been diagnosed with MM and other cancers. **Response:** The NJDOH has provided an assessment of the incidence of cancer within Lyndhurst, New Jersey through several SIR analyses spanning the period of 1990 through 2005. The criteria and limitations of the SIR assessment method has been discussed in further detail within other comments of this public comment section.

4	Based on the data available for the evaluation period, the SIR assessments have not demonstrated that the incidence of multiple myeloma within the evaluated geographical area of Lyndhurst is statistically elevated.

Comment	Comments/Responses
5	**Comment:** In regards to *Conclusion* 4: *NJDOH conclude that number of all malignant cancers combined and the number of multiple myeloma cancers were not statistically significantly elevated in Lyndhurst in the period 1990-2008.* The Standardized Incidence Ratio (SIR) presented here compares the number of cancer cases diagnosed in residents of Lyndhurst during the referenced years to New Jersey as a whole, taking into account age and population size. As presented, this does not answer the question of whether Lyndhurst residents exposed to *Site-related contamination* had an increased incidence of cancer. The nature of the contamination means that all Lyndhurst residents would not be exposed to the same extent, if at all. If we define our 'exposed' group as all Lyndhurst residents than we are introducing exposure misclassification into the SIR. In epidemiology, exposure misclassification results in an expected bias towards the null and often failure to find a statistically significant association. Similarly, the SIR relies on an inappropriate definition of cases. Due to the latency of cancer, residents who may have been exposed to Site-related contamination in utero, or as children, may no longer be residents of Lyndhurst at the time of diagnosis. This will result in further bias. Both errors can lead us to incorrectly conclude that, *"cancers were not statistically significantly elevated."* The SIR presented does not appropriately address the question of whether Lyndhurst residents exposed to *Site-related contamination* had an increased incidence of cancer. While I recognize that this is an extremely difficult question to answer, as currently stated Conclusion 4 is misleading. Conclusion 4 should state that results of the SIR are inconclusive due to limitations of exposure assessment and identification of cases. **Response:** The SIR analysis is a tool that can tell us if the cancer rate is higher or lower than expected in a geographic area. It cannot tell us if exposures are associated with an increase of cancer.

Comment	Comments/Responses
6	**Comment:** I have several questions regarding the methodology supporting the *Basis for Conclusion* 2 that, *"Contaminants detected in indoor air during the April 2009 investigation are likely present from consumer-related and background ambient air sources, since the chemicals were not detected in soil gas below tested homes."* a) Why were other Site-related COCs such as trichloroethylene (TCE) and perchloroethylene (PCE) not analyzed in the soil gas and indoor air samples? Both TCE and PCE are Site-related carcinogens that can enter homes through the vapor intrusion pathway and should be included in the analytical suite. Also, if these were analyzed and not detected in the soil gas samples I would have more confidence that other VOCs detected in the homes were not Site-related. b) Typically the person conducting indoor air sampling will complete a checklist documenting what potential sources were present and that they were removed. Was this done? What range concentrations might be expected if indoor sources were present? c) I saw no details on sampling methodology in the report. Results of soil gas and indoor air sampling can vary greatly depending on season and also over the course of a day. To be sure we capture these peaks in concentrations it is important to conduct repeated samples over an appropriate time period and to do so at a time when conditions will create a 'stack effect'. d) Similarly, I saw no details on detection limits for soil gas sampling. For example, benzene was reported as not detected. Often this may be indicated by the ‘<’ symbol followed by the method detection limit (MDL). This would be helpful in confirming that the MDL was not higher than the concentration detected in indoor air. In tables 17-23 we see frequent reference to “ND” - meaning “non-detect.” But the “non-detect” level is not given. What is the sensitivity of the tests? This would seem to be essential information missing from the PHA. ND does not necessarily mean zero, but the PHA never tells us what it does mean. The PHA concludes that, “Based on the review of data described above, benzene, 1,3-butadiene…and methylene chloride are considered COCs in indoor air for the evaluated residences “but vapor intrusion is not considered the likely source of these contaminants. **Response:** a) Sub slab soil gas samples were collected by NJDEP to determine whether site-

6	related contaminants posed a threat of vapor intrusion to the four residences under investigation. Soil gas data was used to identify if a vapor intrusion source was located below these structures. Soil gas samples were analyzed for targeted VOCs using US EPA Method TO-15 methods. The data summary for all TO-15 chemicals are provided in Table 25, including both PCE and TCE which were not detected. The compounds detected in soil gas are summarized on page 23 of the PHA. No compounds detected exceeded NJDEP soil gas screening criteria indicating a vapor intrusion source was not present below all four structures investigated. b) The NJDEP completed Indoor Air Survey and Sampling Forms for all four residences sampled documenting potential sources within the sampled structures. The NJDEP found source materials in the form of paints and paint thinners in three of the four residences. The home owners were informed of potential consumer sources and asked to remove these sources prior to NJDEP sampling. Two of the three home owners complied with this request. The third, Residence D, Table 29, did not comply with this request and left paint thinners containing methylene chloride and a gas powered lawn mower in an attached garage. Detections of methylene chloride, benzene and 1,3-butadiene were noted to be the highest detections for this residence compared to the remaining residences investigated. Additionally, this residence was noted to be outside the 100-foot radius buffer of the nearest contaminated groundwater well. These factors combined with the absence of contaminants detected in indoor air and their absence in soil gas indicate that they are likely present from consumer sources. A list of chemicals from background and consumer sources and their corresponding levels in indoor air were provided in the PHA as Appendix B for reference. c) Information provided by the NJDEP indicate the date of sample collection, type of sample (i.e. sub slab soil gas and indoor air with basement and first floor living areas) and analytical method. Sampling methodology detailed within the report indicate samples were collected over a 24 hour period and analyzed for targeted VOCs using US EPA Method TO-15 methods. Soil gas and indoor air samples were collected on April 22 and 23, 2009, respectively. The NJDEP determined additional investigation was not required based on the results of soil gas analytical results which did not indicate a vapor intrusion source was below the four structures sampled. d) Typically we do not include method detection limits within the tables of the PHA as this additional information can make the report more cumbersome for the reader to understand. Additionally, MDLs can vary from sample event to sample event so we try to keep the tables as easy to read as possible. However, your inquiry is important to note and we typically do include the MDL when there is an instance that it exceeds an environmental comparison value. The MDLs for all non-detect chemicals analyzed both in soil gas and indoor air samples were below their respective environmental comparison

6	values. Detected values were provided in the all data tables for comparison to their respective environmental comparison value. For detected values, the MDL does not apply as there is a quantifiable value to compare to the environmental comparison values. Additionally, all data presented within this PHA has passed quality assurance/quality control review by the NJDEP as part of their efforts in overseeing remedial investigations and required remedial actions for this site. As part of this review, all data analysis had undergone review to identify contaminants which have exceeded their site-specific cleanup criteria. Given this information, if any contaminant were to exceed a site-specific cleanup level, the NJDEP would require the contaminant to be remediated from the site.

Comment	Comments/Responses
7	**Comment:** While the SIR report is factually correct, it is faulty in its methodology of determining true cause and effect. The statistics are years behind so it is essentially not helpful in identifying a cancer cluster during the time it is occurring. **Response:** The New Jersey State Cancer Registry (NJSCR) currently has complete data for 2009 and is almost complete for 2010, which is consistent with other state cancer registries and the national cancer databases that the registries contribute data to. In order to use cancer data in any type of analysis, it is essential to have a complete year. Before NJSCR data is released for analysis, it undergoes multiple edit and completeness checks. As of the time of data analysis (2/1/13) 2009 data was the most complete cancer data at the national level. It should be noted that, The American Cancer Society produces cancer rate and count estimates for more recent years, which may lead to the impression that 2009 data used in the current analyses is not up to date.

Comment	Comments/Responses
8	**Comment:** The PHA identifies homes that have been at risk for years, but there is no recommendation for follow-up testing or clean up. One home tested in 2009 shows a slightly increased risk. Why is this risk acceptable? Homes testing in 1989 showed even greater risk; nothing has been done to ensure that these homes are now safe. Some of the control homes were also at increased risk. There is no mention if the homeowners are aware. My first request is that these 17 homes be retested immediately, as well as the high-risk controls. It's not obvious that the homes "closest" to the well are the ones most likely to be contaminated, based on groundwater flows. The choice of a 100-foot distance

8	seems arbitrary. Its use should be explained and defended scientifically, taking into consideration the direction of groundwater flow. The 2009 system of home testing is flawed. The number of homes tested was too small to be considered statistically accurate. The testing was done at only one point in time; individual test results can vary due to many factors. My request to have these homes retested in 2010 was denied. My second request is to retest the same homes in 2009 and to increase the number of homes tested. On pg. 24, the PHA reports toluene and benzene tests from a comparison of 17 study homes vs. 16 "control" homes. The conclusion is that there was "no statistical significant difference" between the two groups of homes. Given the small sample sizes (and the unreported variance of the sample data), what was the minimal difference that could have been detected by this statistical test? Why was the actual data not given as a table in the PHA? Given that (a) the NJDEP has decided to ignore the benzene (and associated poisons) in groundwater, and (b) that vapor intrusion "cannot be ruled out," and (c) that the small sample revealed elevated (though not statistically significant) levels of benzene and toluene in 16 homes studied; and (d) that homes along New York Avenue are not the ones most likely to be affected by contaminants from the site – surely a larger study is warranted, with ongoing monitoring for industrial poisons in homes. **Response:** Site investigation and monitoring remains under the jurisdiction of the NJDEP; therefore, they rely on investigative results to determine which additional actions may be necessary. In order to demonstrate the vapor intrusion is occurring, it is necessary to identify the vapor intrusion pathway. This pathway typically occurs when a shallow groundwater table that is contaminated with volatile organic compounds (VOCs) migrates below a structure or home. Depending on several factors including contaminant levels in groundwater, temperature and vapor pressure of the contaminant, vapors from the VOCs are continually released from the groundwater which can migrate upwards and enter the home through susceptible locations (i.e. cracks in concrete floor, crawl spaces with dirt floors). The method to determine whether vapors are present below a structure or home is by conducting sub-slab soil gas sampling. The NJDEP evaluates vapor intrusion investigation data using a "multiple lines of evidence" approach to determine whether additional investigative sampling or mitigation measures are necessary for the properties evaluated. Data used in this assessment included, but was not limited to, the source of vapors (contaminated groundwater or unsaturated soils), soil gas in the unsaturated zone above the source, and upward to the exposure point at target property (e.g. crawl space area, basement, living space area, etc.). This sequential evaluation of independent lines of evidence provides a logical approach for identifying whether or not subsurface vapor intrusion is likely to be occurring and contributing to unacceptable indoor air quality.

8	Regarding the homes testing in 1989, the PHA report identifies a data gap in that soil gas sampling was not conducted to determine if there was a vapor intrusion source present. Soil gas testing was likely not performed as vapor intrusion investigation was still in its early development and formal guidance was not developed. This is a limitation of the indoor air testing for this investigation event. Therefore, due to the lack of soil gas data to verify a benzene source was present at the time of the 1989 investigations and the presence of consumer products which could have contributed, in whole or in part, to indoor air concentrations, it could not be linked solely to site-related contamination. Sub-slab soil gas testing of the nearby residences in 2009 did not indicate contaminant concentrations exceeded New Jersey State vapor intrusion criteria and that there was no evidence a vapor intrusion source was present below the homes tested (see Table 25). These homes were chosen as they were near or within a 100 foot distance of contaminated groundwater. Based on quarterly groundwater monitoring results, the groundwater contaminant plume is being captured by the groundwater recovery and treatment system and has been effective in preventing the plume from migrating into the residential area (see Figure 7). As depicted in Figures 12a, 12b, 12c and 12d, benzene and toluene concentrations in groundwater have shown a decreasing trend over time with the operation of the groundwater recovery and treatment system. Concentrations of benzene in groundwater for the monitoring wells within a 100 foot radius of residences have been shown to be below the New Jersey State groundwater screening levels for vapor intrusion of 15 µg/L since approximately 2002. Toluene has not exceeded the New Jersey State groundwater screening levels for vapor intrusion of 310,000 µg/L based on compiled groundwater data beginning in 1987. Groundwater flow for this site is under hydraulic influence via the pump and treat system. The 100-foot distance follows NJDEP guidance concerning investigation of vapor intrusion sources which is under their jurisdiction for investigation. These residences were selected by the NJDEP as they are located within 100 feet of a monitoring well in which site-related contaminants have been shown to exceed their respective Generic Vapor Intrusion Screening Levels for Groundwater (GVISLG) prompting requirements for a vapor intrusion assessment to be conducted. Additionally, these wells are in close proximity to the groundwater recovery system which demonstrates through groundwater monitoring data to prevent the migration of the contaminated groundwater plume to the residential area. As stated within the NJDEP Vapor Intrusion Guidance Manual, background indoor air sources exist from several categories including household activities, consumer products, building materials and furnishings, and ambient air pollution. Smoking tobacco products, parking a car in an attached garage, using a kerosene heater, burning scented candles, dry cleaning clothes, mothballs, nail polish remover, rug spot cleaner, floor polish, drain cleaners and petroleum-based products, including gasoline are just a few examples of consumer products and activities that can

8	contribute to impact indoor air quality. The NJDEP Vapor Intrusion Guidance Manual further states that common organic pollutants can be 2 to 5 times higher inside a building compared to levels in the ambient air. Further, as the contaminated groundwater plume does not extend into the residential area, increasing the number of homes to test indoor air and soil gas would only support vapor intrusion is not occurring and, if common indoor air contaminants were detected, such as benzene, this sampling would further support the presence of these contaminants due to background/consumer sources. Unless it can be demonstrated through investigation that a vapor intrusion source is located below homes under investigation, there is no support that benzene detected in indoor air is occurring from vapor intrusion. However, as groundwater remains contaminated, the PHA does support continued monitoring of the contaminated groundwater plume protect residents against any potential future threat of vapor intrusion should groundwater monitoring data indicate contamination is migrating towards the residential area. The statistical analysis performed by the environmental consultant, Dames & Moore, concerning the 1989 indoor air testing was provided in the PHA for reference only. The NJDOH is not making any determination as to whether the results of this testing verify a vapor intrusion issue due to the data gap in soil gas testing. Soil gas sampling was not conducted during this investigation period which would be critical to establish whether or not a vapor intrusion source was present below the tested homes. Additionally, contaminant concentrations between the study homes and the control homes were very similar which makes it difficult to make a determination with any degree of certainty as to whether their presence in indoor air originates from a vapor intrusion source, consumer sources, and/or from ambient sources. Vapor intrusion requires a home to home evaluation. Conditions of homes can differ significantly where one home might allow vapor intrusion to occur more readily than another when there is a vapor intrusion source present below the structure. The best indicator to make any type of definitive conclusion regarding vapor intrusion would be soil gas data to determine whether or not a source was present below the structure at concentrations significant enough to pose a threat of vapor intrusion. Unfortunately, there is no soil gas data for the evaluation performed in 1989 where a more definitive conclusion can be made regarding if a source was located below any of the tested structures. However, it is noted that the isopleth map in Figure 13 indicated the plume boundary in 1987 was at the 1 µg/L level near the intersection of New York Avenue and Lafayette Place which is below the NJDEP's generic vapor intrusion screening level for groundwater for benzene at 15 µg/L. Data concerning indoor air testing conducted in 1989 has been provided in Tables 30 (benzene) and 31 (toluene).

Comment	Comments/Responses
9	**Comment:** The well on Forest Avenue was closed when contaminants of concern (COCs) were found in the water. VOC's such as benzene were found in the well water. I have tried to obtain a copy of this report but have been unsuccessful. The well next to the high school which was contaminated with high levels of benzene and other chemicals, should also be tested to see if it was sealed properly and the contamination cleared, especially since it is so close to our high school. I disagree with the PHA statement (p.15) that since the well [Lyndhurst High School well] lies up gradient from the Penick site, it has not been impacted by Penick. Lyndhurst has many underground springs. Their tributaries ensure that the chemicals can spread in many directions, not just the West-Northwest path described in the report. Please release a copy of the well water report. Please also test homes along Forest Avenue, as some of the contaminants found were similar to those found onsite at Penick. **Response:** During the preparation of the draft Public Health Assessment, the NJDOH had contacted the NJDEP regarding the former Forest Avenue well located on the Lyndhurst High School property. The NJDEP indicated that the only information they have regarding this are the well installation and well abandonment records, and NJDEP personnel determined this well was located over 2,000 feet side gradient to the southwest in relation to the Penick/Penco site, where groundwater flow from the site flows in a west-northwesterly direction away from the Lyndhurst High School. NJDEP concluded the Lyndhurst High School well was not in the path of groundwater flow from the Penick/Penco site and was, therefore, not impacted from site-related contamination. (H. Dudar, NJDEP, personal communication, November 25, 2008). As per NJDEP records, the former Forest Avenue well was installed on August 10, 1966 to a depth of 145 feet and sealed by a licensed well driller on May 23, 1996. The well abandonment report issued by the NJDEP indicates the well was sealed with 2,760 pounds of concrete which follows the prescribed protocol for groundwater well abandonment as per New Jersey state regulations. This PHA is confined to focus on evaluation of the Penick/Penco site and its related contamination; therefore, the well was not included in this assessment as it is not related to the site as per the NJDEP. Groundwater data collected from June 1987 through January 2010 demonstrates that the predominant direction of flow for groundwater is in a west-northwest direction towards the Passaic River. Once the groundwater contaminant plume boundary was defined, monitoring of the plume was done on a periodic basis to check contaminant levels, verify groundwater flow direction, boundary limits of the plume and the effectiveness of the groundwater recovery system. All of this data indicates the groundwater plume remained within the area of the Penick site as shown

9	in Figures 3, 7 and 13 and has not been shown to have migrated to any significant extent from its location near New York Avenue to warrant testing of additional homes. Based on the location of the groundwater plume in early 2010, the NJDEP determined the specific residences that required to be investigated for vapor intrusion during the April 2010 event.

Comment	Comments/Responses
10	**Comment:** The proposed deed notice for the former Penick site restricts the use of the land for non-residential use only. Please approve this deed notice immediately. Since this would prohibit day care centers on the land, please explain how it is safe to allow a day care to operate within 100 feet of the Penick site? What is the cumulative risk to growing children? **Response:** The NJDEP conducted a vapor intrusion investigation of four properties, including the day care center, in April 2009 which were within a 100 foot boundary of a nearest contaminated well associated with the former Penick site. This is a NJDEP regulatory requirement under their vapor intrusion guidance policy. The results of this investigation did not indicate the presence of a vapor intrusion source below this day care center or any of the other properties investigated. As depicted in Figures 12a, 12b, 12c and 12d, benzene and toluene concentrations in groundwater have shown a decreasing trend over time with the operation of the groundwater recovery and treatment system. Concentrations of benzene in groundwater for the monitoring wells within a 100 foot radius of residences have been shown to be below the New Jersey State groundwater screening levels for vapor intrusion of 15 µg/L since approximately 2002. Toluene has not exceeded the New Jersey State groundwater screening levels for vapor intrusion of 310,000 µg/L based on compiled groundwater data beginning in 1987. The day care center located at 157 Lafayette Place near the site is subject to the rules promulgated by the Department of Children and Families, specifically the New Jersey Administrative Code (N.J.A.C.) 10:122-5.2(i); Physical Plant Requirements for All Centers. The New Jersey Department of Health (NJDOH) had reviewed all information pertaining to the investigation and historical use of this day care center and the surrounding area. This included review and evaluation of any nearby contaminated sites and also indoor air sampling results collected by the NJDEP in April 2009. A letter was issued by the NJDOH approving the continued use of this day care facility as there were no exposures that presented an increased risk to either adult employees or to children. This information was provided to the Lyndhurst Township Health Administration in April 2010 upon their request. Although a daycare center may be within 100 feet of a contaminated site, it does not mean that exposures are taking place. Their needs to be an established pathway showing direct contact with site contaminants. A vapor intrusion pathway was not established for the daycare center nor did sub-slab soil gas samples indicate a source was present below this structure.

Comment	Comments/Responses
11	**Comment:** The PHA discusses natural attenuation, but this process allows the chemical to dissipate naturally over time. It is a do nothing approach. I request that the NJDEP and the EPA present an active plan for the clean-up of the Penick site and its benzene plume. **Response:** The oversight of remedial actions of this site falls under the jurisdiction of the NJDEP. Remediation of contamination of groundwater is a slow process that takes time through the use of physical treatment such as pump and treat and in-situ (in-place) treatment through the use of chemical and biological treatment methodologies which were and are currently used for the toluene groundwater plume. Once contaminants in the groundwater have been sufficiently reduced to levels that are near the state cleanup criterion, the final stage of cleanup is typically natural attenuation. As depicted in Figure 12c, the seven wells closest to the residential properties along New York Avenue have shown a consistent trend in benzene levels in groundwater to be non-detect to approximately 5 µg/L, well below the New Jersey State groundwater screening levels for vapor intrusion of 15 µg/L for benzene. As groundwater in the upper aquifer is not used for drinking water purposes and there is no threat of vapor intrusion based on the location of the groundwater plume and benzene contaminant levels, the NJDEP has approved natural attenuation as this plume should dissipate in a relatively short time frame. As site investigations have confirmed there is no exposure pathway evident from this groundwater plume, the appropriate plan of action is to allow the NJDEP to continue oversight and monitoring of the plume to ensure the safety of the nearby residents from any future potential of vapor intrusion. Additionally, concerning both groundwater and soil contamination at the former Penick site, the NJDEP has overseen a tremendous amount of remedial efforts to remove contamination to the extent where potential exposure pathways no longer present a threat to the surrounding community.

Comment	Comments/Responses
12	**Comment:** The risk of exposure to some of these chemicals is discussed in the PHA. However, the cumulative risk of exposure to multi-chemicals is not. What are the cumulative risks of exposures to all of these chemicals? There is no acknowledgement of the limitations of the analyses in the PHA. For example, the sensitivity of tests (the level below which there is a “non-detect”) is almost never stated; scientific ignorance and uncertainty about the combined effects of multiple contaminants are never mentioned; the small sample sizes are never commented upon; the power of any particular statistical test to discern a difference is never discussed; the size of the difference that is statistically discernible (given sample

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variance and sample size) is never mentioned.

Contaminants from the site may not by themselves be causing exposures that exceed predetermined safety thresholds, but contaminants from the site may be contributing to total exposures from the site and from other sources that, taken together, can cause adverse health effects in people.

Response:

While it is acknowledged that operations at the former Penick/Penco of Lyndhurst facility used a wide variety of chemicals, include those aforementioned in the above comment, exposures to those chemicals requires that an exposure pathway be completed. As operations were maintained within the confines of the facility property, it is difficult to determine if and to what extend the surrounding community may have been exposed in the past. In examining the investigation data provided by the NJDEP, contaminated soils found within the facilities property was not accessible to area residents as the property boundary was fenced to prevent unauthorized access which would negate exposures to area residents for the exposure pathway concerning contamination on the site property. There was also little evidence that the area of the south drainage ditch was frequently accessed, if at all, based on its location and condition of the area and, therefore, would have posed little to no exposure hazard.

In many instances the question of site-related exposure is difficult and complex to answer as there are many contaminants present in our everyday lives through lifestyle habits (such as smoking), consumer product use, automobile and gas station emissions, and by surrounding industry that contribute to our overall exposure. The focus of the PHA was to determine the extent the former Penick/Penco of Lyndhurst site may have posed a health risk to area residents. The cumulative risks from potential exposures have been determined on a case by case basis for indoor air investigations for each of the homes where sampling was conducted. Concerning completed exposure pathways, for soil exposures at the south drainage ditch area and for inhalation exposures for contaminants detected in indoor air, the cumulative risks were determined and presented in Tables 37 through 39. These completed exposure pathways were determined by the NJDOH based on the historical investigation data obtained from the NJDEP.

Environmental screening guidelines were created to determine whether remedial action is required and whether the contaminant levels could pose a health risk and require additional evaluation. These guidelines have been provided within the data tables of the PHA to illustrate to the reader which chemicals are contaminants of concern based on average and maximum concentrations in the environmental media.

We agree that health effects may occur when individuals are exposed to several sources which, collectively, contribute to a total exposure. However, the objective of our PHA is to determine whether individuals were being exposed to site-related contaminants which may pose the risk of deleterious health effects. It is a

12	difficult proposition to attempt to determine with any degree of certainty the total exposure in an individual or especially a population can be accounted by feasible means for exposures from background, lifestyle, occupation and dietary sources outside of site-related exposures. The language stated within the PHA reflect that it cannot account for other exposures such as those which may occur from lifestyle, occupation or dietary choices. These types of exposures not related to the site which can attribute to any particular adverse health effect(s) cannot feasibly be captured in a health assessment. The objective of this assessment was to determine whether site-related contaminants potentially or actually contributed to past exposures and, if the site contaminants remain, do they continue to pose an exposure pathway, the severity of these exposures, and the potential risk for adverse health effects to develop from those exposures. ATSDR's Guidance Manual for the Assessment of Joint Action of Chemical Mixtures states "Research on the toxicity of mixtures indicates that adverse health effects are unlikely when the mixture components are present at levels below their individual toxicological thresholds." This type of assessment would be performed when the "environmentally relevant doses of chemicals" are present to warrant further assessment. The information provided in Appendix B offers information on general indoor air quality which have been observed during various indoor air investigations which are part of background sources, whether consumer and/or ambient air related. The purpose of providing this information is to illustrate to the reader that other sources do exist; however, they are part of our environment, some of which are difficult, if not impossible to avoid exposure, such as emissions from automobile exhaust.

Comment	Comments/Responses
13	**Comment:** Lyndhurst's Precautionary Principle states, "When an activity raises threats of harm to human health or the environment, precautionary measure should be taken even if some cause and effect relationships are not fully established scientifically." The methodology and the statistics of the PHA do not show the full picture. The purpose of a PHA is to investigate, evaluate, and recommend a plan of action. The PHA recommends ongoing monitoring but no action. Not all the contaminants on the site have been adequately identified and their amounts measured. **Response:** In preparing the PHA, all available site information provided by the NJDEP was reviewed and evaluated which included past and current actions by the NJDEP to prevent exposures to the surrounding community. These actions included removal of direct contact soil horizons throughout the site, bioremedial/groundwater recovery measures to address the groundwater contaminant plume, an action plan in the form of

13	the deed notice to address remaining soil contaminants with engineering controls, and investigation and evaluation of soil gas and indoor air sampling to determine threats to nearby residents. All of these actions were completed in the interests of remediating the site and enabling productive future use of the land and protecting the surrounding community from potential exposures to contaminants from the former Penick site. Had any of these actions not taken place, the PHA would have recommended actions to address site contamination which posed a potential or completed exposure pathway to the surrounding community. As it stands to date, all appropriate actions have been and are currently taking place to protect the community. The groundwater concentrations of the two major contaminants, benzene and toluene have decreased significantly over time and, coupled with the plume location being controlled to the area of the groundwater recovery system, the potential threat of vapor intrusion to nearby residents does not exist based on investigation data. All of these measures should be viewed as significant actions which have helped reduce site contamination to levels and prevent exposures to remaining site contaminants which enable the property to be utilized for commercial purposes.

Comment	Comments/Responses
14	**Comment:** “Safe” (or “reference”) doses for some of the industrial poisons on the site do not exist. Good data on toxicity and human health effects are missing for some contaminants that are known to exist at the site. **Response:** Screening guidelines do exist for many environmental chemicals and are identified in the PHA. The NJDOH acknowledges that some chemical compounds do not have an environmental screening guideline to be used for comparison. In these cases we rely on other standards such as the NJDEP’s groundwater or soil quality standards. Compounds which do not have screening or health-based values may not have sufficient toxicological information to characterize effects from exposures to these compounds. All relevant data on chemical toxicity and human health effects is discussed within the document if contaminants were determined to be within an exposure pathway and have accurate toxicological data where health effects can be determined. It is unclear what compounds the requestor is referring to when stating “good data on toxicity and human health effects are missing for some contaminants that are known to exist at the site.” These chemicals may exist at the site, however, they will not be evaluated if they are not present within the exposure pathway or have sufficient toxicological data to support the assessment in terms of the health risks they may pose.

Comment	Comments/Responses
15	**Comment:** Pg. 17 says, “Based on maximum concentrations, the following contaminants were detected above their respective environmental CVs [comparison values]:” The PHA concludes that, based on these data, the contaminants identified are considered COCs [contaminants of concern] in groundwater for the overburden [uppermost] aquifer. On page 25, we learn that this uppermost aquifer is contaminated with a shorter list of contaminants. It is unclear how the list of COCs on pg. 25 [shorter list] meshes with the [longer] list given on pg. 17. **Response:** The list of COCs on page 17 represents all COCs within the uppermost aquifer for the entire uppermost aquifer area under investigation. The list of COCs on page 25 represent the COCs detected in the upper aquifer within a 100 foot radius of residences under investigation for vapor intrusion, which has shown to be a shorter list than that of the entire upper aquifer investigated. This was presented to illustrate to the reader the COC likely to pose a risk of vapor intrusion to those residences within this 100 foot radius of sampled groundwater wells. The main COCs within this 100 foot radius area are benzene and toluene as presented in Table 32.

Comment	Comments/Responses
16	**Comment:** Tables 17-23 also refer to “average” levels of contamination in the samples. Is this average a mean value? If so, what numerical value was used for the “ND” samples in calculating each mean value? Zero? Some other value? **Response:** In calculating the average level of a contaminant, the method detection limit is used as a value when the contaminant is non-detect.

Comment	Comments/Responses
17	**Comment:** We are told on PHA pgs. 14 and 15 that groundwater in both the uppermost aquifer and in the bedrock aquifer is flowing west-northwest. A flow west-northwest from the site would intersect a point on Riverside Avenue midway between Fern Avenue and Valley Brook Avenue. It is not at all clear that homes along New York Avenue would be the most likely ones to be affected most heavily by contaminated groundwater flows. Since the PHA states that groundwater from the Penick site runs West-Northwest, I request that multiple homes along this path be tested. This would provide improved statistics.

17

Response:

Groundwater flow for this site is under hydraulic influence via the pump and treat system as depicted in Figures 3 and 7 within the PHA. A recent 2011 Permit-By Rule Application for the site concerning the pump and treat system by Langan Engineering and Environmental Services states the following, "Groundwater in this unit is unconfined and, where it not influenced by the existing interceptor trenches or by the small drainage ditch located to the south of the site, flows in a west-northwesterly direction. With the intercept trench pumps operational, the groundwater flow is controlled to the area of the intercept recovery trenches within the site and along New York Avenue since its operational period beginning in 1982. Based on recent groundwater sampling analytical results, the recovery trench system continues to control the migration of the toluene plume in the alluvial and till aquifers, as shown by the absence of toluene in the samples collected from the wells located downgradient of the recovery trench system (i.e. MW-23 and TMW-6)." The uppermost aquifer within the alluvium represented in Figures 3 and 7 is the aquifer of concern regarding the potential for vapor intrusion.

In review of the groundwater contour map, Figure 3, the groundwater contours show groundwater flow towards the intersection of New York Avenue and Lafayette Place. This groundwater contour map best represents the actual path of groundwater flow based on groundwater levels measured at the site. Additionally, site contaminants in groundwater have been shown to be located closer to the northern area of the site near New York Avenue and do not extend toward Delafield Avenue as shown in the historical groundwater plume map in Figure 13 and more recently in Figure 3. The isopleth lines on Figure 7 depict the concentrations in groundwater for the benzene and toluene contaminant plumes. These maps clearly show which wells remain above state groundwater cleanup criteria and also depict surrounding groundwater wells which contaminant levels are below state cleanup criteria. These plumes are now very localized and contained within the site boundaries.

Additionally, historic sampling of monitoring wells MW-17 through MW-20 all located along the western portion of the property near Delafield Avenue (see Figure 13) for the 9 year period between 1987 to 1996 have shown the following:

- Benzene was detected in 1 out of 31 samples at a concentration of 0.4 µg/L, below its NJDEP groundwater quality criteria of 1 µg/L;
- Toluene was detected in 7 out of 31 samples at a range of 0.9 µg/L to 3.5 µg/L (estimated), below its NJDEP groundwater quality criteria of 1,000 µg/L;
- Methylene chloride was detected in 1987 in one sample at 5.12 µg/L, above its NJDEP groundwater quality criteria of 3 µg/L with the remaining 9 years of samples showing non-detect; and,
- All remaining VOCs sampled being below NJDEP groundwater quality criteria for these four wells.

This is strong evidence that the groundwater plume did not extend to the western portion of the site at levels exceeding NJDEP's generic vapor intrusion

17	screening level for groundwater. Therefore, the NJDEP's choice in residence selection for their soil gas and vapor intrusion assessment conducted in April 2009 was appropriate as these homes were the closest to contaminated wells and in the pathway of groundwater influenced by the groundwater recovery system.

Comment	Comments/Responses
18	**Comment:** The PHA does report some calculations based on the 1989 sampling data. For example, we learn that "The average concentrations in ambient air were consistent between the study homes area and the control home area for benzene (3.6 µg/m^3 vs 2.7 µg/m^3) and for toluene (18.3 µg/m^3 vs 13.3 µg/m^3). [It is not clear what "consistent" means in this context.] The reported differences may not be 'statistically significant" but we can see that the average benzene levels in the "study area homes" were 33% higher than in the "control home area" (3.6 µg/m^3 vs 2.7 µg/m^3) and the toluene levels in the "study are homes" were 37% higher than in the "control home area" (18.3 µg/m^3 vs 13.3 µg/m^3). Surely these increases are noteworthy and should provoke additional sampling and analysis. **Response:** The wording "consistent" in this context means that at the concentrations were very similar among ambient, study area and control home air samples. Additionally, these compounds are well within the ranges typically observed in background concentrations as provided as Appendix B.

Comment	Comments/Responses
19	**Comment:** As the PHA says, "…contributions from vapor intrusion cannot be ruled out." And: "Therefore, based on the review of data described above, benzene is considered a COC in indoor air for 16 of the 17 evaluated residences in proximity to the former Penick/Penco site." My comment: why was toluene not deemed a COC. **Response:** All toluene levels were below the lowest environmental screening value which is the ATSDR's Environmental Media Evaluation Guideline of 300 µg/m^3; therefore, additional evaluation was not required.

Comment	Comments/Responses
20	**Comment:** The discussion of expected health effects (pgs. 28-47) reaches many conclusions that are quite possibly misleading. This whole section calculates health effects that might result from exposure to one source or another from the contaminated site – ignoring exposures that might be occurring simultaneously from other of-site

20	sources. First of all, 10 µg/dL is no longer the official "level of concern" for poisoning by toxic lead. In May 2010, the Centers for Disease Control and Prevention changed the 10 µg/dL "level of concern" to a 5 µg/dL "referenced value," acknowledging as it did so that even 5 µg/dL is not adequate to prevent adverse health effects in lead-exposed children. So the PHA has asked and answered the wrong question, and it has used an outdated health criterion (10 µg/dL). The proper public health question is not, "Did exposure to toxic lead in soil cause toxic lead levels in children to rise to 10 µg/dL (or even 5 µg/dL)?" The proper question is, "Did exposure to lead in contaminated soil at the Penick/Penco site cause blood levels in exposed children to rose to even 2 µg/dL?" **Response:** The period of drafting this PHA and the time required for department review predated the May 2010 CDC update to the new reference level at 5 µg/dL. The PHA has been revised to reflect the CDC's current reference level of 5 µg/dL.

Comment	Comments/Responses
21	**Comment:** What is NJDEP intending to do about groundwater contamination at the site? What is to prevent vapors associated with this poisonous groundwater plume from infiltrating into commercial buildings on the site and into commercial buildings and homes off-site…? **Response:** Natural attenuation has been approved by the NJDEP to address the benzene groundwater plume. The concentrations of benzene and toluene in the groundwater plume has been significantly decreased through the implementation of on-site remedial measures, specifically the groundwater recovery system in operation since October 1982 and bioremediation measures initiated in March 2000. The significant decrease in these contaminant concentrations has been provided in Figures 7 and 12 (a through d). Groundwater wells located closest to homes along New York Avenue have shown that benzene has not exceeded the NJDEP's generic vapor intrusion screening level for groundwater (GVISLG) at 15 µg/L since 2002 and toluene has never exceeded the NJDEP's GVISLG. Based on this current information, as long as remedial actions remain effective, vapor intrusion occurring to area homes is not likely to occur. Concerning the commercial properties at the site, the implementation of the above remedial systems in conjunction with the engineering controls under the deed notice at the site are considered appropriate measures to be protective and prevent the occurrence of vapor intrusion from occurring to these properties. Our recommendations to the NJDEP are outlined within the Recommendations section of the PHA and include the following pertaining to addressing groundwater:

21	1. The NJDEP should continue remedial investigations and monitoring of contaminant levels regarding the existing toluene and benzene groundwater plumes to ensure contaminant levels do not pose a risk through vapor intrusion to nearby residents or to employees and consumers who frequent the shopping center located at the former Penick/Penco site. 2. The NJDEP should continue monitoring the operation and effectiveness of the groundwater remediation system to ensure the contaminated groundwater plume is under hydraulic control and not migrating towards nearby residential areas.

Comment	Comments/Responses
22	**Comment:** What is NJDEP planning to do about the elevated levels of industrial poisons in soils on the site? How can anyone develop confidence that words in a “deed restriction” will actually prevent people in the future from being exposed to the witches’ brew of industrial poisons present in soils and groundwater at the site? Why does the PHA not comment on the public health aspects of “natural attenuation” as a “remedy” for groundwater contamination, and of a “deed restriction” as a “remedy” for serious soil contamination? How will the public be protected from this witches’ brew of industrial poisons? **Response:** As stated within the PHA, under the deed notice exposure to surface soils within the site boundary are considered eliminated as the property is covered with an asphalt/concrete cap. This cap is an approved NJDEP remedial action to prevent exposure to remaining contaminants in underlying soil within the concentration criteria outlined in the deed notice. Under the conditions of the deed notice, future site use will be restricted to non-residential use. The deed notice encompasses the entire site property consisting of Block 79, Lots 1 and 2 and Block 73, Lots 1 and 3 as depicted in Figure 5 of the PHA. A deed notice is required when the Department approves a remedial action which allows soil contamination to remain at a site above the unrestricted use soil remediation standards. The deed notice is considered to be protective to public health as the asphalt and concrete cap present an impermeable barrier which prevents people who are on the property from contacting underlying soil contaminants. This type of barrier has been an approved engineering control approved under the NJDEP’s deed notice regulations and has been used as an effective remediation measure at many sites within New Jersey. Therefore, the exposure pathway is considered eliminated. As part of the deed notice requirements, this cap must be maintained indefinitely or the

22	contaminated soil would be required to be removed. All deed notices require biennial recertification (every two years) that engineering and institutional controls are being maintained at the site. Our recommendations concerning remaining site soils are provided within the PHA as follows: 1. The NJDEP should continue to oversee the remediation of all contamination on or emanating from the Penick/Penco site. Additionally, the NJDEP should continue to monitor the effectiveness of all engineering controls associated with the deed notice for the site to ensure that residual contaminants below the protective cap do not pose an exposure risk to residents, employees, or consumers who frequent the shopping center located at the former Penick/Penco site. Regarding natural attenuation as the approved remedial measure at the site, groundwater concentrations of both benzene and toluene have been significantly decreased through groundwater remediation efforts for the past several decades. A recent 2011 Permit-By Rule Application by Langan Engineering and Environmental Services describes groundwater within the upper aquifer as follows “Groundwater within the alluvium has no known use, and the only receptors known are the site’s recovery trenches.” Regarding the underlying till aquifer, the 2011 Permit-By Rule Application further states “Because the hydraulic conductivity is so low. The groundwater within the till is unusable. In addition, no receptors of this groundwater are known or expected.” Regarding the bedrock aquifer below the alluvium and till aquifers, this 2011 Permit-By Rule Application further states “Based on a New Jersey Geological Survey well search and information provided by the NJDEP Bureau of Water Allocation, no potable water supply wells currently exist within a one mile radius of the site. As groundwater at the site is not used as a source for drinking water, the only remaining potential exposure pathway at the site would be for vapor intrusion from contaminated groundwater. This pathway is considered interrupted as 1) the groundwater plumes do not extend into the residential area to pose a source for vapor intrusion as evidenced both in groundwater monitoring data and with NJDEP’s soil gas evaluation conducted in April 2009 (see Table 25 and Figure 7).