Public Health Assessment

Puchack Well Field Site

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Pennsauken Township, Camden County, New Jersey

Public Comment Draft

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Summary

The Puchack Well Field (PWF) site was one of several primary water supply sources for the City of Camden, Camden County, New Jersey. The PWF site occupies an area of approximately 10 acres located in a commercial/residential area of Pennsauken Township, Camden County, New Jersey. Until 1998, the PWF was a part of a blended system serving approximately 50,000 of the 80,000 people in the City of Camden.

In the past, practices of handling and discharging hazardous substances by various nearby commercial and industrial facilities have resulted in contamination of the underlying Potomac-Raritan-Magothy (PRM) aquifer, which the Puchack Well Field utilized. Contamination of the well field was first reported in the 1970s when trichloroethylene (TCE), 1,2-dichloroethane, tetrachloroethylene (PCE), mercury and hexavalent chromium were detected in well number 6. The contamination subsequently spread to the other five supply wells at the PWF.

Groundwater contamination resulted in the closure of the all six supply wells. Use of most wells ended in 1984. The last supply well to be taken out of service was well number 1 in May 1998. From 1984 to 1998, well number 1 was pumped intermittently at a rate of one million gallons per day to prevent the spread of contamination to nearby well fields. The pumped water from well number 1 was blended with water from other wells for distribution in the city's water supply or was discharged untreated to an infiltration basin.

In 1997, the New Jersey Department of Environmental Protection (NJDEP), in cooperation with the United States Geological Survey (USGS), initiated an investigation to obtain additional information on the extent of groundwater contamination related to PWF. Twenty-six monitoring wells were installed and sampled. Twenty-nine additional existing monitoring wells were also sampled. To date, these efforts have not pinpointed the source or sources of the contaminants that have been detected in the well field.

The site was proposed for listing to the National Priorities List (NPL) in September 1997, and was placed on the NPL on March 6, 1998. The United States Environmental Protection Agency (USEPA) has begun a Remedial Investigation/ Feasibility Study (RI/FS) to determine the scope of contamination, identify sources, and design possible remedial alternatives.

This Public Health Assessment evaluates existing groundwater, well field, and drinking water distribution system data, human exposure pathways, and the potential public health issues related to the PWF site. Based on a review of these data, the PWF site is considered by the Agency for Toxic Substances and Disease Registry (ATSDR) and the New Jersey Department of Health and Senior Services (NJDHSS) to have represented a **public health hazard because of past exposures**. This determination is based on the presence of a completed exposure pathway in the past (through community water supplies)

to PCE, TCE, mercury, and chromium to a potentially large population at levels in exceedance of health based comparison values.

Current conditions indicate that exposure to contaminants from the PWF site is no longer occurring since the exposure pathway through use of the PWF was interrupted by the closure of all production wells. For this reason, the ATSDR and the NJDHSS are categorizing the PWF site as **no apparent public health hazard under present conditions**. However, the groundwater contamination plume affecting the PWF site has not yet been fully delineated.

The NJDHSS and the ATSDR support the remedial investigations underway by the USEPA to determine the scope and sources of contamination. The ATSDR and the NJDHSS recommend continued sampling and testing of the groundwater wells, at an appropriate interval, to monitor movement of the contamination plume and its possible spread to other community supply wells in the area.

Past completed human exposure pathways associated with the PWF are of sufficient public health concern to warrant a review of health outcome data for the area. The NJDHSS and the ATSDR will develop a specific plan to examine relevant health databases, possibly including cancers and adverse reproductive outcomes, in areas served by wells of the PWF.

Purpose and Health Issues

This Public Health Assessment evaluates the public health issues associated with the Puchack Well Field (PWF) site, which was proposed for inclusion on the National Priorities List (NPL) in September of 1997, and was placed on the NPL on March 6, 1998. NPL or "Superfund" sites represent those sites that are associated with significant public health concern in terms of the nature and magnitude of contamination present, and the potential to adversely impact the health of populations in their vicinity.

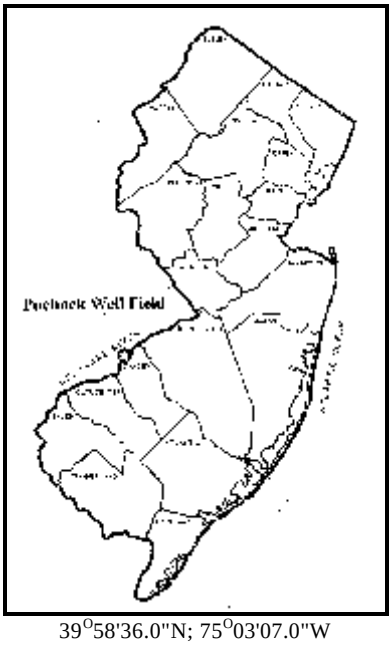
In this document, the Agency for Toxic Substances and Disease Registry (ATSDR) and the New Jersey Department of Health and Senior Services (NJDHSS) will evaluate human exposure pathways associated with known contaminated environmental media within or associated with the PWF site and recommend action consistent with protection of the public health.

At the PWF site, the known contaminated medium is groundwater. The exposure pathway being considered is the ingestion of water from contaminated supply wells in the past.

Background

Site Description and History

The Puchack Well Field is located in Pennsauken Township, Camden County just south of the Betsy Ross Bridge (see inset, and Figure 1 in the Appendix). Drinking water for a majority of residents of Camden City is provided by the Camden City Water Department; the remaining portion of the city is served by the New Jersey American Water Company. Four well fields are maintained by the city of Camden to supply the community system. Three of these, the Morris, Delair, and Puchack Well Fields, are located in Pennsauken Township, and the fourth (Parkside Well Field) is located in Camden City. The area encompassed by the PWF is approximately 450,000 square feet, or 10.33 acres. The Camden City Water Department provided water to approximately 50,000 residents from the PWF in the past.



39°58'36.0"N; 75°03'07.0"W

The Puchack Well Field site consists of six public supply wells, identified as Puchack wells number 1, 2, 3, 5, 6 and 7 (well number 4 was destroyed during construction of the Betsy Ross Bridge). Groundwater withdrawals averaged 6.55 million gallons per day (mgd) at the Puchack Well Field in 1975 and 2.34 mgd in 1988. Wells range in depth from 141 feet to 220 feet. All wells withdraw

groundwater from the lower aquifer of the Potomac-Raritan-Magothy aquifer system.

Contamination by volatile organic chemicals and metals was first detected in the Puchack Well Field in the early 1970s. Puchack well number 6 was removed from service in 1975 because raw water samples collected from that well continued to indicate the presence of total and hexavalent chromium at levels of public health concern. Contamination subsequently spread to Puchack well number 5, 7, 3, 2 and 1, and resulted in the closure of all of the PWF wells except well number 1 by 1984. The Camden City Water Department continued to use Puchack well number 1 to help prevent the migration of contaminants to other public supply wells in the area (Morris and Delair Well Fields). The water obtained from Puchack well number 1 was either discharged to waste or blended with the other supply water until May 1998.

The source of the contamination at the Puchack Well Field is not known, but there are several sites in the area that have been identified by the NJDEP as possible sources. In October 1991, the NJDEP issued a Directive and Notice to Insurers to a number of facilities or companies in the site vicinity. Fifteen separate investigations have been initiated at nearby sites where discharges of hazardous substances to the ground or waters of the State have been identified. As of 1996, the NJDEP had identified more than 38 known contaminated sites in Pennsauken Township. Potential sources of groundwater contamination will be investigated during the Phase II RI/FS.

Demography and Land Use

Land use in the vicinity of the PWF site is urban residential and industrial. The PWF is located in the Coastal Plain physiographic province, in northwestern Camden County, New Jersey near the Delaware River. The well field is situated in the outcrop area of the Potomac-Raritan-Magothy aquifer system (PRM). The PRM has been divided into three aquifers composed mainly of sand and gravel, termed upper, middle, and lower, which are separated by two confining units composed mainly of silt and clay. The depth of the water table is about 70 to 80 feet in the vicinity of the PWF. All of the area wells including those located in the Morris, Delair, and Puchack Well Fields are screened in and withdraw groundwater from the lower aquifer of the PRM. The bedrock is not used as a source of groundwater in the area.

The Puchack Well Field was a part of a blended system serving approximately 50,000 of the 80,000 people in the City of Camden. According to current site information provided by the NJDEP, there are no private potable wells in use which have been impacted by the area-wide groundwater contamination, and all residences in the vicinity of the site are provided with water from a community water supply.

Previous ATSDR/NJDHSS Activity

The ATSDR and the NJDHSS conducted a site visit and generated a Site Visit Report in June 1997. The report noted that contaminated groundwater was the only identifiable potential environmental pathway associated with the PWF site.

The ATSDR and the NJDHSS categorized the site in 1997 as a public health concern because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects (NJDHSS/ATDSR, 1997). In addition, the ATSDR and the NJDHSS concluded that further information was needed to adequately assess the impact of the site on public health. Recommendations were made to conduct the following activities:

1) Insure that contaminated groundwater is not being used for potable purposes;

2) Obtain additional information on contaminants to further characterize the site and the hydrogeology of the area;

3) Continue monitoring of community supply wells in the vicinity of the site.

Site Visit

On July 16, 1998, Sharon Kubiak, Steve M. Miller, and Narendra P. Singh of the NJDHSS visited the PWF site. The NJDHSS was accompanied by representatives of the NJDEP and a representative of the Water Well Division, City of Camden Department of Utilities. The following observations were made during the 1998 site visit:

1) Conditions at the site have changed since the 1997 Site Visit Report as the last operating community supply well number 1 was removed from service as of May 1998.

2) The PWF site is fenced and hazard warning signs are posted. The site contains several structures including an office building and several small buildings housing the community supply wells. The site is currently active, with five people working on the site maintaining the property owned by the Camden City Water Department.

Discussion

The primary public health issue associated with the PWF site pertains to groundwater contamination and its impact on the PRM aquifer which was and continues to be a significant source for community water supplies in the area. The following discussion relies on information presented in these references: CDM, 1999; USEPA, 1997; USEPA, 1996; USGS/NJDEP, 1998; Malcolm Pirnie, 1986; and NJDEP, 1985-90.

The USEPA is conducting the Remedial Investigation/Feasibility Study for the PWF site. The purpose of the first phase of the study is to determine the nature and extent of groundwater contamination at the site. Field activities include a hydrogeological assessment (in cooperation with the USGS), soil boring sampling, and associated surface water and sediment testing. A second phase of investigation will examine sources of the groundwater contamination and plans to prevent further contamination of groundwater.

Groundwater Investigations

Community Supply Wells and the Distribution System

The Puchack Well Field served a part of the population of Camden City. Water from these wells was generally mixed with water from nearby well fields (Morris and Delair Wells) before distribution to the population.

In the early 1970s, volatile organic chemicals (VOCs), mercury, and chromium were detected in Puchack well number 6. The VOCs detected included trichloroethylene (TCE), tetrachloroethylene (perchloroethylene, or PCE), 1,2-dichloroethane, and chloroform. In 1984, TCE levels ranged from 30 to 70 parts per billion (ppb); the current maximum contaminant level (MCL) for TCE is 1 ppb. Historical chromium concentrations, of which 90% is in the form of hexavalent chromium, reached the highest levels at well number 7 (l,000 ppb) in 1984. Other maximum chromium concentrations included 600 ppb in well number 5 (in 1978), and 180 ppb in well number 3 (in 1982). Concentrations at each of these wells exceeded the maximum contaminant level (MCL) for total chromium of 100 ppb. In 1981, mercury contamination was detected at the Puchack well number 2 (5.5 ppb), well number 3 (2.3 ppb), and well number 5 (8.4 ppb); the current MCL for total mercury is 2 ppb.

Well number 6 was removed from service in 1975; well 5 was taken out of service between 1981 and 1983. By 1984, use of the PWF was largely abandoned, with the exception of well number 1. The Camden City Water Department used Puchack well number 1 to help prevent the migration of contaminants to other public supply wells in the area; water from this well was either discharged to waste or blended with other supply water from the Morris and Delair well fields. By May 1998, well number 1 was taken out of service. While VOCs have been consistently present in wells in the PWF, they have been only sporadically found in wells in the Morris and Delair well fields. The Morris and Delair fields had less

than 1 ppb TCE and PCE in 1980 and 1 to 2 ppb in the late 1980s. During the off-peak winter months, water from the PWF was used as little as possible with concurrent increases in production at the other well fields. Results of the analyses for VOCs in the distribution system from 1985 to 1990 are summarized in Table 1 (in the Appendix). Maximum levels of TCE and PCE observed in the part of Camden served by the Puchack and Morris and Delair well fields were 37 and 14 ppb, respectively. Average TCE levels ranged from about 1 to 19 ppb, and average PCE levels ranged from not detectable to 14 ppb. There were no distribution system data from 1981-1984, and 1989. There were no data available on chromium or mercury in the distribution system.

On March 6 and 7, 1996, representatives of the NJDEP collected groundwater samples from Puchack wells number 1, 2, 3, 5, 6 and 7. The samples were analyzed for volatile organic and inorganic chemicals. At the time, Puchack wells number 2, 3, 5, 6 and 7 were not used to provide water to Camden City. Analytical results indicated the presence of chromium, mercury, and TCE in all of the Puchack well samples. Chromium concentrations ranged from 46.6 ppb to 1,410 ppb; mercury concentrations ranged from 0.15 ppb to 0.77 ppb; and TCE concentrations ranged from 0.3 ppb to 20 ppb.

Monitoring Wells

In 1997, the NJDEP and the United States Geological Survey (USGS) initiated an investigation to obtain additional information on the extent of groundwater contamination related to the PWF. Twenty-six monitoring wells were installed and sampled. Twenty-nine additional existing monitoring wells were also sampled. Of these 55 wells, 26 wells are located in the immediate vicinity of the PWF. Results of the analyses of the 26 monitoring wells are summarized in Table 2 (in the Appendix).

Analytical results indicated elevated levels of metals including dissolved chromium (up to 10,250 ppb), dissolved hexavalent chromium (up to 11,540 ppb), and dissolved mercury (up to 2.5 ppb). VOCs were detected in most of the samples. TCE was detected in 16 samples ranging from 0.1 ppb to 140 ppb. The compound 1,1-dichloroethylene was detected in six samples ranging from 1 ppb to 10 ppb. Other VOCs detected included carbon tetrachloride, chlorobenzene, ethylbenzene, PCE, 1,1-dichloroethane, 1,2-dichloropropane, and xylene.

Human Exposure Pathways Analysis

To determine whether residents of Camden City were or are exposed to contaminants in the groundwater through the community supply wells located at the PWF, the ATSDR and the NJDHSS evaluate the environmental and human components that lead to human exposure. This pathways analysis consists of five elements: (1) a source of contamination; (2) transport through an environmental medium; (3) a point of human exposure; (4) a route of human exposure; and (5) an exposed population.

The ATSDR and the 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 which 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.

Based upon available data regarding the above described contamination in community supply wells and within the distribution system, the ATSDR and the NJDHSS have determined that a completed human exposure pathway to VOCs, mercury, and chromium existed in the past through use of contaminated groundwater. Contaminants were introduced from the impacted wells into the community water supply distribution system. This exposure pathway to VOCs and metals is estimated to have occurred from the onset of documented contamination (in the early 1970s) until May 1998, when the last remaining well was taken off line.

VOCs, particularly TCE and PCE, were measured at the wells and in the distribution system. Use of water from the distribution system would result in exposure to the contaminants through ingestion of the water, dermal contact, and inhalation of volatilized fractions during showering or bathing. Although there were no data available for chromium and mercury in the distribution system, their presence in the distribution system and exposure through ingestion can be inferred from the data from the Puchack wells.

The potential for current exposure to contaminated groundwater associated with the PWF site no longer exists, since all of the community supply wells located at the PWF have been taken out of service. Thus, the completed exposure pathway to VOCs, mercury, and chromium from PWF is now interrupted.

The total number of persons associated with the completed exposure pathway through the community water supply in the past is difficult to determine, although the NJDEP has estimated that approximately 50,000 people were served by water from the PWF. Exposure potential is dependent upon the dynamics of the water system during the period in question, and the location of potentially affected residences relative to the point of entry within the water system. A summary of the exposure pathway associated with community water supply wells at the PWF is presented in the following table.

Completed Human Exposure Pathway Associated with PWF						
Pathway Name	**Source**	**Environmental Media**	**Point of Exposure**	**Route of Exposure**	**Exposed Population**	**Contaminants (Time Documented)**
Community Water Supply	PWF	Groundwater	Residences served by water from the PWF of the community water supply	Ingestion, dermal contact, and inhalation	Residents receiving water from the PWF in the past (approximately 50,000)	VOCs Mercury Chromium (early1970s to 1998)

Public Health Implications

This section discusses the potential for health effects in persons exposed to specific contaminants (for completed human exposure pathways), reviews health outcome data, and addresses specific community health concerns. Health effects evaluations are accomplished by reviewing toxicologic and epidemiologic information about contaminants of concern, and by estimating the amount (or dose) of those contaminants that a person might come in contact with on a daily basis. This estimated exposure dose is then compared to established health guidelines. People who are exposed for some crucial length of time to contaminants of concern at levels above established guidelines are more likely to have associated illnesses or disease.

Toxicologic and Epidemiologic Evaluation

To assess the public health significance of completed human exposure pathways associated with oral exposure to these groundwater contaminants, exposure doses were estimated and compared to ATSDR's Minimal Risk Levels (MRLs) or USEPA Reference Doses (RfDs), when available. In addition, lifetime excess cancer risk estimates (LECRs) based on these exposure doses were calculated, when applicable. For the purposes of this evaluation, exposure estimates were based upon highest average concentrations of TCE and PCE detected in the distribution system (19 ppb and 14 ppb, respectively). For adults, the exposure dose estimates assumed a 70 kg body weight and ingestion rate of 2 liters of water per day, while for children, the estimates assumed a 10 kg body weight and an ingestion rate of 1 liter of water per day. An exposure duration of 24 years was assumed for LECR estimates for adults**.**

Because of the frequency with which community water supplies in New Jersey have been contaminated with VOCs in the past, the NJDHSS has conducted several large-scale epidemiologic studies to assess the potential public health impact of VOCs in drinking water. The results of these efforts are included in the discussion below.

Effects of TCE and PCE in Adults

The effects of exposure to TCE and PCE have been evaluated in scientific studies for their possible impact upon adult human health. Laboratory animals have been exposed to these chemicals via contaminated air, drinking water, and food. The results of these studies indicate that the nervous system and liver, and to a lesser degree the kidney and heart, are the primary organs of adult animals affected by these VOCs (ATSDR, 1997a; ATSDR, 1997b). TCE and PCE are classified as probable human carcinogens by the International Agency for Research on Cancer (IARC, 1995) based on the weight of evidence from laboratory animal experiments and limited human epidemiologic studies.

Following long-term, high level exposure, TCE has been shown to produce liver cancer in mice and kidney and testicular tumors in rats (ATSDR, 1997b; IARC, 1995). Chronic, high level PCE exposure produces liver cancer in mice and kidney tumors and mononuclear cell leukemia in rats (ATSDR, 1997a;

IARC, 1995). It should be noted that the exposure levels needed to cause these adverse impacts in laboratory animals are many times higher than exposure levels that could have occurred through the use of contaminated drinking water (ATSDR, 1997a; ATSDR, 1997b).

Epidemiological studies of occupationally-exposed workers suggest an association between long-term inhalation exposure to high levels of TCE and increased risk of liver and biliary tract cancer and non-Hodgkin's lymphoma (IARC, 1995; ATSDR, 1997b). Increased risks of esophageal cancer, cervical cancer, and non-Hodgkin's lymphoma have been observed in workers exposed to high levels of PCE (IARC, 1995; ATSDR, 1997a). A study by the NJDHSS found that communities with a history of TCE- and PCE-contaminated water supplies had higher rates of leukemias and non-Hodgkin's lymphomas, particularly among females (Cohn et al., 1994; Fagliano et al., 1990). In Massachusetts, another study suggested that increased exposure to PCE was associated with higher incidence of leukemias (Aschengrau et al., 1993).

Participants in the ATSDR TCE Exposure Subregistry (approximately 5,000 individuals with exposure to TCE in private wells, at levels ranging up to 24,000 ppb, for a duration as long as 33 years) have reported a variety of health problems at rates above national averages, including anemia and other blood disorders, stroke, urinary tract disorders, liver and kidney problems, diabetes, and skin rashes, eczema and other skin allergies (ATSDR, 1999a). Only the rate for strokes was reported to increase with increasing concentration of TCE in drinking water. It should be noted that these data are based on self-reported health conditions and have not been verified through physician records. ATSDR is evaluating information on cancer occurrence in the Subregistry and has not yet published its results or conclusions.

Effects of TCE and PCE in Children and the Fetus

Children may be particularly susceptible to the toxic effects of chemicals; fetuses may also be sensitive to toxic effects if the chemicals can cross the placental barrier. Recent epidemiologic studies suggest that fetal exposure to VOCs in drinking water could result in adverse health effects. The NJDHSS evaluated the effects of VOCs in drinking water on birth outcomes in an area of northern New Jersey (Bove et al., 1995). This exploratory study found that maternal residence during pregnancy in areas with TCE-contaminated drinking water was associated with an increased risk of birth defects of the neural tube and oral cleft. Exposure to PCE during pregnancy was associated with an increased risk of oral cleft defects. The authors concluded that their study by itself cannot determine whether the drinking water contaminants caused the reported adverse birth outcomes, but that further study was needed.

An ATSDR study of exposure to VOCs in drinking water and occurrence of adverse pregnancy outcomes was conducted for residents of the U.S. Marine Corps Base at Camp LeJeune, North Carolina (ATSDR, 1997c). The researchers reported a significantly decreased mean birth weight and increased

small for gestational age babies for two potentially susceptible subgroups: infants of mothers older than 35 years of age and infants of mothers with histories of fetal death. However, length of exposures to VOCs was not known for the entire period during which pregnancy outcomes were evaluated. Therefore, this study provides limited evidence for a causal relationship between exposure to VOCs and the reproductive and developmental effects evaluated.

A study of childhood leukemia conducted in Woburn, Massachusetts, concluded that the incidence of childhood leukemia was associated with the mother's potential for exposure to water from specific wells contaminated with TCE and PCE, particularly for exposure during pregnancy (MDPH, 1997). The study did not find any association between the development of childhood leukemia and the child's exposure to contaminated water after birth. The Woburn study should be interpreted with caution, however, since small numbers of study subjects led to imprecise estimates of risk. A study by the NJDHSS found a statistically elevated rate of childhood leukemia in towns served by community water supplies contaminated with TCE and PCE in the years 1979 to 1987, compared to towns without a history of such contamination (Cohn et al., 1994). Overall, the associations drawn from these limited epidemiological data in humans are suggestive, yet inconclusive, that exposure to these VOCs through drinking water may cause birth defects or childhood cancers in children exposed while a fetus. ATSDR, NJDHSS, and others are conducting or sponsoring research to clarify this possible relationship.

Comparison of Exposure Estimates with Toxicologic Information for TCE and PCE

No chronic oral MRL is available for TCE to evaluate the potential for non-carcinogenic health effects, although there is a provisional RfD of 0.006 milligrams per kilogram per day (mg/kg/day). Estimated exposure doses for adults and children, calculated for a concentration of 19 ppb of TCE, were 0.0005 mg/kg/day and 0.002 mg/kg/day, respectively. These levels are below the provisional RfD and were well below the No Observed Adverse Effects Level (NOAEL) of 50 mg/kg/day for animal studies presented in the ATSDR Toxicological Profile for this chemical. At such concentrations, it is unlikely that non-carcinogenic adverse health effects would occur. For adults, the LECR was estimated to be 2 in one million; this level of risk is considered by ATSDR to represent no apparent increased risk of cancer. Based upon a PCE concentration of 14 ppb detected in the distribution system in 1985, estimated exposure doses for adults and children were 0.0004 mg/kg/day and 0.001 mg/kg/day, respectively. These levels are below the U.S. Environmental Protection Agency's (USEPA) RfD for PCE of 0.01 mg/kg/day, and are far below the NOAEL of 941 mg/kg/day for animal studies presented in the ATSDR Toxicological Profile for this chemical. At such concentrations, it is unlikely that non-carcinogenic adverse health effects would occur. For adults, the LECR was estimated to be 7 in one million; this level of risk is considered by ATSDR to represent no apparent increased risk of cancer.

Effects of Mercury

Mercury is a metallic element that may occur naturally in rocks and soils, and can be released into

the atmosphere. Mercury and mercury compounds have numerous commercial applications, and may be released into the environment through industrial emissions, waste disposal practices, and waste incineration. Mercury exists in a number of chemical and physical forms which generally can be classified as either inorganic or organic. Inorganic mercury includes liquid (metallic) mercury, mercurous mercury, and mercuric mercury. Organic mercury compounds are formed when mercury combines with carbon. When exposure occurs by ingestion, the body absorbs 90% of organic mercury and 15% of inorganic mercury.

Most mercury found in water is expected to be inorganic as opposed to organic mercury (e.g., methyl mercury). In general, inorganic mercury is less bioavailable and less toxic than organic mercury. The target organ for inorganic mercury toxicity is the kidney while the most sensitive toxic endpoint for methyl mercury exposure is the nervous system. Exposure to all forms of mercury has been associated with adverse health effects and all forms are considered poisonous. Inhaling low levels of mercury vapor (metallic mercury) has been associated with tremors, emotional instability, and kidney dysfunction (proteinuria and reduced filtration). Inhaling high levels of mercury vapor has been associated with respiratory, cardiovascular, and gastrointestinal effects. There are no data available to indicate that elemental mercury causes cancer, and it is classified as a Group D (not classifiable) carcinogen by the USEPA. Limited data indicate an increase of renal tumors in rats fed high levels of methylmercury and there is limited evidence that mercuric chloride (an *inorganic* form) is carcinogenic in animals (ATSDR, 1999b).

Mercury was detected in Puchack wells at a concentration of 8.4 ppb in 1981, but there are no data indicating levels in the distribution system. However, at a concentration of 8 ppb, an adult daily dose would be approximately 0.0002 mg/kg/day, and a child's daily dose would be 0.0008 mg/kg/day. There is no chronic MRL available for mercury, but the MRL for intermediate oral exposure to mercuric chloride is 0.002 mg/kg/day, which incorporates a safety factor of 100; the USEPA RfD is 0.0003 mg/kg/day. Adult exposure dose estimates for mercury are below the MRL and RfD, while the child's estimate falls between these comparison values. However, actual exposures in the distribution would be less due to mixing with uncontaminated well water.

Effects of Chromium

Chromium is a naturally occurring metallic element found in rocks, soil and foods. This metal has numerous commercial uses and may be found in the environment as a result of waste disposal practices. Chromium exists in several forms other than as a metal. Two common forms are trivalent chromium (III), and hexavalent chromium (VI). Chromium (III) compounds are stable and are commonly found in variable amounts in soil, surface water and groundwater. Chromium (III) is an essential nutrient that helps the body use sugar, protein, and fat. Chromium (VI) may be present in the environment as a result of industrial processes. Chromium (VI) compounds are readily reduced to chromium (III) in the presence of oxidizable organic matter. Ingesting very large amounts of chromium can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Laboratory animals (mice) that ingested large amounts of chromium had reproductive problems and offspring with birth defects. Skin contact with liquids

or solids containing chromium(VI) may lead to skin ulcers. Some people have allergic reactions including severe redness and swelling. Chromium (VI) is classified as a human carcinogen, and occupational inhalation studies indicate a correlation between long-term exposure to chromium (VI) compounds and lung cancer. Oral exposure to chromium (VI) has not been linked to increased risk of cancer; however there have been no epidemiologic studies assessing cancer risk from elevated chromium levels in drinking water. Exposure to chromium (III) is not believed to cause cancer. Because chromium (VI) has a greater potential to be toxic than chromium (III), the USEPA has set its reference dose (RfD) for chronic ingestion of chromium (VI) at 0.003 mg/kg/day and for chronic ingestion of chromium (III) at 1.5 mg/kg/day. There are no oral MRLs for hexavalent or trivalent chromium (ATSDR, 1993).

Chromium (VI) was not measured within the distribution system, but concentrations exceeded 100 ppb in the wells. At a concentration of 100 ppb (the Maximum Contaminant Level for total chromium), and assuming 90% in the hexavalent form, an adult daily dose of chromium (VI) would be approximately 0.003 mg/kg/day, and a child's daily dose of chromium (VI) would be approximately 0.01 mg/kg/day. Both of these levels would reach or exceed the EPA Reference Dose for chromium (VI) for non-cancer effects.

Health Outcome Data

As mentioned above, the NJDHSS has conducted several epidemiologic studies in New Jersey examining the relationship between TCE and PCE contamination of drinking water and the risk of cancers and adverse reproductive outcomes. However, there has not been a specific evaluation of health outcome data, such as cancer incidence, in the areas historically served by the Puchack Well Field.

Community Health Concerns

In order to gather information on community health concerns, NJDHSS contacted the Camden City Health Department, and the NJDEP Community Relations Coordinator. The community health concerns associated with the site focus upon the groundwater contamination particularly by volatile organics and chromium and their impact on community supply wells. Local officials, as well as private citizens, have expressed concern to NJDEP about the PWF site and other well fields in the area.

Conclusions

Based on a weight-of-evidence analysis of the health and environmental information compiled, each Public Health Assessment assigns a hazard category in response to the public health risk posed by the site being evaluated. Each category relates to a set of additional actions or interventions that may be considered by the ATSDR, the NJDHSS or other public health agencies, as well as recommendations for further action to the USEPA, NJDEP or other environmental agencies.

The PWF site is considered by the ATSDR and the NJDHSS to have represented a **public health hazard because of past exposures**. This determination is based on the following considerations: 1) the presence of a completed exposure pathway in the past (through community water supplies) to VOCs (including PCE and TCE), mercury, and chromium to a potentially large population; 2) exposure levels to these contaminants in comparison to information from toxicologic and/or epidemiologic studies. Although the comparisons to toxicologic information do not indicate that adverse health effects would be likely due to TCE and PCE exposure levels, there are suggestions from epidemiologic studies that exposure to TCE and PCE in drinking water may pose a risk of certain cancers and adverse reproductive outcomes.

Current conditions indicate that exposure to contaminants from the PWF site is no longer occurring since the exposure pathway through use of the PWF was interrupted by the closure of all production wells. For this reason, the ATSDR and the NJDHSS are categorizing the PWF site as **no apparent public health hazard under present conditions**. However, the groundwater contamination plume affecting the PWF site has not yet been fully delineated.

Past completed human exposure pathways associated with the PWF are of sufficient public health concern to warrant a review of health outcome data for the area.

Recommendations

The NJDHSS and the ATSDR support the USEPA's Remedial Investigation/Feasibility Study to determine the nature and extent of groundwater contamination at the PWF site, identify sources, and develop plans to prevent further contamination of groundwater.

The ATSDR and the NJDHSS recommend continued sampling and testing of the groundwater wells, at an appropriate interval, to monitor movement of the contamination plume and its possible spread to other community supply wells in the area.

Health outcome data for the area should be examined. Past completed human exposure pathways associated with the PWF are of sufficient public health concern to warrant a review of health outcome data for the area. The NJDHSS and the ATSDR will develop a specific plan to examine relevant health

databases, possibly including cancers and adverse reproductive outcomes, in areas served by wells of the PWF. Because there have been other contaminated drinking water supply sources serving Camden City and nearby municipalities, it may be useful to examine health outcome data on a broader regional basis as well.

Local health officials and other community leaders should be surveyed for additional public health concerns and the need for future community educational activity. Site-specific educational materials should be prepared and disseminated as necessary.

Public Health Action Plan

The Public Health Action Plan (PHAP) for the PWF site contains a description of the actions to be taken at or in the vicinity of the site. The purpose of the PHAP is to ensure that this Public Health Assessment not only identifies public health hazards, but 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 taken or to be implemented are as follows:

Actions Undertaken by ATSDR/NJDHSS:

1. Available data and information have been evaluated by the ATSDR and the NJDHSS to determine public health concerns regarding potential human exposure pathways associated with the PWF site.

Actions Planned by ATSDR/NJDHSS:

1. The NJDHSS, in cooperation with the ATSDR, will assess adverse health outcomes in geographic areas served by the water from the PWF. A plan will be developed to determine the scope of the evaluation regarding types of outcomes, time frames, geographic areas of study, and appropriate comparison populations.

2. The ATSDR and the NJDHSS will review water quality and other data associated with the PWF generated from the RI/FS for public health significance. Should new data alter the interpretation of the public health implications of the PWF site, or conclusions and recommendations in this Public Health Assessment, the NJDHSS and the ATSDR will re-evaluate this PHAP.

3. The NJDHSS and the ATSDR will assess the need for future community education activity. The NJDHSS will contact local health officials and community leaders to assess community needs.

ATSDR Child Health Initiative

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

Children would have been exposed in the past to contaminants from the PWF site through use of community water supplies. As discussed in the Public Health Implications section, epidemiologic studies of mother's and children's exposure to TCE and PCE in drinking water suggest an increased risk of certain cancers and adverse reproductive outcomes. For this reason, reviews of health outcome data for the area served by wells of the PWF should consider including an examination of childhood cancer incidence and adverse reproductive outcomes.

Certification

This Public Health Assessment was prepared by the New Jersey Department of Health and Senior Services (NJDHSS) 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 begun.

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

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Appendices

Figure

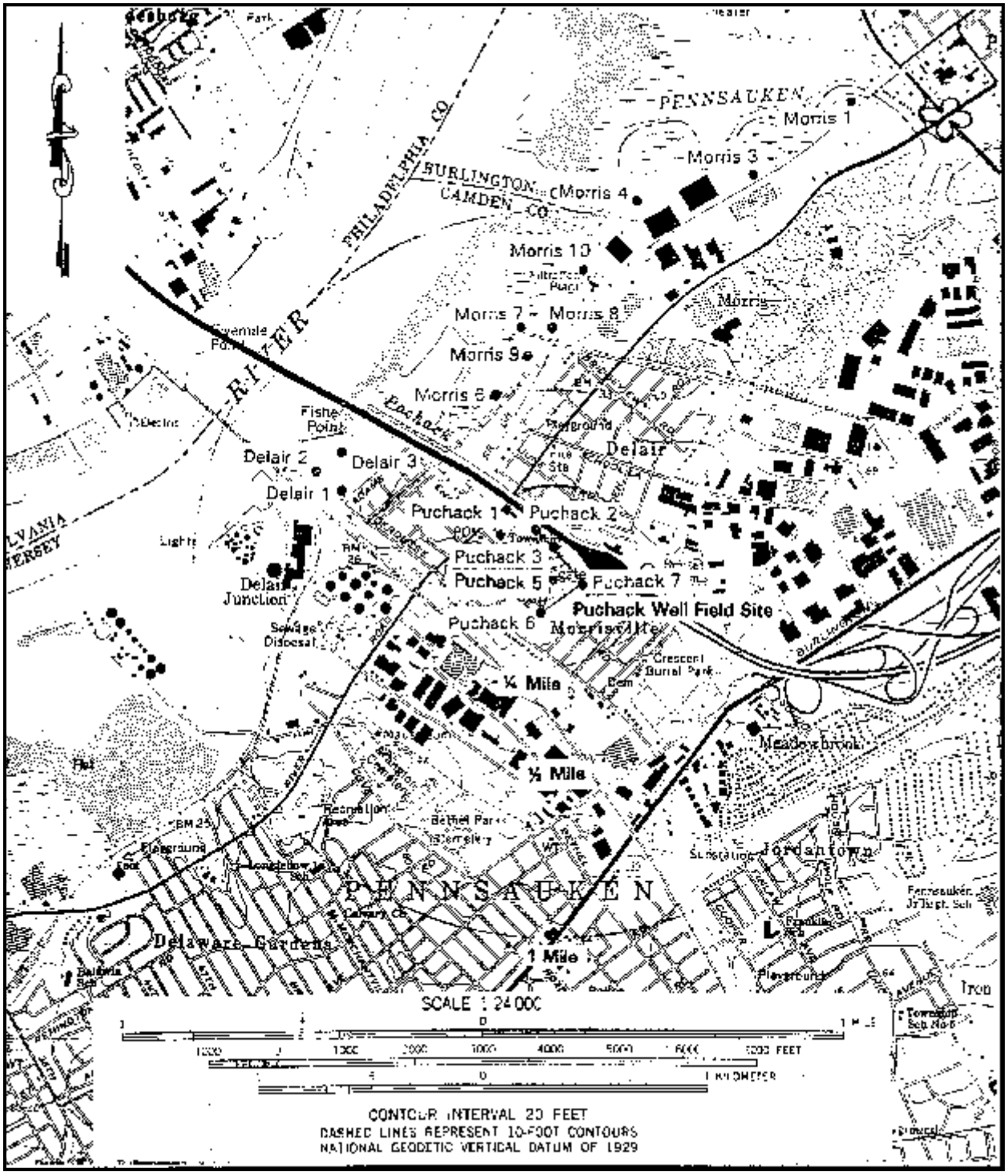

Figure 1 - Location of Puchack Well Field.

Tables

Table 1 Contaminants in Camden City Water Department distribution system samples. Source: NJDEP Bureau of Safe Drinking Water (NJDEP, 1985-1990).

Sample Dates	Average and (Range of Detection) in ppb.	
	PCE	TCE
1/3/85	14	4.5
6/28/85	4.8 (1.8-10)	19 (7.7-37)
12/31/85	2.2 (2.0-2.7)	8.7 (7.0-12)
6/12/86	0.8 (0.3-1.5)	4.3 (3.7-5.8)
12/19/86	1.1 (ND-2.3)	2.7 (0.6-5.3)
6/23/87	2.9 (1.8-5.0)	6.6 (2.7-8.4)
12/29/87	ND	1.7 (1.5-1.9)
12/8/88	0.6 (ND-1.3)	1.4 (ND-2.5)
5/18/90	0.7 (0.2-1.5)	1.1 (0.2-1.9)

Note: The Comparison Value for both PCE and TCE is 1 ppb (MCL).
ppb parts per billion
PCE tetrachloroethylene
TCE trichloroethylene
ND Not Detected
MCL Maximum Contaminant Level

Table 2 Contaminants in monitoring well samples located near the Puchack Well Field site. Source: CDM, 1999.

Contaminant	Range of Detection (in ppb)	Comparison Value	
		in ppb	Source
PCE	0.28 - 280	1	MCL
TCE	0.4 - 140	1	MCL
1,1-dichloroethylene	1 - 10	2	MCL
1,1-dichloroethane	0.04 - 6	50	MCL
1,2-dichloropropane	0.3 - 2	5	MCL
ethylbenzene	3 - 1,000	700	MCL
chlorobenzene	14	4	MCL
carbon tetrachloride	1.5	0.3	CREG
o-xylene	5 - 1,700	1,000	MCL
chromium (dissolved)	1.2 - 10,250	100	MCL
hexavalent chromium (dissolved)	735 - 11,540	30 (child)	RMEG
mercury (dissolved)	0.4 - 2.5	2	MCL

MCL Maximum Contaminant Level
RMEG Reference Dose Media Evaluation Guide
CREG Cancer Risk Evaluation Guide
PCE tetrachloroethylene
TCE trichloroethylene
ppb parts per billion

Glossary

ATSDR Plain Language Glossary of Environmental Health Terms

Absorption: How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure: Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Additive Effect: A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

Adverse Health Effect: A change in body function or the structures of cells that can lead to disease or health problems.

Antagonistic Effect: A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

ATSDR: The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level: An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Biota: Used in public health, things that humans would eat – including animals, fish and plants.

CAP: See **C**ommunity **A**ssistance **P**anel**.**

Cancer: A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control

Carcinogen: Any substance shown to cause tumors or cancer in experimental studies.

CERCLA: See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure: A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway: See **Exposure Pathway**.

Community Assistance Panel (CAP): A group of people from the community and health and environmental agencies who work together on issues and problems at hazardous waste sites.

Comparison Value (CVs): Concentrations or the amount of substances in air, water, food, and soil that are unlikely,

upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):

CERCLA was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concern: A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Delayed Health Effect: A disease or injury that happens as a result of exposures that may have occurred far in the past.

Dermal Contact: A chemical getting onto your skin. (see **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration: The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemical of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA):

The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Epidemiology: The study of the different factors that determine how often, in how many people, and in which people will disease occur.

Exposure: Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure

Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure; and,
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

Malignancy: See **Cancer**.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: **P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Plume: A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For examples:
the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:

1. Urgent Public Health Hazard
2. Public Health Hazard
3. Indeterminate Public Health Hazard
4. No Apparent Public Health Hazard
5. No Public Health Hazard

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with

them (See **Exposure Pathway**).

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

SARA: The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

Sample Size: The number of people that are needed for a health study.

Sample: A small number of people chosen from a larger population (See **Population**).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Synergistic effect: A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

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

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.