Public Health Assessment for

CEDAR BROOK AREA GROUNDWATER CONTAMINATION
WINSLOW TOWNSHIP, CAMDEN COUNTY, NEW JERSEY

JULY 7, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

PUBLIC HEALTH ASSESSMENT

CEDAR BROOK AREA GROUNDWATER CONTAMINATION

WINSLOW TOWNSHIP, CAMDEN COUNTY, NEW JERSEY

Prepared by:

New Jersey Department of Health and Senior Services
Public Health Protection and Emergency Preparedness
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary

Cedar Brook is a rural area of Winslow Township, Camden County, New Jersey. The area includes agricultural land, single family residences, commercial businesses and some industry. In 1999, groundwater contamination was discovered in the Cedar Brook area and was reported to the Camden County Department of Health and Human Services. Residents living in and/or near the Cedar Brook area discussed health concerns regarding this contamination with the New Jersey Department of Health and Senior Services at an Availability Session on June 28, 2001. The private potable wells located in the Cedar Brook area were tested by the New Jersey Department of Environmental Protection and the Camden County Department of Health and Human Services. Results indicated the presence of volatile organic compounds, metals, and nitrate.

The New Jersey Department of Health and Senior Services, through a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry, conducted a multichemical, multipathway (ingestion and inhalation) exposure assessment for the Cedar Brook area and evaluated health implications of the contaminants from domestic water use. Ingestion exposure doses were calculated based upon maximum and average contaminant concentrations and compared with health comparison values. Inhalation exposures to volatile organic compounds during showering were evaluated. Generally, the risks associated with inhalation exposure from residential use of contaminated water were greater than those of ingestion.

Contaminants of concern included trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, other volatile organic compounds, mercury, thallium, lead and nitrate. Past exposures to contaminants posed a ***Public Health Hazard*** from domestic water use via the ingestion and inhalation pathways. Exposure doses calculated for trichloroethylene, mercury, thallium, lead and nitrate exceeded health-based comparison values and warranted further review of available toxicological data. There was a potential for adverse non-cancer health effects from past exposures to trichloroethylene, lead and nitrate; non-cancer adverse health effects were unlikely for mercury and thallium. Based on the average and maximum contaminant concentrations detected in the Cedar Brook area wells, past exposure to trichloroethylene posed a moderate to high increased cancer risk; exposures to tetrachloroethylene and 1,2-dichloroethane posed a low to moderate increase in cancer risk.

Point of Entry Treatment systems were installed at residences with confirmed volatile organic compounds and mercury contamination above primary drinking water standards. There is currently ***No Apparent Public Health Hazard*** from volatile organic compounds and mercury associated with household water use at these residences. This assessment is contingent upon the proper operation and maintenance of the treatment systems.

Treatment systems were not provided for the removal of lead or nitrate, and exposures to these substances may be continuing at levels of concern. In two wells, lead was found to exceed the federal and state lead Action Level. Health effects from lead exposures do not have a known threshold and thus may occur in children and developing fetuses at low levels of exposure. Lead

exposure may occur from many sources, including lead paint and drinking water. The source of lead in drinking water may be associated with household plumbing rather than groundwater. Five wells had nitrate levels above the New Jersey Maximum Contaminant Level of 10 mg/L. Elevated levels of nitrate are associated with methemoglobinemia, a serious condition in infants. Typical sources of nitrates in well water include faulty household septic systems, nearby farms, home fertilizer use and municipal landfills. As such, current exposures to lead and nitrate pose a ***Public Health Hazard.***

Exposure from the vapor intrusion pathway could not be evaluated due to the lack of soil gas and/or indoor air data. Therefore, past, present, and future exposures to groundwater contaminants through this pathway remain an ***Indeterminate Public Health Hazard.***

Recommendations for the Cedar Brook area include the collection of soil gas data and providing area residents with a safe public water supply system. Health effects associated with lead and nitrate should be communicated to residents and appropriate treatment options recommended.

Statement of Issues

Under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), the New Jersey Department of Health and Senior Services (NJDHSS) conducted a site visit at the Lightman Drum Superfund site in Winslow Township, Camden County in April 2000. During the site visit, the NJDHSS became aware of community concerns regarding a nearby groundwater contamination problem in the Cedar Brook area of Winslow Township. Residents living in and/or near the Cedar Brook area discussed their concerns with the NJDHSS at an Availability Session conducted by the NJDHSS in June 2001. Residents at this meeting voiced concern about the quality of their private well water and possible health effects from contaminants detected in the water. The purpose of this health assessment is to evaluate the public health implications of the contamination found in private wells in the Cedar Brook area.

Background and History

Cedar Brook is a rural area of Winslow Township, Camden County, New Jersey (see Figure 1). The area includes agricultural land, single family residences, commercial businesses, and some industry.

Figure 1: Location of Cedar Brook Area

Residential private well contamination in the vicinity of Route 73 and Waterford Road in Winslow Township, Camden County was discovered in 1999 and reported to the Camden County Department of Health and Human Services (CCDHHS). Sampling results indicated the presence of volatile organic compounds (VOCs) including elevated levels of trichloroethylene (TCE) and tetrachloroethylene (also known as perchloroethylene, or PCE) and metals. Since January 2000, 241 private potable well tests have been conducted in this area for VOCs, metals and several inorganic compounds by the New Jersey Department of Environmental Protection (NJDEP) and the CCDHHS to determine the level and extent of the contamination. Based on the sampling results compiled by the NJDEP and the CCDHHS, the currently known contaminated area is shown in Figure 2.

The New Jersey Spill Fund Program administered by the NJDEP enabled the immediate provision of Point of Entry Treatment (POET) systems for properties with confirmed well water contamination above the state or federal drinking water standards (Maximum Contaminant Levels or MCLs). Depending on the nature of contamination, the wells required a Granular

Activated Carbon (GAC) unit for VOCs, a kinetic degradation fluxion (KDF) unit for mercury, or both. However, GAC and KDF units do not remove lead, thallium or nitrate. Under expected operating conditions, the treatment systems remove VOCs and mercury in water to levels that are in compliance with drinking water standards. Annual maintenance begins with the collection of one raw and three treated water samples from each affected residence. If sample results indicate contamination breakthrough, appropriate measures are taken. The NJDEP has recommended that the existing Winslow Township public water supply lines be extended to homes in the Cedar Brook area, followed by the sealing of contaminated wells. It should be noted that there are uncontaminated wells located adjacent to contaminated wells.

There are several potential sources of groundwater contamination in the vicinity of the Cedar Brook area. The source(s) of contamination are currently being investigated. As part of an effort to identify contributing source(s) of area groundwater contamination, the NJDEP retained L. Robert Kimball and Associates, Inc. to perform a Preliminary Site Assessment (NJDEP 2002). Known contaminated sites as well as suspect properties located within a one-mile radius of the Cedar Brook study area were evaluated and categorized as to their potential as a source of area groundwater contamination.

Eleven properties located in the immediate vicinity of the Cedar Brook study area were identified as potential contamination sources. Based upon the anticipated likelihood of their contributing VOCs to area groundwater, these properties were further categorized as exhibiting high, medium, or low contamination potential. Properties categorized as high or medium are listed below:

Property Name	**Potential Contamination Category**	**Type of Operation**
former Lightman Drum and Chemical Company	high	drum recycling operation
I & B Builders	medium	general contractor/construction company
Texaco Service Station	medium	gasoline and oil service station
SAR Industrial Finishing, Inc.	medium	painting business

Source: NJDEP (2002)

The only property categorized as a high potential contamination source was the former Lightman Drum and Chemical Company (Lightman Drum). From 1974 through the mid to late 1980's, Lightman Drum operated an industrial waste hauling and drum reclamation business. Drums containing paints, thinners, solvents, coatings, waste oil, pesticides, adhesives, and acids were emptied either directly on the ground or into an on-site, unlined waste pit. Residues were stored on-site prior to final disposal. Throughout its years of operation, Lightman Drum was cited by the NJDEP for numerous environmental violations. The site was added to the National Priorities List (a.k.a. Superfund) on October 22, 1999. The Lightman Drum site is currently an active drum brokerage facility, selling used and reconditioned drums (ATSDR 2001).

Site Visit

On April 11, 2000, Sharon Kubiak, James Pasqualo, Stella Tsai and Jeffrey Winegar of the NJDHSS visited the Cedar Brook area. NJDHSS staff were accompanied by Christian Agnew of the ATSDR Regional Office. A representative of the CCDHHS was also present during the site visit.

Community Health Concerns

On April 26, 2001, a NJDHSS Availability Session was held at the Winslow Township Municipal Building. Several local government officials attended the session to discuss contamination of residential private wells.

The NJDHSS held a second Availability Session with residents of the Cedar Brook area on June 28, 2001. A representative of the CCDHHS was also present. In response to community requests, the NJDHSS agreed to prepare a Public Health Assessment (PHA) to address the health implications of the contaminants found in area private wells.

Past ATSDR or NJDHSS Activities

In cooperation with the ATSDR, a site visit and two Availability Sessions were conducted by the NJDHSS for the Cedar Brook area.

Environmental Contamination

Extent of Groundwater Contamination

The Cedar Brook area is located in the Atlantic Coastal Plain and is underlain by the Cohansey-Kirkwood aquifer system. The Cohansey-Kirkwood system is a water table aquifer that dips eastward toward the Atlantic Ocean. In the vicinity of the Cedar Brook area, the aquifer thickness is about 200 to 250 feet (NJDEP 2002). Groundwater flow in the area is believed to be from west to east following the topography and surface water flow pattern. The Pump Branch and the Great Egg Harbor River flow southwest through the Cedar Brook area.

Review of available well records maintained by the NJDEP Bureau of Water Allocation indicate that many of the private wells within the Cedar Brook area were installed during the late 1970s through the mid 1990s (NJDEP 2002). Well records also show that the well depths range from 50 to 100 feet below ground surface, with an average depth of approximately 80 feet.

The extent of the contaminated groundwater plume has expanded from that initially characterized in 1999. The contaminated area, as shown in Figure 2, was defined by the NJDEP based on analytical results of groundwater samples collected from area private wells. The contamination was determined to be located north of Waterford/Pump Branch Road, west of Route 73, south of the relocated Cedar Brook Road loop, and west of Breckinridge Drive (NJDEP 2002). Mercury contamination was limited to the area where Railroad Avenue and Cedar Brook Road intersect (see Figure 3). Based on year 2000 United States Census data, approximately 4,000 individuals reside within a one-mile radius of the contaminated area (see Figure 4).

Between 1999 and 2000, the NJDEP, CCDHHS and/or their contractors conducted 239 tests of private potable wells located in the Cedar Brook area for VOCs, metals and inorganics. Of these, 102 samples were found to contain no detectable levels of contaminants, while 137 (57%) had detectable concentrations of contaminants. Table 1 provides a list of the detected contaminants in private potable wells, their frequency of detection, and maximum, mean, and median concentration. TCE, PCE, mercury and 1,2-dichloroethane (1,2-DCA) were the most frequently detected contaminants in the Cedar Brook area wells. The concentrations of TCE, PCE, mercury and 1,2-DCA (in descending order of magnitude) are also shown in Figure 5. In comparison, the frequency of detection of other contaminants in the wells was low.

Since August 2003, two additional wells located on Pump Branch Road were tested and identified as being contaminated with VOCs (TCE and 1,2-DCA).

Maximum concentrations of contaminants were compared to environmental and health-based comparison values (CVs) (ATSDR 2002). CVs are concentrations below which adverse health effects are not expected to occur. Exceedence of a CV does not mean that health effects are expected to occur, since actual exposure levels depend on site-specific conditions, and since CVs are derived using conservative (protective) assumptions. If contaminant concentrations are above environmental CVs, further analyses of potential exposure and health risk are conducted.

Environmental Guideline Comparison

In the Cedar Brook area, the major past use of well water was domestic, therefore federal and New Jersey Maximum Contaminant Levels (MCLs) were selected as the primary CVs. The maximum concentration of each contaminant detected, along with federal and New Jersey MCLs, are presented in Table 2 for comparison purposes. Where the MCL is unavailable, Environmental Media Evaluation Guide (EMEG), Reference Dose Media Evaluation Guide (RMEG) or Region 3 Risk Based Concentrations (RBCs) was used. EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. ATSDR derives RMEGs from USEPA's oral reference doses, which are developed based on USEPA toxicological evaluations. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. The RBCs are chemical concentrations corresponding to a fixed level of risk (i.e., a Hazard Index of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower concentration) in water, air, biota, and soil.

The maximum groundwater concentrations of acetone, cis-1,2-dichloroethylene, methyl chloride, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, aluminum and manganese were less than the corresponding CVs, and as such, are unlikely to cause adverse health effects. Federal and state primary drinking water regulations require that the total concentration of trihalomethanes (a.k.a. disinfection byproducts which include bromodichloromethane and chloroform) be less than 80 micrograms per liter (μg/L, or parts per billion, ppb). The sum of the maximum concentrations of bromodichloromethane and chloroform detected in the Cedar Brook area groundwater was 10.5 ppb, which is about an order of magnitude lower than the New Jersey MCL. The maximum concentration of iron detected in well water was 638 ppb which is approximately two times higher than the New Jersey Recommended Upper Limit (RUL). RULs are non-enforceable and provide guidance for contaminants that which may cause cosmetic effects (skin or tooth discoloration) or aesthetic effects (taste, odor, or color) in drinking water. Therefore, it is unlikely that bromodichloromethane, chloroform and iron would cause any health-related adverse effects at the maximum concentration detected in the Cedar Brook area groundwater.

TCE, PCE, mercury, 1,2-DCA and nitrate were detected in five or more well samples at levels exceeding CVs. Benzene, carbon tetrachloride, 1,1-dichloroethylene (1,1-DCE), methyl tertiary butyl ether (MTBE), methylene chloride, 1,1,2-trichloroethane (1,1,2-TCA), 1,1,2,2-tetrachloroethane (1,1,2,2-PCA), tetrahydrofuran, lead and thallium were found in one to four well samples at a level exceeding the CV. These chemicals were considered the contaminants of concern (COC) in groundwater at the Cedar Brook area site and were retained for further evaluation.

A brief discussion of the toxicologic characteristics of the COC in groundwater are presented in Appendix A.

Discussion

Exposure Pathway Evaluation

In this section, exposure pathways are evaluated to determine whether Cedar Brook area residents could have been (past scenario), are (current scenario), or will be (future scenario) exposed to contaminants. In evaluating exposure pathways, NJDHSS investigated whether exposure to contaminated media has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation of contaminants.

An exposure pathway is a series of steps starting with the release of a contaminant in a 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.

ATSDR and NJDHSS classify exposure pathways into three groups: (1) “completed pathways”, that is, those in which exposure has occurred, is occurring, or will occur; (2) “potential pathways”, that is, those in which exposure might have occurred, may be occurring, or may yet occur; and (3) “eliminated pathways”, that is, those that can be eliminated from further analysis because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified.

Completed Pathways

A completed exposure pathway must include each of the elements that link a contaminant source to a receptor population. Based on available information, it is reasonable to assume that completed exposure pathways existed among those individuals who live (or lived) in the Cedar Brook area and utilized private well water prior to the installation of POET systems. Based on contaminant physicochemical and transport properties, the completed exposure pathways are as follows:

(a) ingestion of dissolved contaminants in tap water;
(b) inhalation of volatile contaminants released from water during household use; and
(c) dermal absorption of dissolved contaminants in tap water.

A summary of all major exposure pathways identified for the Cedar Brook area is presented in Table 3. The ingestion and inhalation (via domestic water use only) exposure pathways for VOCs and mercury have been interrupted through the installation of the POET systems at affected residences; this assumes a continued satisfactory performance of the POET systems.

Contaminant exposures from food (i.e., vegetables irrigated with contaminated water) and outside water-related activities (i.e., lawn watering, swimming in backyard pools) were considered minor and have not been evaluated in this report. ATSDR generally considers dermal exposures to be a minor contributor to the overall exposure dose relative to the contribution of ingestion and inhalation exposures (ATSDR 2002). As such, dermal exposure will not be evaluated in this assessment.

Potential Pathways

The following potential exposure pathways were also identified in the Cedar Brook area:

Vapor Intrusion **-** Volatile chemicals in groundwater can emit vapors that may migrate through subsurface soils and into indoor air spaces of overlying buildings (USEPA 2002). The vapor intrusion pathway may be important for buildings with or without a basement. Vapors can accumulate in occupied spaces to concentrations that may pose safety hazards, health effects, or aesthetic problems (e.g., odors). In residences with low contaminant concentrations, the primary concern is whether the chemicals pose an unacceptable health risk due to chronic exposures.

The USEPA has published draft guidance for the evaluation of vapor intrusion to indoor air from contaminated groundwater and soils (USEPA 2002). This guidance employs a tiered approach in the evaluation of whether vapors are present at levels which may pose an unacceptable exposure risk. For the Cedar Brook area, the tiered approach for assessing the vapor intrusion could not be completed primarily due to the lack of site-specific groundwater plume delineation and soil gas sampling data. However, based on a review of the high concentration of contaminants detected and their associated volatility, it appears that vapor intrusion may be an important exposure pathway.

Operation and maintenance of the POET system: Mechanical failure and/or premature breakthrough of contaminants in the POET system effluent could lead to contaminant exposure. The potentially exposed population is the POET system users.

Migration of the groundwater contaminant plume: Additional wells may become contaminated due to the migration of the groundwater contaminant plume. The potentially exposed population would be area residents who use private wells as their main water supply source, but do not have POET systems.

Contaminants not removed by the POET system: As mentioned earlier, the GAC and the KDF units do not remove lead, thallium and nitrate. The potentially exposed population are residents with private wells with elevated levels of these contaminants.

Exposure Dose Estimates for Completed Exposure Pathways

Ingestion of Dissolved Contaminants: Non-Cancer Health Effects

The evaluation of potential non-cancer health effects for the selected contaminants (see Table 2) is accomplished by estimating the amount or dose of those contaminants that an adult or child might have ingested on a daily basis. The contaminant exposure dose is calculated using the following formula:

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

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in water (milligrams per liter or mg/L);
IR = ingestion rate (liters per day or L/day); and
BW = body weight (kg)

The estimated exposure dose is then compared to established health guideline CVs. Examples of health guideline CVs are the ATSDR Minimal Risk Level (MRL) and the USEPA Reference Dose (RfD). An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. MRLs are developed for evaluating non-cancer health effects at varying duration of exposure: acute (less than 14 days), intermediate (15 to 364 days), and chronic (365 days and greater). The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. MRLs and RfDs 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).

To ensure that MRLs and RfDs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies.

Based on the information gathered during the June 2001 Availability Session, it was assumed that Cedar Brook area residents were exposed to groundwater contaminants for approximately 15 years. Therefore, the calculated contaminant doses are compared with chronic MRLs, when available. The results of this evaluation are presented in Table 4.

The chronic exposure dose calculated for adults and children for the contaminants benzene, carbon tetrachloride, 1,2-DCA, 1,1-DCE, methylene chloride, 1,1,2,2-PCA, tetrahydrofuran and 1,1,2-TCA were lower than the corresponding CVs, and, therefore, are unlikely to cause non-cancer adverse health effects. The MRL for chronic exposure to MTBE is unavailable; however, the MRL for intermediate duration exposure is 0.3 mg/kg/day. The adult exposure dose was about two orders of magnitude lower than the intermediate MRL; the child exposure dose was 30 times lower than the intermediate MRL. As such, past exposure to MTBE is unlikely to cause non-cancer health effects.

Since exposure doses calculated for adults and children for the contaminants PCE, TCE, thallium and nitrate were higher than the corresponding health-based CVs (i.e., MRLs, RfDs), the potential exists for non-cancer adverse health effects. 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/RfD to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

A brief evaluation of the non-cancer health implications of these contaminants are presented below. Lead and mercury are included in this evaluation although CVs are currently unavailable for these contaminants.

PCE. The chronic oral RfD for PCE of 0.01 mg/kg/day is based on hepatotoxicity effects in which mice were exposed to PCE for six weeks. An uncertainty factor of 1,000 and a NOAEL of 14 mg/kg/day were used to calculate the oral RfD. A LOAEL of 71 mg/kg/day was also established in the same study. Although the maximum exposure dose calculated for adults and children (0.017 and 0.038 mg/kg/day) exceeded the RfD, the exposure doses are about 360 and 800 times lower than the NOAEL and about 4,000 and 1,900 times lower than the LOAEL. Based on the maximum concentration of PCE detected, the likelihood of non-cancer adverse health effects in Cedar Brook area residents is low.

Based on the average concentration of PCE detected (27.5 ppb), the chronic adult and child exposure doses (0.00078 and 0.0017 mg/kg/day) were lower than the RfD and, as such, no significant non-cancer health effects are expected.

TCE. The RfD for chronic oral exposure to TCE is presently under review by the EPA (EPA 2004). However, the EPA Region 3 reports an RfD of 0.0003 mg/kg/day (LOAEL and uncertainty factors are unavailable). Based on the maximum concentration of TCE detected (2,060 ppb), the calculated chronic adult and child exposure doses (0.059 and 0.13 mg/kg/day) were about 200 and 430 times higher than the EPA Region 3 RfD. As such, the potential for non-cancer adverse health effects (i.e., renal) is possible. Specific duration and levels of exposure to Cedar Brook area residents have not been documented to date. Based on the average concentration of TCE detected (76.6 ppb), the calculated chronic adult and child exposure doses (0.002 and 0.004 mg/kg/day) were approximately 7 and 13 times higher than the EPA Region 3 RfD. As such, the potential still exists for non-cancer health effects.

Lead. Two of the 233 wells from the Cedar Brook area were identified as having lead levels (27.3 and 24.5 ppb) above the federal and state Action Level of 15 ppb. The source of lead in drinking water may be associated with household plumbing. No MRL or RfD is available for lead. Accumulation of lead in the body can cause damage to the nervous or gastrointestinal system, kidneys, or red blood cells. Children, infants, and fetuses are the most sensitive populations. Lead may cause learning difficulties and stunted growth, or may endanger fetal development. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (i.e., no NOAEL or LOAEL is available).

Mercury. Sixty seven percent (18/27) of the wells that tested positive for mercury in the Cedar Brook area had levels above the New Jersey MCL. The nervous system is sensitive to all forms of mercury. There is no chronic oral MRL or RfD available for mercury, and the calculated exposure dose for adults and children (see Table 4) could not be compared to a health-based CV.

An intermediate oral MRL for mercury (0.002 mg/kg/day) is available and is based on increased kidney weight of rats exposed to mercuric chloride once every five days for 26 weeks (ATSDR 2003). An uncertainty factor of 100 and a NOAEL of 0.23 mg/kg/day were used to calculate the MRL. Maximum exposure doses calculated for adults and children (0.00043 and 0.00094 mg/kg/day) were about 530 and 245 times less than the oral intermediate NOAEL. As such, the likelihood of non-cancer adverse health effects in Cedar Brook residents is low.

Thallium. Four wells from the Cedar Brook area showed levels of thallium above the NJMCL. Thallium, a naturally occurring trace metal, can be found in pure form or combined with other substances to form salts. It is used mostly in the manufacture of electronic devices, switches and closures. Thallium was used as a rat poison but was banned in 1972 because of its harmful effects. Based on the maximum thallium concentration detected (i.e., 5.9 ppb), the calculated exposure dose for adults and children (i.e., 0.00017 and 0.00037 mg/kg/day) were above the chronic oral EPA Region 3 RfD of 0.00007 mg/kg/day.

Since there was no chronic toxicity study available for thallium, data from the following sub-chronic study was used to calculate a health-based CV for comparison with site-specific exposure doses. Sprague-Dawley rats were exposed orally for 90 days to an aqueous solution of thallium sulfate (ATSDR 2003). The highest dose at which no adverse health effects were observed (0.25 mg/kg/day), which was then converted to its molar equivalent of 0.2 mg/kg/day thallium. Since this dose is about 1,200 and 540 times higher than the calculated exposure doses for adults and children, respectively, it is unlikely that non-cancer health effects from thallium would occur in residents consuming private well water from the Cedar Brook area.

Nitrate. Four wells from the Cedar Brook area had nitrate concentrations above the New Jersey MCL of 10,000 ppb. Typical sources of nitrates in well water include faulty household septic systems, nearby farms, home fertilizer use and municipal landfills. Assuming exposures at the maximum nitrate concentration detected (33,000 ppb), the calculated exposure dose for infants (5.28 mg/kg/day) is higher than the RfD (1.6 mg/kg/day). The RfD for nitrate is based on a NOAEL of 0.23 mg/kg/day and an uncertainty factor of 1.0. However, the reported LOAEL range for nitrate is 1.8 to 3.2 mg/kg/day. Therefore, ingestion of water from these wells containing excessive nitrate levels will cause methemoglobinemia in infants.

Acute exposures to nitrate are associated with methemoglobinemia, or "blue baby syndrome". This blood disorder in infants, is caused when nitrate is converted to nitrite which interacts with the hemoglobin in red blood cells. The methemoglobin formed in this reaction cannot carry sufficient oxygen to the cells and tissues of the body. Cases of methemoglobinemia have been reported among infants where nitrate-contaminated well water was used to prepare formula and other baby foods. At the present time, there are no available published data describing the long-term health effects of nitrate exposures in children.

Ingestion of Dissolved Contaminants: Cancer Risk

The site-specific lifetime excess cancer risk (LECR) indicates the carcinogenic potential of contaminants. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population. For example, ATSDR 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}). Similarly, one additional cancer case among 100,000 persons exposed would be considered to pose "no apparent increased risk" (10^{-5}); one additional case among 10,000 persons exposed would be considered as a "low increased risk" (10^{-4}); one additional cancer case among 1,000 persons exposed would be considered as a "moderate increased risk" (10^{-3}); and for one additional cancer case in 100 persons exposed, there would be a "high increased risk" (10^{-2}).

The United States Department of Health and Human Services (USDHHS) cancer class for the contaminants in the Cedar Brook area wells is presented in Table 5. The cancer classes are defined as follows:

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

Exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \; x \; IR \; x \; ED}{BW \; x \; AT}$$

where, C = concentration of contaminant in water (mg/L)
IR = ingestion rate (L/day)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (years)

Lead, mercury, thallium and nitrate are not currently classified as either cancer class 1 or 2 and were not evaluated further. For contaminants with a cancer class of 1 or 2, the calculated lifetime excess cancer risk (LECR) is presented in Table 5. As indicated by the LECR, benzene, carbon tetrachloride and methylene chloride posed "no apparent" to "low" increased cancer risk; 1,2-DCA, PCE and TCE may potentially cause "low" to "moderate" increased risk based on the maximum contaminant concentration. Based on the average contaminant concentration (the more likely exposure scenario) detected in the Cedar Brook area, the LECR is reduced by one to two orders of magnitude and the resulting risk classification is "no apparent" to "low" increased risk (see Table 5). Specific duration and levels of exposure to Cedar Brook area residents have not been documented to date.

Inhalation of Contaminants from Showering: Non-Cancer Health Effects

A number of studies have shown that inhalation exposure from residential uses of VOC contaminated water may equal or exceed those of ingestion (Moya et al. 1999; Keating et al. 1997; Giardino and Andelman 1996; Weisel and Jo 1996, Tancrede et al. 1992; McKone 1987). The greatest amount of exposure to volatile substances may occur in the shower, when the rate of transfer from the liquid to gas phase is at its maximum The USEPA has defined a list of chemicals for which vapor intrusion modeling should be conducted, based on volatility and toxicity criteria (USEPA 2002). Using the classic McKone model (McKone 1987; McKone and Bogen 1992), the indoor air concentration of the selected contaminants in the shower, bathroom and household were calculated for Cedar Brook area chemicals of concern meeting the USEPA criteria (Table 6). The model applies a three-compartment framework to simulate the 24-hour contaminant concentration profile within the shower, bath and household. The model equations and assumptions for the Cedar Brook area are presented in Appendix A. The McKone model does not account for other domestic water uses such as cooking, laundry and dishwashing which are approximately one-third of the total residential water usage (Andelman et al. 1985).

The predicted concentration of the contaminants in the shower, bathroom and household are presented in Table 6. The time-weighted average (TWA) concentrations were calculated using the following formula:

$$TWA = \Sigma C_x \ x \ ET_x/24$$

where, C = concentration of contaminant in air
ET = exposure time
$_x$ = shower, bath or household

The calculated time-weighted average concentrations (provided in both $\mu g/m^3$ and ppb for comparison purposes) and the corresponding health CVs are also presented in Table 6.

The calculated chronic exposure concentrations for the contaminants benzene, carbon tetrachloride, 1,2-DCA, 1,1-DCE, MTBE, methylene chloride and PCE were lower than the corresponding ATSDR chronic MRL or USEPA RfC, and, therefore, are unlikely to cause non-cancer adverse health effects. The MRL for chronic exposure to 1,1,2,2-PCA and TCE are unavailable; however, the MRL for intermediate duration exposure are available. The intermediate inhalation MRL for TCE (100 ppb), which incorporates an uncertainty factor of 30, is based on a sub-chronic study in which five male JCL-Winston rats were exposed to TCE. Decreased post-exposure heart rate and slow wave sleep were observed at 50 ppm which was identified as the less serious LOAEL. The calculated maximum exposure concentration (68.25 ppb) was about 735 times less than the LOAEL. As such, past exposure to TCE via inhalation is unlikely to cause non-cancer health effects.

The intermediate inhalation MRL (400 ppb) for 1,1,2,2-PCA is based on a sub-chronic study in which 55 female Sprague-Dawley rats were exposed to 130 ppm of 1,1,2,2-PCA. Liver, kidney, adrenal, genital, and lung pathologies were monitored and compared with controls. At the established LOAEL (130 ppm), increased liver weights, granulation and vacuolization in liver cells were observed. An uncertainty factor of 300 was used to calculate the intermediate MRL. The maximum exposure concentration (0.08 ppb) calculated for 1,1,2,2-PCA was about seven orders of magnitude less than the LOAEL. As such, past exposure to 1,1,2,2-PCA via inhalation is unlikely to cause non-cancer health effects.

The LOAEL for 1,1,2-TCA is unavailable, however, a number of researchers have reported study-specific LOAELs that ranged between 416 and 12,934 ppm (ATSDR 2003). Using this LOAEL range, the calculated 1,1,2-TCA concentration is about 3,500 to 108,000 times lower than the LOAEL. As such, non-cancer health effects are not expected from 1,1,2-TCA inhalation exposures associated with the Cedar Brook area site.

The calculated indoor air concentration of mercury was found to be higher than the ATSDR chronic MRL (0.2 $\mu g/m^3$) and, therefore, the contaminants have the potential to cause non-cancer adverse health effects. Based on the maximum concentration of mercury detected in the groundwater, the calculated TWA air phase concentration (i.e., 5.02 $\mu g/m^3$) indicates that residents may have been exposed to indoor air concentrations of mercury 25 times the chronic MRL of 0.2 $\mu g/m^3$ (ATSDR 2003). The MRL for mercury is based on a LOAEL of 6.2 $\mu g/m^3$ and an uncertainty factor of 30. This indicates that harmful effects from inhalation of mercury vapors is possible. Even at the average indoor air concentration calculated for mercury (1.6 $\mu g/m^3$), adverse health effects are possible.

Inhalation of Contaminants from Showering: Cancer Risk

The USDHHS cancer class for the selected volatile contaminants is presented in Table 7. The inhalation exposure doses were calculated using the following formula:

$$\text{Exposure Dose (mg/kg/day)} = \frac{C \times CR \times ED}{BW \times AT}$$

where, C = concentration of the contaminant in air (mg/cubic meter or m^3)
CR = contact (inhalation) rate (m^3/day)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (years)

The unit risk or the USEPA Region 3 carcinogenic slope factor inhaled (CSFi) is also provided in Table 7. The unit risk is defined as the upper-bound LECR estimated to result from continuous exposure to an agent at a concentration of 1 µg/L in water, or 1 $\mu g/m^3$ in air. The interpretation of unit risk is as follows: if unit risk = 1.5×10^{-6} $(\mu g/L)^{-1}$, 1.5 excess cancers are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the chemical in 1 liter of drinking water. The cancer slope factor 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., $(mg/kg/day)^{-1}$. LECRs were calculated by multiplying: 1) the TWA concentration with the unit risk; or 2) the exposure dose with the CSFi. The resulting LECRs show that all of the cancer class 1 or 2 VOCs posed a risk greater than 10^{-6}.

At the maximum groundwater concentration of TCE (2,060 ppb), the highest cancer risk was 8.98×10^{-3} which posed a "high" increased risk. At the average TCE concentration (76.6 ppb), the more likely exposure scenario, the LECR was 3.34×10^{-4} which posed a "moderate" increased risk. The LECRs calculated for PCE indicated "no apparent" to "moderate" increased risk based on the average and maximum groundwater concentrations, respectively.

The LECRs calculated for the remaining contaminants detected in the Cedar Brook area groundwater ranged from 10^{-7} to 10^{-5} or "no" to "low" increased risk.

Cumulative Dose and Health Effect Interaction

In the Cedar Brook area, residents were exposed to VOCs, metals and nitrate via groundwater and indoor air. For the purpose of this report, the exposure to, and toxicological effects of, the contaminants were evaluated by individual pathways. However, the cumulative exposure to chemicals through multiple pathways should be considered.

Non-carcinogenic risk is normally characterized in terms of a hazard index. This index is simply the ratio of the estimated exposure dose to the RfD. Hazard indices for combined ingestion and inhalation exposure were added to show the potential severity of past exposures and the resulting likelihood of adverse non-cancer health effects (see Figure 6). Based on the maximum concentration of each contaminant detected, TCE had the highest combined hazard index across multiple exposure pathways (219), followed by mercury (25) and nitrate (3.3).

As measures of probability, individual cancer risk estimates can be added. The combined risk for adults and children associated with ingestion and inhalation for TCE, PCE and 1,2-DCA are presented in Figure 7. It is evident that past TCE exposure posed the greatest risk to the Cedar Brook residents. The total estimated LECRs for TCE, based on maximum and average concentrations, are considered to be "high" and "moderate", respectively. PCE and 1,2-DCA posed relatively lower cancer risks at both maximum and average concentrations.

Exposure to multiple chemicals with similar toxicological characteristics may increase their public health impact. The severity of the impact depends on the particular chemicals being ingested, pharmacokinetics, and toxicity in children and adults. Research on the toxicity of mixtures indicates that adverse health effects are unlikely when the mixture components are present at levels well below their individual toxicological thresholds.

Child Health Considerations

The NJDHSS and ATSDR recognize 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 types of exposures to hazardous substances. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The NJDHSS and ATSDR evaluated the potential risk for children residing in the Cedar Brook area who were exposed to contaminants in their drinking water. Based on the maximum contaminant concentrations detected and a 15 year exposure duration, a “high” increased risk of cancer effects for area residents, including children, was determined.

TCE and PCE were the contaminants most frequently detected in the Cedar Brook area wells. A study conducted in Woburn, Massachusetts concluded that the elevated incidence of childhood leukemia was associated with the mother's potential for exposure to drinking water contaminated with TCE, PCE, chloroform and other organic compounds, particularly during pregnancy (Massachusetts Department of Public Health 1997). The study also suggested that exposures to these contaminants, whether individual or mixtures, might have had an effect on blood-forming organs during fetal development, but not during childhood. Similarly, a New Jersey study found a statistically elevated rate of childhood leukemia in towns served by community water supplies contaminated with TCE and PCE (NJDHSS 1993). A literature review of drinking water contaminants and adverse pregnancy outcomes was conducted (Bove et al. 2002). Results of studies on chlorination disinfection byproducts indicated moderate evidence for associations with certain birth defects, although this evidence was less clear for chlorinated solvents including TCE and PCE.

Infants exposed to elevated nitrate concentrations are at risk of methemoglobinemia or “blue baby syndrome”. This is a serious condition that prevents the transport of oxygen to an infant’s cells and tissues.

Health Outcome Data

Based on a review of data available from the NJDEP and CCDHHS, completed exposure pathways existed among Cedar Brook area residents who used contaminated groundwater for drinking and other domestic water use. Information obtained during public Availability Sessions indicated that exposures continued for approximately 15 years until POET systems were installed by the NJDEP. One of the health outcomes of concern identified in the Discussion above is a potential increase in cancer risk from past exposures.

Since 1978, statewide cancer incidence data have been collected by the New Jersey State

Cancer Registry (NJSCR) in the NJDHSS. Incidence data at the municipal level (Winslow Township, Camden County) would not be representative since the Cedar Brook area population is a small fraction of the town. Accurate cancer incidence rates for the Cedar Brook area population cannot be calculated because population denominator information is not available from the U.S. Census. Initial review of NJSCR cancer incidence data for the township revealed no cases in the Cedar Brook area during the period 1979 through 2001. However, due to the complicated mailing address pattern for municipalities in that area and change of street names for the 911 emergency system, the initial review of cancer data may have missed cases in the Cedar Brook area. Consequently, NJDHSS has worked with local officials to better characterize mailing and street names. A new review of cancer data for a larger area will be conducted in order to more accurately document cancer incidence in this community.

Conclusions

The NJDHSS and the ATSDR have evaluated public health implications associated with contamination of residential private wells in the Cedar Brook area of Winslow Township, Camden County. Contaminants of concern included TCE, PCE, 1,2-DCA, other VOCs, mercury, thallium, lead and nitrate. Past exposures to contaminants posed a ***Public Health Hazard*** from domestic water use via the ingestion and inhalation pathways. Exposure doses calculated for TCE, PCE, mercury, lead, thallium and nitrate exceeded health-based comparison values and warranted further review of available toxicological data. There was a potential for adverse non-cancer health effects from past exposures to TCE, lead and nitrate; non-cancer adverse health effects were unlikely for mercury and thallium. Based on the average and maximum contaminant concentrations detected in the Cedar Brook area wells, past exposure to TCE posed a moderate to high increased cancer risk; exposures to PCE and 1,2-DCA posed a low to moderate increase in cancer risk.

Cedar Brook area residents with confirmed VOCs and mercury contamination of their private wells were provided with POET systems by the NJDEP. There is currently ***No Apparent Public Health Hazard*** from VOCs and mercury associated with domestic water use at these residences. This assessment is contingent upon the proper operation and maintenance of the POET systems.

Treatment systems were not provided for the removal of lead or nitrate, and exposures to these substances may be continuing at levels of concern. In two wells, lead was found to exceed the lead Action Level. Health effects from lead exposures do not have a known threshold and thus may occur in children and developing fetuses at low levels of exposure. Lead exposure may occur from many sources, including lead paint and drinking water. The source of lead in drinking water may be associated with household plumbing rather than groundwater. Five wells had nitrate levels above the New Jersey MCL of 10 mg/L. Elevated levels of nitrate are associated with methemoglobinemia, a serious condition in infants. Typical sources of nitrates in well water include faulty household septic systems, nearby farms, home fertilizer use and municipal landfills. As such, current exposures to lead and nitrate may pose a ***Public Health Hazard.***

Exposure from the vapor intrusion pathway could not be evaluated due to the lack of soil gas and/or indoor air data. Therefore, past, present, and future exposures to groundwater contaminants through this pathway remain an ***Indeterminate Public Health Hazard*.**

Recommendations

1. Soil gas data should be collected by the NJDEP in order to evaluate exposures associated with vapor intrusion.

2. The nature and extent of the groundwater plume should be fully delineated, especially with respect to its potential for future impact on private and public water supply wells. The NJDEP should continue its effort to identify the contamination source(s).

3. There were wells that tested clean within the area of contamination. In some instances, these wells are located directly adjacent to residences with wells that were heavily contaminated. The NJDEP should implement a monitoring program to test these "clean" wells on a frequent basis to identify problems as they arise and to avoid potential contaminant exposures.

4. Residents with contaminated wells containing VOCs and mercury should continue to use the POET systems to remove contaminants from the well water. The NJDEP should continue to ensure the proper operation and maintenance of the POET systems.

5. For those households with elevated lead and/or nitrate levels, the NJDEP should provide information to residents on treatment options that are available for reducing exposures.

6. As soon as feasible, the responsible government agency should connect Cedar Brook area residences to a safe public drinking water supply system.

Public Health Action Plan (PHAP)

The purpose of a PHAP is to ensure that this 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 ATSDR and NJDHSS to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDHSS and the ATSDR are as follows:

Public Health Actions Undertaken by NJDHSS and ATSDR

1. Available site information and private well sampling data have been evaluated by the NJDHSS and ATSDR to determine the public health significance of human exposure pathways associated with VOCs and inorganic chemicals detected in potable private well water.

2. Two Availability Sessions in the Cedar Brook area were held on April 26 and June 28, 2001 to discuss community health concerns and share public health information. ATSDR educational materials were distributed to residents.

3. A public meeting was held on January 11, 2005 to present and discuss the findings and conclusions of the Public Health Assessment prepared for the site (see Appendix C). Residents were informed that lead, thallium and nitrate are not addressed by the existing POET systems. Information regarding treatment options was provided to residents.

Public Health Actions Planned by NJDHSS and ATSDR

1. When available, the NJDHSS and ATSDR will review soil gas data to assess the vapor intrusion exposure pathway.

2. The NJDHSS and ATSDR will review future private well water quality monitoring data to assess the effectiveness of POET systems.

3. The NJDHSS and the ATSDR will make this Public Health Assessment available to residents in the Cedar Brook area directly or through the CCDHHS, township library, or Internet.

4. The NJDHSS will conduct outreach to area physicians and provide copies of relevant ATSDR documents (e.g., Case Studies in Environmental Medicine, ToxFAQs).

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CERTIFICATION

The Public Health Assessment for the Cedar Brook Area Contamination site, Winslow Township, Camden County, New Jersey, was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement Partner.

Gregory V. Ulirsch
Technical Project Officer, SPAB, DHAC
Agency for Toxic Substances and Disease Registry (ATSDR)

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

Alan Yarbrough
Team Leader, CAT, SPAB, DHAC, ATSDR

Table 1: Summary of Chemical Analysis Data of Groundwater Contaminants at the Cedar Brook Area Site

Number of private well tests[1] = 239
Number of private well test with no contamination detected = 102

Contaminant	Frequency of Detection	Maximum Detected Concentration (ppb)	Mean Detected Concentration (ppb)	Median Detected Concentration (ppb)
Volatile Organic Compounds (VOCs)				
Acetone	3	45.2	27.87	19.2
Benzene	2	23.8	17.15	10.5
Bromodichloromethane	1	2	2	-
Carbon Tetrachloride	2	2.6	2.2	2
Chloroform	4	8.5	3.18	3.61
cis-1,2-Dichloroethylene	3	5.43	2.86	2.85
1,2-Dichloroethane (1,2-DCA)	13	76.6	18.3	9.55
1,1-Dichloroethylene (1,1-DCE)	2	44.2	28.7	13.2
Methyl chloride	1	0.47	0.47	-
Methyl tertiary butyl ether (MTBE)	5	108	42.84	7.15
Methylene Chloride	2	31.4	15.92	2
1,1,2,2-Tetrachloroethane (1,1,2,2,-PCA)	1	3.7	3.70	-
Tetrachloroethylene (PCE)	70	600	27.15	10

Table 1: (Cont'd.)

Contaminant	Frequency of Detection	Maximum Detected Concentration (ppb)	Mean Detected Concentration (ppb)	Median Detected Concentration (ppb)
Tetrahydrofuran	1	30.6	30.6	-
Toluene	5	21.3	8.02	4.34
1,1,1-Trichloroethane (1,1,1-TCA)	9	13.7	3.87	1.33
1,1,2-Trichloroethane (1,1,2-TCA)	1	3.9	3.9	-
Trichloroethylene (TCE)	137	2,060	76.59	19.35
Metals				
Aluminum	1	6,870	6,870	-
Iron	3	638	241.91	45.15
Lead	2	27.3	25.9	24.5
Manganese	1	0.06	0.06	-
Mercury	27	14.96	4.95	3.78
Thallium	4	5.9	4.2	4
Inorganics				
Nitrate (as N)	7	33,000	14,030	12,500

[1]Two additional well were identified as contaminated since August 2003

Table 2: Comparison of Maximum Concentration of Site Contaminants in Private Wells at Cedar Brook Area Site with Environmental Guideline Values

Contaminant	Freq. of Detection > New Jersey MCL[1]	Max. Conc. (ppb[2])	Mean of NJMCL Exceedances (ppb)	USEPA MCL (ppb)	NJMCL (ppb)	Other CV[3] (ppb)	Retained for Further Evaluation
Volatile Organic Compounds (VOCs)							
Acetone	0	45.2				1,000 (child)[4] 4,000 (adult)[4]	No
Benzene	2	23.8	17.15	5	1		**Yes**
Bromodichloromethane	0	2		80[5]	80[5]		No
Carbon Tetrachloride	1	2.6	2.6	5	2		**Yes**
Chloroform	0	8.5		80[5]	80[5]		No
cis-1,2-Dichloroethylene	0	5.43		70	70		No
1,2-Dichloroethane (1,2-DCA)	13	76.6	18.3	5	2		**Yes**
1,1-Dichloroethylene (1,1-DCE)	2	44.2	28.7	7	2		**Yes**
Methyl chloride	NA[6]	0.47				190[7]	No
Methyl tertiary butyl ether (MTBE)	2	108	100.1		70		**Yes**
Methylene Chloride	1	31.4	31.4	5	3		**Yes**
1,1,2,2-Tetrachloroethane (1,1,2,2,-PCA)	1	3.7	3.7		1		**Yes**
Tetrachloroethylene (PCE)	61	600	31.08	5	1		**Yes**
Tetrahydrofuran	NA[6]	30.6				8.8[7]	**Yes**

Table 2: (Cont'd.)

Contaminant	Freq. of Detection > New Jersey MCL	Max. Conc. (ppb)	Mean of NJMCL Exceedances (ppb)	USEPA MCL (ppb)	NJMCL (ppb)	Other CV (ppb)	Retained for Further Evaluation
Toluene	0	21.3		1,000	1,000		No
1,1,1-Trichloroethane (1,1,1-TCA)	0	13.7		200	30		No
1,1,2-Trichloroethane (1,1,2-TCA)	1	3.9	3.9	5	3		No
Trichloroethylene (TCE)	133	2,060	78.87	5	1		**Yes**
Metals							
Aluminum		6,870				20,000 (child)[8] 70,000 (adult)[8]	No
Iron	1	638	638		300[9]		No
Lead	2	27.3	25.9	15[10]	15[10]		**Yes**
Manganese	0	0.06				500 (child)[4] 2,000 (adult)[4]	No
Mercury	18	14.96	6.91	2	2		**Yes**
Thallium	4	5.9	4.2	2	2		**Yes**
Inorganics							
Nitrate (as N)	5	33,000	17.62	10,000	10,000		**Yes**

[1]Maximum Contaminant Level; [2]parts per billion; [3]Comparison Value; [4]Reference Media Evaluation Guide (RMEG) Value; [5](Bromodichlormethane + Chloroform) ≤ 80 ppb; [6]New Jersey MCL not available; [7]USEPA Region 3 Risk Based Concentration (RBC) Value; [8]Environmental Media Evaluation Guide (EMEG) Value; [9]USEPA/New Jersey Recommended Upper Limit (RUL); [10]USEPA/New Jersey Action Level (AL)

Table 3: Major Exposure Pathways for Cedar Brook Area Site

Environmental Pathway	Exposure Point	Exposure Scenario(s)	Route of Exposure	Receptor	Pathway Classification		
					Past	Present	Future
Groundwater	Tapwater (Wells)	Drinking	Ingestion	Residents	Completed	Eliminated[1] Potential[2]	Eliminated[1] Potential[2]
		Household use	Inhalation/Dermal	Residents	Completed	Eliminated	Eliminated
		Showering	Inhalation/Dermal	Residents	Completed	Eliminated	Eliminated
	Indoor Air	Vapor Intrusion	Inhalation	Residents	Completed	Completed	Eliminated[3]

[1]Exposures to VOCs and mercury have been eliminated using POET systems
[2]POET systems may not eliminate lead, thallium and nitrate
[3]NJDEP/USEPA are expected to implement a risk-based remedy for the groundwater contamination

Table 4: Non-Cancer Health Guideline Values: Comparison of Calculated Exposure Dose with Maximum Concentration of Cedar Brook Area Site Contaminants (exposure dose in parentheses is based on average concentration)

Contaminant	Maximum Conc. (ppb)	Max. (Avg.) Exposure Dose (mg/kg/day)		Health Guideline Comparison Values (CV) (mg/kg/day)			Exceeds CV
		Adult	Child	ATSDR MRL[1]	USEPA Chronic Oral RfD[2]	USEPA Region 3 RfD	
Volatile Organic Compounds (VOCs)							
Benzene	23.8	0.00068	0.00149		0.004		No
Carbon Tetrachloride	2.6	0.00007	0.00016		0.0007		No
1,2-Dichloroethane (1,2-DCA)	76.6	0.00219	0.00479			0.03	No
1,1-Dichloroethylene (1,1-DCE)	44.2	0.00126	0.00276	0.009(C[3])			No
Methyl tertiary butyl ether (MTBE)	108	0.00309	0.00675	0.30 (I[4])			No
Methylene Chloride	31.4	0.00090	0.00196	0.06 (C)			No
1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)	3.7	0.00011	0.00023	0.04 (C)			No
Tetrachloroethylene (PCE)	600	0.01714 (0.00078)	0.03750 (0.0017)		0.01		**Yes**
Tetrahydrofuran	30.6	0.00087	0.00191			0.2	No
1,1,2-Trichloroethane (1,1,2-TCA)	3.9	0.00011	0.00024		0.004		No
Trichloroethylene (TCE)	2,060	0.05886 (0.00219)	0.12875 (0.00479)	0.2 (A[5])		0.0003	**Yes**

Table 4: (Cont'd.)

Contaminant	Maximum Conc. (ppb)	Max. (Avg.) Exposure Dose (mg/kg/day)		Health Guideline Comparison Values (CV) (mg/kg/day)			Exceeds CV
		Adult	Child	ATSDR MRL[1]	USEPA Chronic Oral RfD[2]	USEPA Region 3 RfD	
Metals							
Lead	27.3	0.00078	0.00171				**No CV**
Mercury	14.96	0.00043	0.00094				**No CV**
Thallium	5.9	0.00017 (0.00012)	0.00037 (0.00026)			0.00007	**Yes**
Inorganics							
Nitrate (as N)	33,000		5.28[6] (2.24)		1.6		**Yes**

[1]Minimum Risk Level (MRL), [2]Reference Dose, [3]Chronic, [4]Intermediate, [5]Acute, [6]Dose based on ingestion of drinking water used to prepare infants formula: 0.64 L/day and 4 kg infant

Table 5: Calculated Lifetime Excess Cancer Risk (LECR) based on Maximum Concentration of Cedar Brook Area Site Contaminants (LECR in parentheses is based on average concentration)

Contaminant	Maximum Concentration (ppb[1])	Maximum Exposure Dose (mg/kg/day)	USDHHS[2] Cancer Class	USEPA SF[3] $(mg/kg/day)^{-1}$	LECR
Benzene	23.8	0.00015	1	0.055	8.01×10^{-6}
Carbon Tetrachloride	2.6	0.00002	2	0.13	2.07×10^{-6}
1,2-Dichloroethane (1,2-DCA)	76.6	0.00047	2	0.091	4.27×10^{-5} (1.02×10^{-5})
Methylene Chloride	31.4	0.00019	2	0.0075	1.44×10^{-6}
Tetrachloroethylene (PCE)	600	0.00367	2[4]	0.052[5]	1.91×10^{-4} (8.64×10^{-6})
Trichloroethylene (TCE)	2,060	0.01261	2[4]	0.011[5]	1.39×10^{-4} (5.16×10^{-6})

[1]parts per billion,
[2]United States Department of Health and Human Services
[3]Slope Factor
[4]The cancer classification of PCE and TCE is under review by USEPA
[5]The cancer Slope Factor of PCE and TCE is under review by USEPA

Table 6: Comparison of Modeled Indoor Air Concentration or Exposure Dose with Non-Cancer Health Guideline Values (TWA in parentheses is based on average concentration)

Contaminant	Modeled Indoor Air Concentration[1] ($\mu g/m^3$)			TWA[2]		ATSDR Chronic MRL[3]	USEPA RfC[4]	TWA or Dose Exceed CV
	Shower	Bath	House	($\mu g/m^3$)	(ppb)	(ppb)	($\mu g/m^3$)	
Benzene	449	77	0.49	3.97	1.24		30	No
Carbon Tetrachloride	51	8.75	0.06	0.45	0.07	30		No
1,2-Dichloroethane (1,2-DCA)	1,564	268	1.69	13.82	3.42	600		No
1,1-Dichloroethylene (1,1-DCE)	882	151	0.95	7.79	1.96		200	No
Methyl tertiary butyl ether (MTBE)	1,885	323	2.04	16.65	4.62	700		No
Methylene Chloride	725	124	0.78	6.41	1.85	300		No
1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)	64	11	0.07	0.57	0.08	400 (I[5])		No
Tetrachloroethylene (PCE)	1,1155	1,912	12	98	14.53	40		No
1,1,2-Trichloroethane (1,1,2-TCA)	73	12.64	0.08	0.65	0.12			**No CV**
Trichloroethylene (TCE)	41,524	7,118	44.85	366 (13.64)	68.25 (2.54)	100 (I)		No
Mercury	568	97	0.61	5.02 (1.66)	0.61 (0.2)	0.2 $\mu g/m^3$		**Yes**

[1]Modeled indoor air concentration based on maximum contaminant concentration in water (McKone and Bogen, 1992), [2]Time-weighted average, [3]Minimum Risk Level, [4]Reference Concentration, [5]Intermediate MRL

Table 7: Lifetime Excess Cancer Risk (LECR) Associated with VOCs during Showering (LECR in parentheses is based on average concentration)

Contaminant	USDHHS Cancer Class	Maximum Time-weighted Average (μg/m^3)	Maximum Exposure Dose (mg/kg/day)	Unit Risk (μg/m^3)$^{-1}$	USEPA Region 3 CSFi[1] (mg/kg/day)$^{-1}$	LECR
Benzene	1	3.97	0.000243	7.80 X 10^{-6}		6.63 X 10^{-6}
Carbon Tetrachloride	2	0.45	2.76 X 10^{-5}	1.50 X 10^{-5}		1.45 X 10^{-6}
1,2-Dichloroethane (1,2-DCA)	2	13.82	0.000846	2.60 X 10^{-5}		7.70 X 10^{-5} (1.84 X 10^{-5})
Methylene Chloride	2	6.41	0.000393	4.00 X 10^{-7}		5.50 X 10^{-7}
Tetrachloroethylene (PCE)	2[2]	98.53	0.006033		0.02[3]	1.21 X 10^{-4} (5.46 X 10^{-6})
Trichloroethylene (TCE)	2[2]	366.79	0.022457		0.4[3]	8.98 X 10^{-3} (3.34 X 10^{-4})

[1]Carcinogenic Slope Factor Inhaled
[2]The cancer classification of TCE and PCE is under review by USEPA
[3]The cancer Slope Factor of TCE and PCE is under review by USEPA

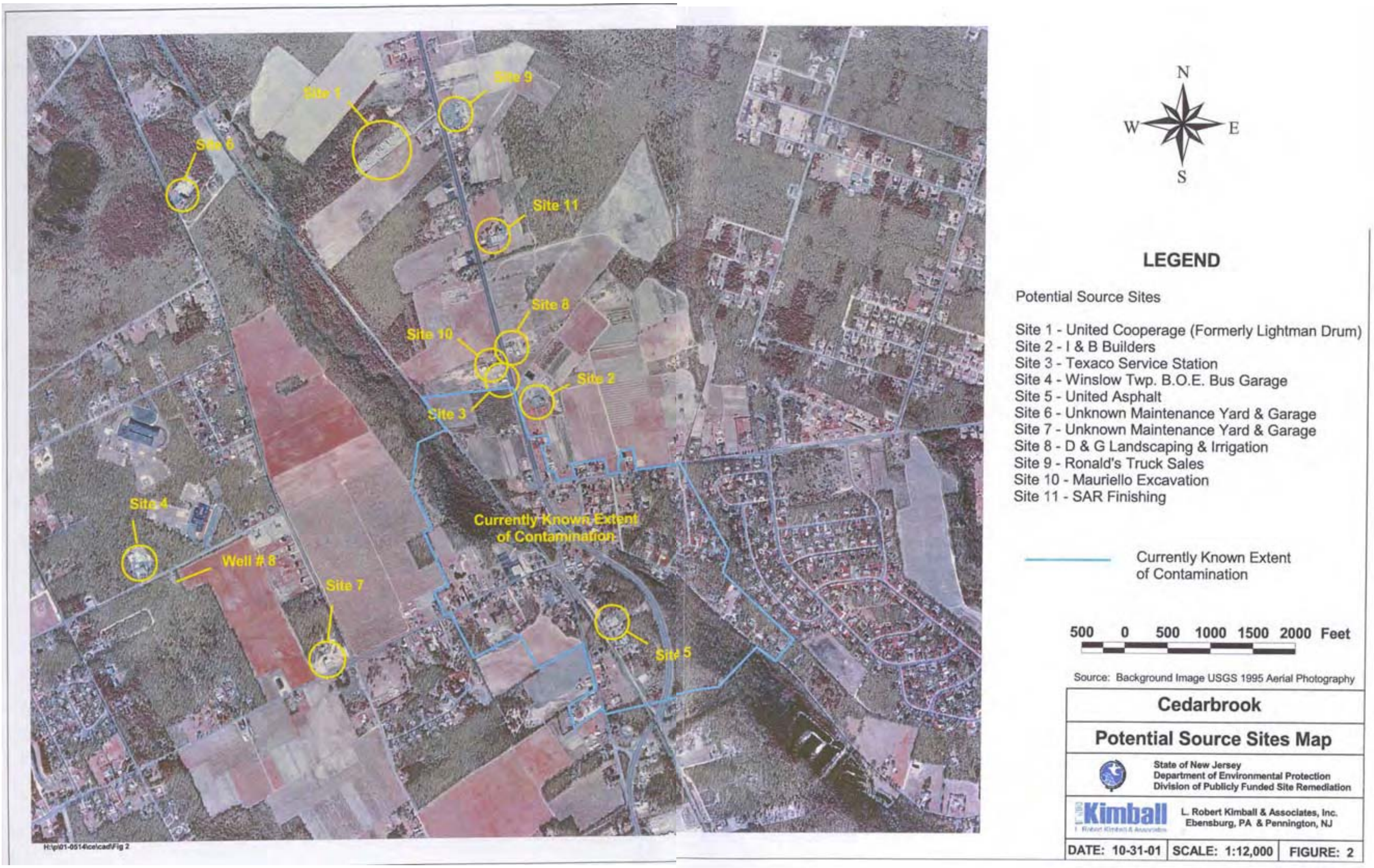


Figure 2: Location of Cedar Brook contaminated area and potential sources of pollution

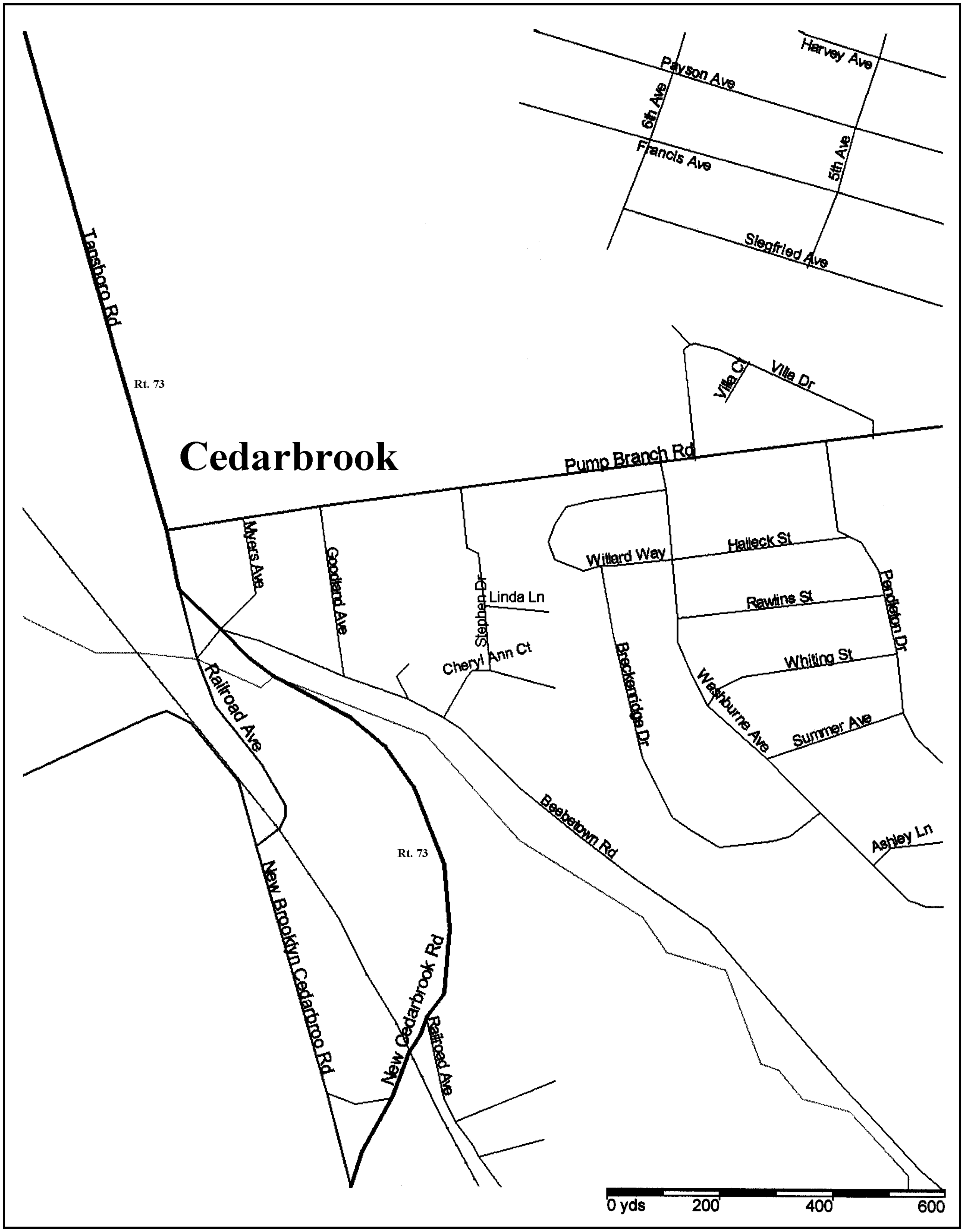
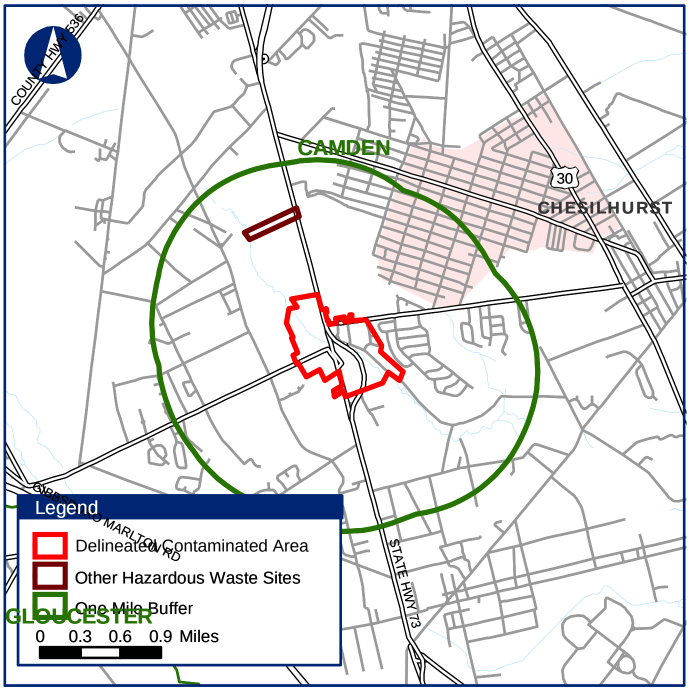


Figure 3: Street map of the Cedar Brook Area

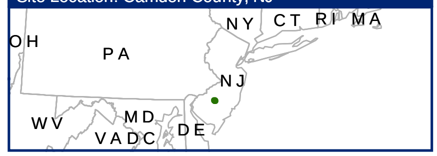
Cedar Brook Area
Winslow Township, NJ
EPA Facility ID: NJXCRA791000

ATSDR CDC
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY



Base Map Source: Geographic Data Technology (DYNAMAP 2000), August 2002
Site Boundary Data Source: ATSDR Public Health GIS Program, August 2002
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

Site Location: Camden County, NJ

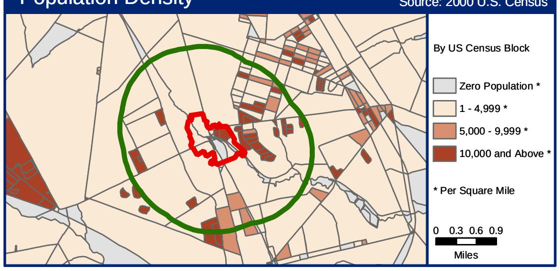


Demographic Statistics
Within One Mile of Site*

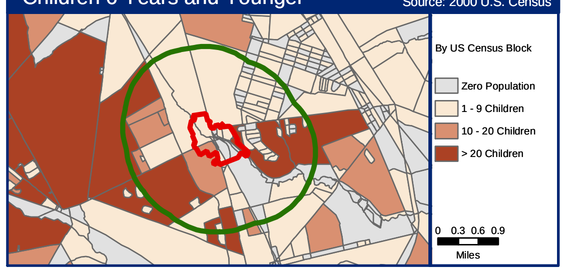
Total Population	4,125
White Alone	3,535
Black Alone	475
Am. Indian & Alaska Native Alone	6
Asian Alone	30
Native Hawaiian & Other Pacific Islander Alone	0
Some Other Race Alone	37
Two or More Races	42
Hispanic or Latino**	100
Children Aged 6 and Younger	350
Adults Agend 65 and Older	273
Females Aged 15 to 44	888
Total Housing Units	1,309

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.

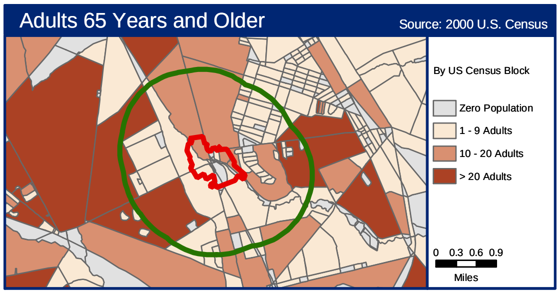
Population Density Source: 2000 U.S. Census



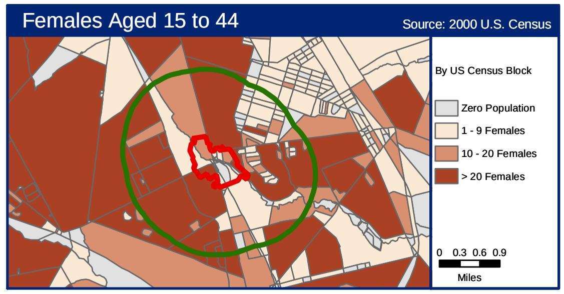
Children 6 Years and Younger Source: 2000 U.S. Census



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



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



GENERATED: 12-22-2003

CDC
FOR INTERNAL AND EXTERNAL RELEASE
CENTERS FOR DISEASE CONTROL AND PREVENTION | UNITED STATES DEPARTMENT OF HEALTH AND HUMAN SERVICES

Figure 4: Cedar Brook Area Demographic Information

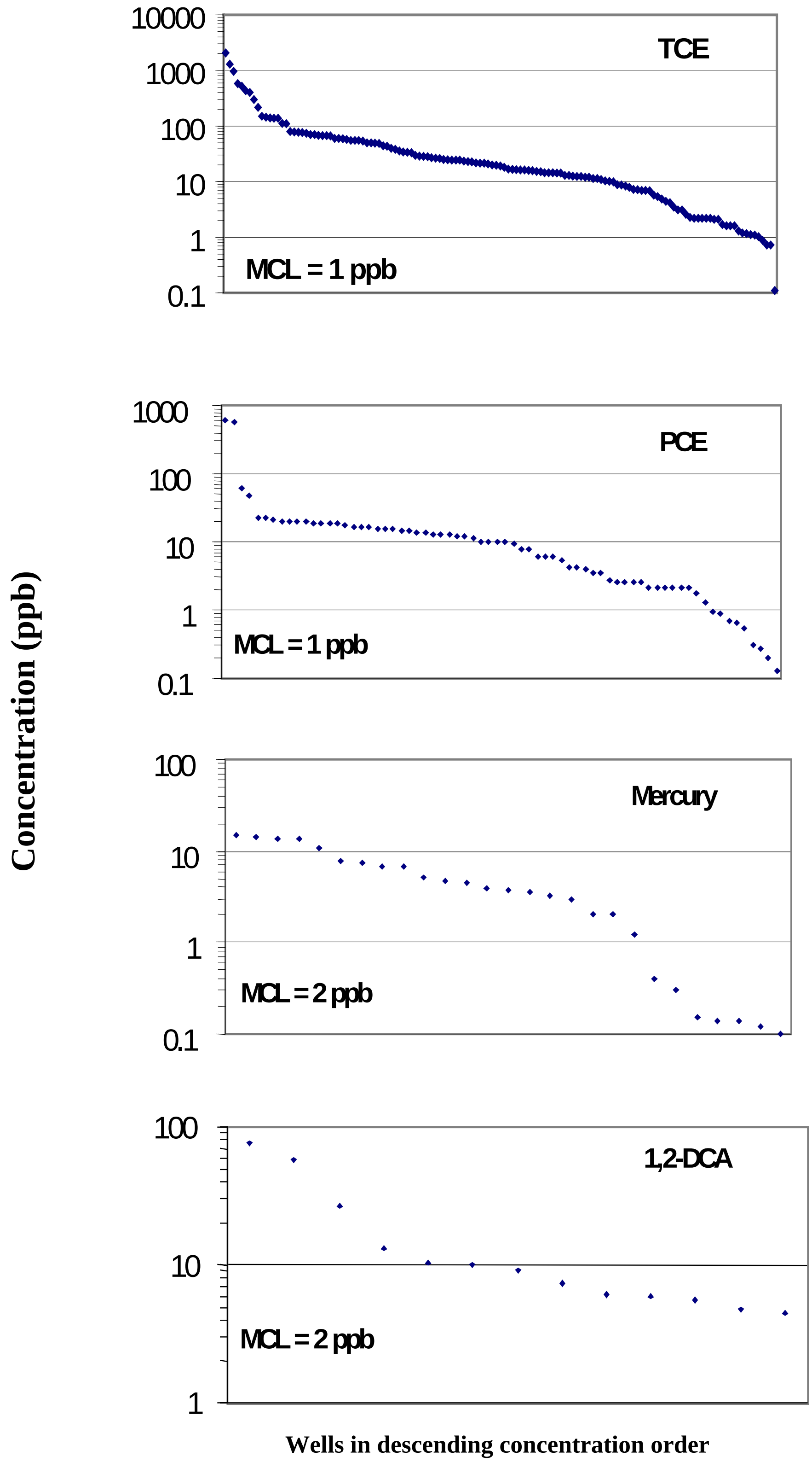


Figure 5: Distribution of concentration of TCE, PCE, Mercury and 1,2-DCA detected in various wells

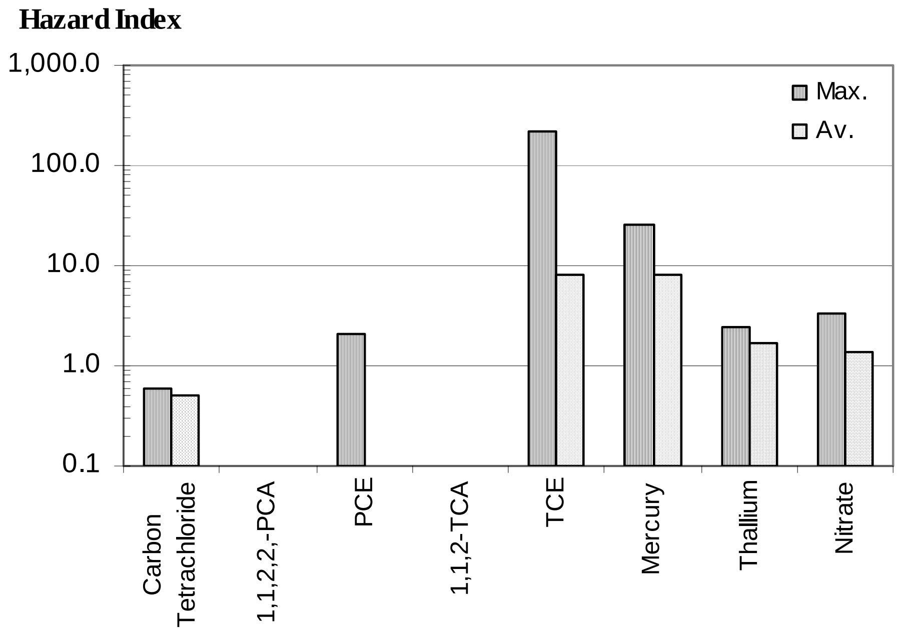


Figure 6: Cumulative non-cancer hazard from domestic water use (ingestion and inhalation pathway) from groundwater contaminants at the Cedar Brook area

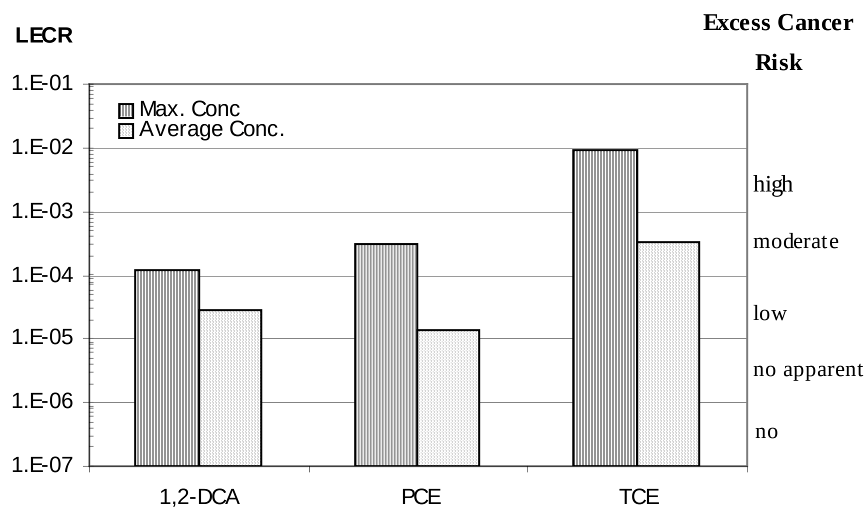


Figure 7: Cumulative cancer risk from domestic water use (ingestion and inhalation pathway) from groundwater contaminants at the Cedar Brook area

Appendix A – Toxicological Summaries of Contaminants of Concern

The toxicological summaries provided below are based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html). Health effects are summarized for the chemicals of concern found above environmental guideline CVs in Cedar Brook area private wells. The health effects described in the toxicological summaries 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.

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 is slightly soluble in water, and can remain in groundwater for a long time, but it quickly evaporates from surface 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 vapor intrusion, 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 TCE is "probably carcinogenic to humans".

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 1 part per million (1 ppm) 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.

Mercury Mercury is a naturally occurring metal which has several forms. Metallic mercury is a shiny, silvery liquid which, when heated, can be 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. Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments. People are commonly 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, the release of mercury from dental work, working with mercury, or 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.

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 pass to a nursing infant through breast milk, although the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Harmful effects due to mercury that passes 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 with their nervous and digestive systems, and kidney damage.

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.

1,2-DCA 1,2-DCA, also called ethylene dichloride, is a manufactured chemical. It is a clear liquid and has a pleasant smell and sweet taste. The most common use of 1,2-DCA is in the production of vinyl chloride which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. It is also used as a solvent and is added to leaded gasoline to remove lead. People can be exposed to 1,2-DCA by breathing air or drinking water that contains 1,2-DCA.

Nervous system disorders, liver and kidney diseases, and lung effects have been reported in humans ingesting or inhaling large amounts of 1,2-DCA. In laboratory animals, breathing or ingesting large amounts of 1,2-DCA has also caused nervous system disorders and liver, kidney, and lung effects. Animal studies also suggest that 1,2-DCA may damage the immune system. Kidney disease has also been seen in animals ingesting low doses of 1,2-DCA for a long time. Studies in animals indicate that 1,2-DCA does not affect reproduction.

Human studies examining whether 1,2-DCA can cause cancer have been considered inadequate. In animals, increases in the occurrence of stomach, mammary gland, liver, lung, and endometrium cancers have been seen following inhalation, oral, and dermal exposure. The USDHHS has determined that 1,2-DCA may reasonably be expected to cause cancer. The EPA has determined that 1,2-DCA is a probable human carcinogen and IARC considers it to be a possible human carcinogen.

Nitrate Nitrate, a component of plant fertilizer, is a common groundwater contaminant in agricultural areas. Elevated nitrate levels can cause methemoglobinemia (“blue baby syndrome”) in infants. Methemoglobinemia is a condition in which the normal capacity of the blood to carry oxygen is diminished. Nitrate is converted in the stomach to nitrite, which is absorbed into the blood. It binds to hemoglobin in red blood cells and interferes with oxygen transport. Most cases of methemoglobinemia have been reported among infants who have been fed infant formula using well water with more than 20 mg/L of nitrate, but cases may occur at lower levels when there are also high dietary sources of nitrate.

Benzene Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is 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 such as plastics, resins, and nylon and synthetic fibers. Benzene is also used to make rubber, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural constituent of crude oil, gasoline, and cigarette smoke. Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions. Indoor air generally contains higher levels of benzene from products such as glues, paints, furniture wax, and detergents.

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 (365 days or longer) 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. It is not known whether benzene exposure affects the developing fetus in pregnant women or fertility in men. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

The USDHHS has determined that benzene is a known human carcinogen. Long-term exposure to high levels of benzene in the air can cause leukemia, cancer of the blood-forming organs.

Carbon Tetrachloride Carbon tetrachloride is a clear, volatile liquid with a sweet smell that can be detected at low levels. 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. People are or were exposed to carbon tetrachloride by breathing contaminated air near manufacturing plants or waste sites, breathing workplace air when it was used, or drinking contaminated water near manufacturing plants and waste sites.

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects result from either eating, drinking, or breathing it, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it swells and cells are damaged or destroyed. Kidneys are also damaged, causing a buildup of wastes in the blood. If exposure is low and then stops, the liver and kidneys can repair the damaged cells and function normally again. 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 can occur. There have been no studies in people on carbon tetrachloride's effects on reproduction or development, but studies in rats showed no adverse effects.

The USDHHS has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. Animals that ingested carbon tetrachloride over a long time developed liver cancer. It is not known whether breathing carbon tetrachloride causes cancer in animals, or if breathing or ingesting it will cause cancer in people.

1,1-Dichloroethylene (1,1-DCE) 1,1-DCE is an industrial chemical with a mild, sweet smell. It is used to make certain plastics, such as flexible films like food wrap, and in packaging materials. It is also used to make flame retardant coatings for fiber and carpet backings, and in piping, coating for steel pipes, and in adhesive applications. Workers may be exposed in industries that make or use it. Food that is wrapped in plastic wrap may contain very low levels of 1,1-DCE. A small percentage of drinking water supplies may contain very low levels of 1,1-DCE, and air near factories that make or use DCE may contain low levels of it.

The main effect from breathing high levels of 1,1-DCE is on the central nervous system. Breathing lower levels of 1,1-DCE in air for a long time may damage the nervous system, liver, and lungs. Workers exposed to 1,1-DCE have reported a loss in liver function, but other chemicals were present. Animals that breathed high levels of 1,1-DCE had damaged livers, kidneys, and lungs. The offspring of some of the animals had a higher number of birth defects. Animals that ingested high levels of 1,1-DCE had damaged livers, kidneys, and lungs. There were no birth defects in animals that ingested the chemical. We do not know if birth defects occur when people are exposed to 1,1-DCE.

The EPA has determined that 1,1-DCE is a possible human carcinogen. Studies on workers who breathed 1,1-DCE have not shown an increase in cancer, but these studies are not conclusive. Animal studies have shown mixed results. Several studies reported an increase in tumors in rats and mice, and other studies reported no such effects.

Methyl tertiary-butyl ether (MTBE) MTBE is a flammable liquid with a distinctive, disagreeable odor. It has been used since the 1980s as an additive for unleaded gasolines to achieve more efficient burning. MTBE is also used to dissolve gallstones. MTBE quickly evaporates from open containers and surface water, so it is commonly found as a vapor in the air, and small amounts of MTBE may dissolve in water and get into underground water. People are be exposed to MTBE while pumping gasoline, breathing exhaust fumes while driving a car, or breathing air near highways or in cities. Exposure to MTBE may also occur through drinking, swimming, or showering in water that has been contaminated with MTBE.

Exposure to MTBE may cause nausea, nose and throat irritation, and nervous system effects. There is no evidence that MTBE causes cancer in humans. One study with rats found that breathing high levels of MTBE for long periods may cause kidney cancer. Another study with mice found that breathing high levels of MTBE for long periods may cause liver cancer.

The USDHHS, the IARC, and the EPA have not classified MTBE as to its arcinogenicity.

Methylene chloride Methylene chloride is a colorless liquid with a mild, sweet odor. It 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. The most likely way to be exposed to methylene chloride is by breathing contaminated air.

Breathing in large amounts of methylene chloride may cause dizziness, nausea, and tingling or numbness of fingers and toes. A person breathing smaller amounts of methylene chloride may become less attentive and less accurate in tasks requiring hand-eye coordination. 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.

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 USDHHS has determined that methylene chloride can be reasonably anticipated to be a cancer-causing chemical, and the EPA has determined that methylene chloride is a probable cancer-causing agent in humans.

1,1,2-Trichloroethane (1,1,2-TCA) 1,1,2-TCA is a colorless, sweet-smelling volatile liquid. It is used as a solvent and as an intermediate in the production of the chemical, 1,1-dichloroethane. 1,1,2-TCA is sometimes present as an impurity in other chemicals, and it may be formed when another chemical breaks down in the environment under conditions where there is no air. People may be exposed to 1,1,2-TCA by breathing outdoor air that contains it from industrial releases or waste sites, drinking contaminated water, or breathing contaminated workplace air.

When animals swallowed food or water containing 1,1,2-TCA, effects on the stomach, blood, liver, kidneys, and nervous system were seen. We do not know whether 1,1,2-TCA can affect reproduction in people. Animal studies have not shown the chemical to affect normal reproduction and development. No information is available on whether or not 1,1,2-TCA will cause cancer in people. Only one study is available on the ability of 1,1,2-TCA to cause cancer in animals. This study found an increase in liver cancer in mice, but not in rats, who were fed the chemical for their lifetime. The IARC has determined that 1,1,2-TCA is not classifiable as to its carcinogenicity to humans.

1,1,2,2-Tetrachloroethane (1,1,2,2-TCA) 1,1,2,2-TCA is a volatile chemical with a sweet odor. Presently it is used only as a chemical intermediate in the production of other chemicals. In the past, it was also used in large amounts as a solvent, to clean and degrease metals, and in paints and pesticides. 1,1,2,2-TCA can be found at low levels in both indoor and outdoor air. Limited exposure could occur from breathing in vapors or touching it due to spills or accidents in the workplace.

Breathing, drinking, or touching 1,1,2,2-TCA can cause liver damage, stomachaches, or dizziness if you are exposed to large amounts for a long period of time. The health effects from long-term exposure to low levels of 1,1,2,2-TCA are not known. It is also not known whether 1,1,2,2-TCA will cause reproductive effects in people. It is not known whether 1,1,2,2-TCA causes cancer in people. In a long-term study, it caused an increase in liver tumors in mice, but not in rats. The IARC has determined that 1,1,2,2-TCA cannot be classified as to its ability to cause cancer in humans, while the EPA has determined that it is a possible human carcinogen.

Tetrahydrofuran (THF) THF, a four-carbon cyclic ether, is a clear, flammable liquid with an ether-like odor. It is widely used as an industrial solvent. It is also used for resins, coatings, adhesives, magnetic tapes, printing inks, Grignard reactions, lithium aluminum hydride reductions and polymerizations; chemical intermediate, and preservative for histological samples.

Although it has been used in large quantities for many years, few long-term toxicology studies, and no reproductive or developmental studies, have been conducted on THF. THF is a central nervous system depressant. At lower concentrations, THF can cause headaches and can irritate the nose and throat. THF is anesthetic (causes loss of sensation and consciousness) at high concentrations (25,000 ppm) and also causes decreased blood pressure and strong respiratory stimulation. A concentration of 25,000 ppm was reported lethal to humans (duration of exposure not given).

No human cancer information is available. In one animal test, there was no evidence of carcinogenicity. The USDHHS, the IARC, and the EPA have not classified THF as to its carcinogenicity.

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 USDHSS 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.

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 USDHSS, 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.

Appendix B – Transfer of Contaminants to the Air

Exposure to volatile contaminants in water can occur from pathways other than ingestion. These pathways are inhalation of contaminants transferred to the indoor air from showers, baths, toilets, dishwashers, washing machines and cooking; ingestion of contaminants in food; and dermal absorption of contaminants while washing, bathing and showering. For VOCs, the exposure from transfer of contaminants during showering has been considered as potentially important.

A mathematical model has been developed to simulate the daily concentration histories of VOCs within various compartments of the indoor air environment as a result of home water use (McKone 1987). The results of this model provide a basis for calculating the pathway exposure factor, which can be used to estimate the inhalation exposure attributable to the contaminant concentration in tap water. The model divides the indoor air volume into three compartments:

- shower/bath stall,
- bathroom, and,
- household.

The gas phase contaminant concentrations within these compartments are dependent on the rate of mass transfer from the water to air, compartment volumes, and air exchange rates. Using measured mass transfer coefficients from water to air for radon, McKone and Bogen (1992) has shown that the transfer efficiency of a contaminant is given by:

$$\Phi_x = \Phi_R * \frac{2.0 * 10^6}{\left[\frac{2.5}{D^{2/3}{}_L} + \frac{RT}{H * D_a^{2/3}}\right]}$$

where Φ_x = mass transfer efficiency of contaminant x from water to air,
Φ_R = mass transfer efficiency of radon from water to air = 0.70 for showers and 0.54 for all household water uses, including showers,
D_L = contaminant diffusion coefficient in water (m^2/sec),
D_a = contaminant diffusion coefficient in air (m^2/sec),
R = universal gas constant (Pa-liter/mol-^{o}K),
T = temperature in (^{o}K), and,
H = Henry's law constant in (Pa-liter/mol)

The gas phase concentration of contaminant in shower, bathroom, and household indoor air can be approximated using the above transfer estimate and a simple relationship proposed by Fisk et al. (1987). The concentration of an indoor air contaminant is given as:

$$Cs = Cw * (Ws * \Phi_x)/VRs$$

$$Cb = Cw * (Ws * \Phi_x)/VRb$$

$$Ch = Cw * (Wh * \Phi_x)/VRh$$

where Cw = concentration of contaminant in the water (mg/L),
Cs = concentration of contaminant in the shower (mg/m^3),
Cb = concentration of contaminant in the bath (mg/m^3),
Ch = concentration of contaminant in the house (mg/m^3),
Ws = water use rate per individual in the shower (liters/hr),
Wh = water use for all household activities and averaged over 24 hrs (liters/hr),
VRs = average ventilation rates in the shower (m^3/hr),
VRb = average ventilation rates in bathroom (m^3/hr), and,
VRh = average ventilation rates in the house (m^3/hr).

The input parameter for the model is given in Table A.

Table A: Input parameters used to calculate air phase concentration

Parameter Description	**Notation**	**Value**	**Unit**
Shower water use rate per person	Ws	480	Liter/hr
Total water use in the house	Wh	42	Liter/hr
Ventilation rate in the shower	VRs	12	m^3/hr
Ventilation rate in the bath	VRb	54	m^3/hr
Ventilation rate in the house	VRh	750	m^3/hr
Shower Duration	Ets	0.13	hr
Exposure time in the bathroom	Etb	0.33	hr

Gas and Liquid Phase Diffusion Coefficients

The diffusion coefficient of contaminant in the air was estimated by using Fuller, Schettler, and Giddings' (Geankoplis, 1982) equation:

$$Da = \frac{0.00100 * T^{1.75}\sqrt{\frac{1}{M_A} + \frac{1}{M_B}}}{P * [(\Sigma v_A)^{1/3} + (\Sigma v_B)^{1/3}]^2}$$

where T = temperature in (^{o}K),
M_A = molecular weight of the contaminant,
M_B = molecular weight of air,
P = atmospheric pressure (atm),
Σv_A = sum of structural diffusion volume increments, and,
Σv_B = diffusion volumes.

The diffusion coefficient of contaminant in the water was estimated by using Othmer and Thakar's (Geankoplis, 1982) equation:

$$D_L = \frac{14.0 * 10^{-5}}{\mu^{1.1}_B * V^{0.6}_A}$$

where μ_B = viscosity of water (cp), and,
V_A = solute molar volume at the boiling point.

References:

Geankoplis, C.J. (1982) Mass Transport Phenomena, *Ohio State University*, Columbus, OH.

McKone, T.E. (1987) Human Exposure to Volatile Compounds in Household Tap Water: The Indoor Inhalation Pathway, *Environmental Science and Technology*, 21: 1194-1201.

McKone, T.E. and Bogen, K.T. (1992) Uncertainties in Health-Risk Assessment: An Integrated Case Study Based on Tetrachloroethylene in California Groundwater, *Regulatory Toxicology and Pharmacology*, 15:86-103.

Appendix C

Summary of Public Comments and Responses
Cedar Brook Area Groundwater Contamination Site Public Health Assessment

The NJDHSS held a public comment period from December 1, 2004 through January 22, 2005 to provide an opportunity for interested parties to comment on the draft Public Health Assessment prepared for the Cedar Brook Area Groundwater Contamination Site. At the request of community members, this public comment period was extended until February 11, 2005. No written comments were received by the NJDHSS during the public comment period.

The following summary presents comments provided by interested parties during a January 11, 2005 public meeting held by the NJDHSS and ATSDR to present and discuss the draft Public Health Assessment. Approximately 50 residents and township and county officials attended the meeting.

Responses to comments pertaining to NJDHSS activities were prepared by the NJDHSS; responses to comments pertaining to NJDEP activities were prepared by the NJDEP. Questions regarding this summary or any aspect of this Public Health Assessment may be addressed to the NJDHSS at (609) 584-5367.

Comment 1: *Ingestion of nitrate in water causes "blue baby syndrome" in infants. Does it have any similar adverse health effect(s) on senior citizens?*

NJDHSS Response: At the present time there is no evidence in the literature that indicates ingestion of nitrate contaminated water (at 10 mg/L, which is the federal and NJ State MCL) is associated with methemoglobinemia in adults.

Comment 2: *Was there a health outcome data analysis conducted for the site?*

NJDHSS Response: The NJDHSS reviewed cancer incidence data, 1979 through 2001, from the New Jersey State Cancer Registry for the township. That review found no cancer cases residing on streets in the Cedar Brook area. However, due to the complicated mailing address pattern for municipalities in that area and change of street names for the 911 emergency system, the initial review of cancer data may have missed cases in the Cedar Brook area. Since then, the NJDHSS has worked with local officials to better characterize mailing and street names for this area. A new review of cancer data for a larger area will be conducted in order to more accurately document cancer incidence in the community.

Comment 3: *What is the basis of MCLs?*

NJDHSS Response: Maximum Contaminant Levels (MCLs) are based on an ingestion health risk of developing either a cancer or a non-cancer health problem. For most

MCLs, the calculations are based on consumption of two liters of water a day containing contaminants for a duration of 70 years. However, certain MCLs, such as for nitrate, are based on exposures to infants. The goal for MCLs of cancer-causing contaminants is to minimize the risk of developing cancer to one in a million after a lifetime of exposure. That is usually not possible because of limitations in detection or treatment. The great majority of contaminants with standards set in this way are not considered as "known" human carcinogens. Rather, they are considered to be "probable" or "possible" human carcinogens, which mean that the risk to humans is more theoretical. In general, MCLs for chemicals having adverse non-cancer health effects are set based on safety factors that reduce the level of exposure far below those at which the effect was observed. Often the level at the standard is one thousand or more times lower. Furthermore, standards are typically made stricter by including an additional "safety" factor to account for other sources of exposure, including contamination in food and air.

One of the keys to understanding MCLs is that, with rare exception, there is a large margin of safety built into the standard, so that exceeding the standard by a small amount does not noticeably change whether the person is "safe". In fact, there is typically a wide shading of gray, and measurable health effects for most contaminants of concern would not be expected unless the standard were exceeded by an order or two of magnitude (i.e., 10 to 100 times).

Comment 4: *The work associated with the extension of the main public water supply line is almost complete. When will resident "hook up" begin?*

NJDEP Response: According to Ben Blair, Project Manager, Churchill Engineering, Inc., the bidding process to connect residences to public water supply will start in the Spring of 2005. A questionnaire asking information about connection details is either mailed or being mailed to affected residents. The contaminated wells will be sealed by a contractor after giving the connection.

Comment 5: *The remedial investigation of the Lightman Drum Factory Superfund site is on-going. Why is the Lightman Drum Factory still in operation?*

NJDEP Response: The Lightman Company remains a licensed drum recycling facility and today is under close scrutiny during respective agency regulatory inspections. The groundwater contamination at and emanating from the site is the result of illegal disposal activities which took place between 1972 and the early 1980's, during the time that the facility was temporarily a transportation, storage and disposal (TSD) facility. Current operations at the site do not interfere with the on-going remedial investigation on and off-site.

Comment 6: *Why is contamination source identification for the Cedar Brook groundwater contamination so difficult?*

NJDEP Response: In order to determine the source(s) of groundwater contamination, extensive environmental samples must be collected and analyzed from a number of different properties. Prior to sampling, the NJDEP must obtain written permission from the owners to access their properties and perform work. Some owners will not grant permission. NJDEP will continue to pursue access for the source investigation study and adjust sampling locations where feasible.

Comment 7: *Pumping at the sewage lift station caused drying of some of the shallow potable wells in the Cedar Brook area. Did the high sewage pumping rate have an effect on the contaminant movement from the source area?*

NJDEP Response: Sewage pumping occurs through a closed system of pipes and would not effect groundwater contamination migration. However, during building construction or sewer pipe placement, dewatering of the excavations may effect groundwater flow and contamination migration. The effect on groundwater depends on pumping rate and the depths of the excavations and groundwater.

Comment 8: *What are the criteria for testing potable wells in the Cedar Brook groundwater contamination area? How is the CKE line drawn by NJDEP? Why wasn't the contamination plume delineated after five years?*

NJDEP Response: The Camden County Health Department notified the NJDEP of potable well contamination in the Cedar Brook area as a result of well testing for real estate sales. The NJDEP then launched multiple area-wide potable sampling events. The properties sampled were chosen by location and proximity to the known contaminated wells. The potable well sampling continued, adding new locations radially out from the known contaminated wells until clean areas were found.

The Currently Known Extent (CKE) area of contamination is determined by potable well results. The Department delineated this area by encompassing all the contaminated wells that are within a 1,000 foot radius of four other contaminated wells. Any property with three acres or less that is partially included in the CKE area was included in the total. Inclusion of larger properties was dependent on the location of the potable well and its proximity to other contaminated wells in the area using the 1,000 foot rule. The CKE area includes properties with contaminated wells, in addition to properties that were not tested or tested below contaminant criteria but are within the delineated area.

The CKE area for the Cedar Brook site was delineated months after the site was transferred to the NJDEP. Multiple rounds of potable well sampling and data reduction were conducted prior to the CKE delineation. The NJDEP continues to monitor the perimeter of the CKE by sampling potable wells outside of the delineated area. If the contamination migrates, the CKE delineation is adjusted.

Comment 9: *Is there a remediation plan for the Cedar Brook area groundwater contamination?*

NJDEP Response: Not yet. The immediate environmental concern for the Cedar Brook area is to eliminate human exposure to contamination and to provide a reliable source of potable water to the property owners in the CKE area of contamination. Once this concern is mitigated and the human exposure pathway is eliminated, the NJDEP will perform a Remedial Investigation (RI) to determine the horizontal and vertical extent of the groundwater plume of contamination. A Remedial Action (RA) plan for the groundwater contamination will then be developed.

Comment 10: *NJDEP conducts potable well testing in the area. The contaminant concentration numbers are not reported back to the residents; the test results are reported as "below MCL". Is there a way to obtain the actual concentrations from NJDEP?*

NJDEP Response: Contaminant concentration numbers are reported to the property owner when they are at or above the Maximum Contaminant Level (MCL). If a property owner is interested in their result levels reported as "below MCL," they can contact the NJDEP representative at the phone number provided on their results letter in a timely manner and the actual numbers from lab data can be provided.

ATSDR Glossary of Terms

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms.

General Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific

population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond,

incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of

people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

CERTIFICATION

The Public Health Assessment for the Cedar Brook Area Contamination site, Winslow Township, Camden County, New Jersey, was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement Partner.

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

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