ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

WATSON JOHNSON LANDFILL
RICHLAND TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA
EPA FACILITY ID: PAD980706824
JUNE 23, 2004

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.

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PUBLIC HEALTH ASSESSMENT

WATSON JOHNSON LANDFILL

RICHLAND TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA

EPA FACILITY ID: PAD980706824

Prepared by:

Pennsylvania Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ATSDR	Agency for Toxic Substance and Disease Registry
CCl_4	Carbon tetrachloride
CEL	Cancer Effect Level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	ATSDR=s cancer risk evaluation guide
CSF	EPA=s Cancer Slope Factor
CV	comparison value
1,2-DCE	cis-1,2-dichloroethylene, also known as cis-1,2 dichloroethene
EMEG	ATSDR=s environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
HC	ATSDR Health Consultation
MBK	methyl butyl ketone
MEK	methyl ethyl ketone
MCL	EPA=s Maximum Contaminant Level
mg/kg	milligram per kilogram
MRL	ATSDR=s minimal risk level
MTWA	Milford Township Water Authority
NOAEL	No Observable Adverse Effect Level
NPL	National Priorities List
PADEP	Pennsylvania Department of Environmental Protection
PADOH	Pennsylvania Department of Health
PCE	tetrachloroethene (also known as tetrachloroethylene)
PHA	ATSDR Public Health Assessment
PHAP	public health action plan
QBWS	Quakertown Borough Water Supply
RfD	reference dose
RI	remedial investigation
RMEG	ATSDR=s reference dose media evaluation guide
RW	residential well
1,1,1-TCA	1,1,1-Tetrachloroethane
TCE	trichloroethene (also known as trichloroethylene)
TRI	EPA=s Toxic Release Inventory
SD	sediments
SI	site inspection
SS	surface soil
SW	surface water
VC	vinyl chloride
VOC	Volatile organic compound
WBFD	Walnut Bank Farm Development
Φg/L	micrograms per liter
<	less than

SUMMARY

The Watson Johnson Landfill (the site) is a 32-acre area northeast of the Tohickon Creek and about 2000 feet west of Route 212 in Richland Township, Bucks County, Pennsylvania. The landfill began accepting wastes sometime between 1936 and 1955. In the mid 1960s, the landfill accepted 3200 tons of waste from W.R. Grace Company=s Quakertown chemical facility. The landfill has been inactive since 1973.

In preparing for this public health assessment (PHA), the Pennsylvania Department of Health (PADOH), working under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), reviewed environmental sampling data from the United States Environmental Protection Agency (EPA) (September 1998 - November 2002) and a local water supplier (March 2003) and gathered community concerns during discussions with residents in their homes and at town meetings.

Groundwater at the site is contaminated with volatile organic compounds (VOCs) and arsenic. VOCs in on-site groundwater appear to be the result of past disposal practices. VOCs and arsenic have also been detected in off-site groundwater (private and public wells) and may be present in other media. The VOCs in groundwater south of the site are possibly originating at the site. The source of arsenic contamination is not clear, but may be related to local geological structure.

After reviewing the environmental data, potential exposure situations, human health studies, and contaminant toxicology information, PADOH and ATSDR conclude:

1. Past and present exposures (ingestion) to arsenic in well water for less than a lifetime (any amount of time less than 70 years) would have varying degrees of theoretical risks for the development of cancer based on the concentrations of arsenic in the water and the lengths of exposure. It is unlikely, however, that past and present exposures to arsenic in water would result in noncancerous harmful health effects.

2. Continuous (past, present, & future) exposures (ingestion) to arsenic in water over a lifetime (70 years) in homes near the site could theoretically cause a no apparent to moderate increased risk of cancer. Human health studies provide additional evidence of a possible association of a dose-related increased risk of cancer; thereby, potentially threatening the health of the people who use their well water. However, the levels of arsenic necessary to cause cancer are generally higher than those observed at this site. It is unlikely that continuous exposure to arsenic in the water, even over a lifetime, would result in noncancerous harmful health effects.

3. Past, present, and future exposures (ingestion & inhalation) to trace (very low) levels of VOCs in homes to the east and west of the site along Richlandtown Pike and Heller Road do not threaten the health of the residents using their well water.

4. Past and present exposures (ingestion & inhalation) to trichloroethene (TCE) and tetrachloroethene (PCE) at levels above their Maximum Contaminant Levels (MCL) in residential wells south of the site along North Ambler Street, Highland Street, Penrose Street, Woodland Avenue and southeast of the site along Richlandtown Pike are not expected to result in adverse health effects for the residents using their well water.

5. Inhalation exposure to TCE (if unabated over a lifetime) by some residents living south of the site theoretically causes a low increased risk of their exposure resulting in cancer. Although epidemiology studies do not show an association between TCE and cancer at the levels found at this site, to err on the side of caution, as well as practice prudent public health, we recommend the provision of inline carbon filtration units or connection to municipal water for residents where TCE is present in private well water at levels above its MCL. EPA is considering providing municipal water to the residences. As residences are connected to a public water supply, the potential for future exposure to TCE at levels above its MCL will be diminished.

6. The public health significance of potential exposure to VOCs in additional wells south of the site that were not sampled because residents either refused EPA=s offer to sample or because EPA was unable to contact them after repeated attempts is unknown due to the lack of data.

7. Past exposure to TCE in residential tap water from Quakertown Borough Water Supply (QBWS) wells #10 & 17 represents an unknown threat to public health and cannot be further evaluated. It is not possible to assess the likelihood of a health threat from past exposure to TCE in residential tap water prior to the installation and operation of air strippers on wells #10 and 17 due to the lack of historical information identifying when these wells first became contaminated, the number of days per year the wells were in service, and the water quality at the tap.

8. We do not know if the arsenic concentrations in the QBWS system (and ultimately at residential taps) fluctuated over time as various wells are brought on and offline to meet seasonal water demands. Assuming the arsenic concentrations at the residential taps were consistent over time, then continuous (past, present, & future) exposures (ingestion) to arsenic by residents receiving municipal water from QBWS wells could theoretically over a lifetime (70 years) cause a low increased risk of developing cancer to the people using their tap water. However, based on human studies it is unlikely that even a lifetime of exposure to arsenic in the tap water at the concentrations detected would actually cause cancer. It is also unlikely that a lifetime of exposures to arsenic in the tap water would result in noncancerous health effects. Exposure to arsenic in tap water would not threaten the health of the residents consuming municipal water.

9. Past exposure to concentrations of arsenic in water from the Walnut Bank Farm Development (WBFD) well would not threaten the health of residents who used this water because of the brevity of their exposure prior to the well=s closure.

10. The public health significance of potential exposure to VOCs or other contaminants in landfill surface soil and the surface water and sediments in the Tohickon Creek is not known due to inadequate sampling data. However, based on the limited data collected during the 2002 interim sampling effort, exposure to low levels of arsenic or VOCs detected in surface soil, surface water, and sediments in the few areas that were sampled would not threaten the health of people who may come in contact with them. Additional, comprehensive sampling and evaluation of these media are necessary to determine if contaminants are present at concentrations that could impact public health.

EPA plans to further sample site monitoring wells, soils, surface water and sediments in the Tohickon Creek as part of their Remedial Investigation/Feasibility Study Work Plan for this site. When additional sampling results become available, PADOH will analyze them and determine future public health actions for the community.

PURPOSE AND HEALTH ISSUES

The purpose of this PHA is to identify potential human exposures to contaminants near the Watson Johnson Landfill by evaluating existing on and offsite environmental data, community concerns, and to recommend appropriate public health follow up activities. Health questions raised by the community are addressed in the Community Health Concerns section of this document or have been addressed during meetings in the resident=s home or in other settings.

BACKGROUND

Site Description and Operational History

The Watson Johnson Landfill site (the site) consists of a 32-acre inactive and unlined landfill located approximately three-quarter mile north of Quakertown in Richland Township, Bucks County, Pennsylvania (Figures 1-2). The site lies northeast of Tohickon Creek and is approximately 2,600 feet south of East Pumping Station Road and 2,000 feet west of Richlandtown Pike. The site can be accessed through an unimproved road from East Pumping Station Road (Figure 2). The entire property consists of approximately 56 acres, of which 32 acres were used as a landfill [1].

The landfill accepted waste from approximately 1936 until 1973 from all of Quakertown Borough, portions of Perkasie and Sellersville Boroughs, and upper Bucks County areas. Although the exact types and quantities of wastes accepted at the landfill are not known, a Waste Disposal Site Survey (Eckhardt Survey) that was completed in 1979 indicated that W.R. Grace & Company disposed a total of 3,200 tons of waste at the landfill from their Quakertown chemical facility from 1965 through 1968. According to the report, the waste was composed of various organic and inorganic compounds, resins, and elastomers [1].

The topography of the general site area is shown on Figure 2. The land surface in the vicinity of the landfill is relatively flat, sloping slightly to the southwest toward the Tohickon Creek which flows from northwest to southeast and is about one-quarter mile from the site. Woodlands and isolated wetlands are located southwest of the site, extending from the landfill to Tohickon

Creek Wetlands adjacent to the landfill are part of a larger wetland area southwest of the site. This contiguous wetland area drains into the Tohickon Creek. The site is located within one watershed. Overland flow from the site probably enters a wetland that is adjacent to the landfill=s southwestern border. Portions of surface water flow through this wetland and eventually discharge to the Tohickon Creek [1].

During the time the landfill was active; several leachate ponds were located along the southern and western edge of the landfill. In July 1972, the owner of the landfill, Watson Johnson, pumped the leachate from one of these lagoons into the wetland adjacent to the landfill where it eventually flowed into the Tohickon Creek. The discharge caused a fish kill to occur in the Tohickon Creek Investigations by the Bucks County Health Department and the Pennsylvania Fish Commission determined that the pumping of leachate from the Watson Johnson landfill was the cause of the fish kill. The former Pennsylvania Department of Environmental Resources subsequently issued an order to the landfill in 1973. The order determined that the site was an illegal solid waste disposal site that allowed leachate to discharge into surface waters of the Commonwealth; therefore, the site was ordered to immediately cease operations. The soil and vegetation-covered landfill has been inactive since 1973 and access to the site is presently unrestricted [1].

Environmental Contamination

EPA sampled water in private residential wells near the site from 1998 to 2002 and detected various levels of arsenic and VOCs (primarily TCE) in the water in some of the wells (Table 2). Based on the initial sampling rounds, during the autumn of 2000, EPA requested PADOH to determine the public health significance of the residential exposure to the contaminated well water. PADOH prepared two health consultations (HC)s [2,3] to address the issue. EPA subsequently proposed the site to the National Priorities List (NPL) of hazardous waste sites on June 14, 2001, and formally added it to the NPL on September 13, 2001 [4].

This section discusses the results of environmental samples collected by the Milford Township Water Authority (MTWA) and EPA or their respective contractors from November 1997 and May 2000 (MTWA) and September 1998 through November 2002 (EPA). During EPA=s investigation, media that were sampled on or near the Watson Johnson landfill included groundwater, surface water, surface soils, and sediments. The sampling data are divided into Aon-site@ and Aoff-site@ data. The term on-site refers to sampling locations within the landfill property. The term off-site refers to surrounding sample locations near the site.

In addition to reviewing the results of on-site and off-site environmental media sampling, PADOH conducted a search of EPA=s Toxic Release Inventory (TRI) database. The TRI is a publicly available database that contains information on toxic releases and other waste management activities reported annually by regulated industries and federal facilities. This search did not reveal any toxic chemical releases and other waste management activities that could be responsible for the off-site contamination discussed in this document.

On-site Sampling Data

Monitoring Wells

EPA installed (July 1999) and sampled (September 1999) groundwater in three shallow and/or deep monitoring well clusters on the Watson Johnson Landfill (Figure 3). Arsenic and VOCs (primarily TCE) were detected in both the shallow and deeper groundwater beneath the site.

The maximum concentration of arsenic in shallow on-site groundwater was 3.9 micrograms per liter (Φg/L). The maximum concentration of arsenic in deeper on-site groundwater was 4.2 Φg/L [2]. The maximum concentrations of the chlorinated VOCs that included tetrachloroethene (PCE), vinyl chloride (VC), cis-1,2-dichloroethene (cis-1,2-DCE) and trichloroethene (TCE) in shallow on-site groundwater were 6.9 Φg/L, 7.1 Φg/L, 26 Φg/L, and 1560 Φg/L, respectively. The maximum concentrations of chlorinated VOCs in deeper on-site groundwater were PCE at 9.9 Φg/L, VC at 10.4 Φg/L, cis-1,2-DCE at 44.6 Φg/L, and TCE at 14.3 Φg/L. A non-chlorinated VOC, methyl ethyl ketone (MEK), was also detected in deeper on-site groundwater at a maximum concentration of 3.0 Φg/L. MEK was not detected in shallow on-site groundwater [2] (Table 1).

Surface Soil

During March 2002, EPA conducted interim surface soil sampling (SS-01-15) at the site in fourteen locations (Figure 4) [5]. Arsenic was detected in all of the samples at concentrations ranging from 3 milligrams per kilogram (mg/kg) to 24 mg/kg. The maximum concentration of arsenic (24 mg/kg) was found in sample SS-02. EPA will be conducting a comprehensive characterization of surface soil as part of their Remedial Investigation/Feasibility Study Work Plan at this site (Figure 5) [1].

Surface Water and Sediments

During March 2002, EPA conducted interim sampling of surface water (SW-01-05) in wetlands and in an intermittent tributary to the Tohickon Creek at five locations (Figure 4) [1]. Arsenic was detected in one out of the five samples (SW-04) at an estimated concentration of 2.4 Φg/L. TCE was not detected in any of the surface water samples [5].

During March 2002, EPA also conducted interim sampling of sediments (SD-01-10) of an intermittent tributary to the Tohickon Creek and wetlands at ten locations (Figure 4) [5]. Arsenic was detected in all samples at concentrations ranging from an estimated 3.0 mg/kg to an estimated 9.1 mg/kg. The maximum concentration of arsenic (9.1 mg/kg) was detected in interim sampling in SD-02. TCE was not detected in any of these interim sediment samples [5]. EPA will be conducting a comprehensive characterization of surface water and sediments on-site and off-site in the Tohickon Creek as part of their proposed Remedial Investigation/Feasibility Study Work Plan for this site, and PADOH will evaluate the results of the media characterization when the data becomes available (Figure 6) [1].

Off-site Sampling Data

Residential

<u>Arsenic</u>

During September 1998 and July 1999, EPA sampled several residential wells (RWs) near the site (Figure 7 & 8). During June 2001 and again during March and April 2000, EPA sampled residential wells primarily south of the site (Figure 9).

The September 1998 and July 1999 sampling showed that RWs near the site along Richlandtown Pike, East Pumping Station Road, Turntable Circle, Heller Road and Junction Lane contained arsenic at concentrations ranging from 3.0 to 33.5 μg/L (Table 2). Five (5) out of 29 home wells contained concentrations of arsenic above EPA=s proposed regulatory standard (MCL) of 10 μg/L, effective January 23, 2006 [6]. The maximum concentration (33.5 μg/L) of arsenic was detected during the September 1998 sampling along Richlandtown Pike in RW-12 [2] (Figure 7).

The June 2001 and March-April 2002 sampling showed that RWs south of the site along Heller Road, Woodland Avenue, Penrose Street, and Ambler Street contained arsenic ranging from less than 2.0 μg/L (non-detect) to 28.0 μg/L (Table 2). The maximum concentration of arsenic (28.0 μg/L) was detected during the March-April 2002 sampling along Penrose Street in RW-51 (Figure 9) [3,5].

During November 2002, private wells throughout the residential area surrounding the Watson Johnson landfill were sampled by Tetra Tech, Inc. for EPA (Figure 10). Arsenic was detected in 73 of 74 samples at concentrations ranging from 2.1 to 41 μg/L. Water in twenty (20) private wells (RWs 8, 32, 42, 70-77, 80, 83, 84, 90, 91, 105, 107, 109 & 115) contained arsenic at concentrations equal to or above its proposed MCL of 10 ppb (μg/L). Concentrations in well water from these homes ranged from 10 μg/L to 41 μg/L [7].

<u>VOCs</u>

During the September 1998 and July 1999 sampling events, trace levels (1.0 μg/L or less) of one or more of several chlorinated VOCs that included 1,1-dichloroethane (1,1-DCA), 1,1,1-trichoroethane (1,1,1 -TCA), 1,1-dichloroethene (1,1-DCE), carbon tetrachloride ($CC1_4$), and PCE were detected in four (4) of the residential wells sampled. Only one residential well (RW-4 in Figure 7, same as RW-12 in Figure 8) showed trace levels of chlorinated VOCs in both sampling events. Low levels of non-chlorinated VOCs (MEK and/or methyl butyl ketone (MBK) were detected in three of the 17 residential wells sampled during September 1998. MEK and MBK were not detected in residential wells sampled during July 1999. VOCs were not detected in any of the other residential wells during one or both of these sampling events [2].

During the June 2001 sampling event, TCE was detected in nine (9) out of forty (40) RWs near the site (Figure 9). TCE was detected in four RWs south of the site in the area approximately bounded by Heller Road, Highland Avenue, Penrose Street, and Woodland Avenue at concentrations ranging from an estimated 0.8 Φg/L to 15.0 Φg/L. The maximum concentration (15.0 Φg/L) of TCE was in the well water (RW-31). TCE was also present in a few of the private wells (RWs 3-6 & RW-30) east of the site along Richlandtown Pike in concentrations ranging from an estimated 0.1 Φg/L to a known concentration of 4.0 Φg/L in RW-30. With the exception of the single home (RW-30) that had a TCE concentration of 4.0 Φg/L, all the other wells along Richlandtown Pike contained low concentrations (less than 0.3 Φg/L) of TCE in the water. During the June 2001 sampling event, only one home (RW-31) that was south of the site had a concentration (15.0 Φg/L) of TCE in well water exceeding its MCL of 5 Φg/L [3].

During March and April 2002 private wells predominately south of the site were again sampled. TCE was detected in seven (7) out of thirty one (31) residential wells south of the site (RWs-20, 31, 47, 50, 55, 64, & 66) at concentrations exceeding its MCL of 5.0 Φg/L (Figure 9). The maximum concentration (33.3 Φg/L) of TCE was detected along Ambler Street in RW-64 [5].

During November 2002 private wells throughout the residential area surrounding the Watson Johnson landfill were sampled by Tetra Tech, Inc. for EPA (Figure 10). TCE was detected in 9 out of 74 samples at concentrations ranging from an estimated 0.06 to 24 Φg/L. Water in two (2) private wells (RWs-78 & 104) contained TCE at concentrations above its MCL of 5.0 Φg/L. Concentrations of TCE in well water from these homes were 18 and 24 Φg/L. PCE was detected in 8 out of 74 samples at concentrations ranging from an estimated 0.2 to 6.1 Φg/L. Water in seven (7) private wells contained PCE at trace levels estimated to be in the range of 0.2 to 0.5 Φg/L. Water in one (1) private well (RW-81) contained PCE at a concentration above its MCL of 5.0 Φg/L. Water in this well contained PCE at a concentration of 6.1 Φg/L [7].

Public Wells

During November 1997 and May 2000, MTWA sampled raw water from the Walnut Bank Farm Development (WBFD) well (Figure 8). The WBFD well contained arsenic at concentrations of 17.3Φg/L and 23.9 Φg/L, respectively. VOCs were not detected in the WBFD well [8].

During July 1999, EPA sampled raw water from two Quakertown Borough Water Supply (QBWS) wells (Figure 8). During this sampling event, combined raw water from the two QBWS wells was found to contain arsenic at 6.0 Φg/L, 1,1-DCE at 0.6 Φg/L, cis-1,2-DCE at 7.0 Φg/L, TCE at 35.0 Φg/L and PCE at 1.0 Φg/L. The water from the two QBWS wells has been treated by air stripping to remove VOCs prior to being blended with water from other QBWS wells and distributed to residential taps since 1989 [2,9].

On March 17, 2003, two residential taps south of the site along Ambler Avenue were sampled by the Borough of Quakertown to determine the level of arsenic reaching the taps from the QBWS system. Arsenic was detected in tap water at the residences at concentrations of 7.0 µg/L and 10.0 µg/L.

Quality Assurance and Quality Control

In preparing this PHA, PADOH reviewed and evaluated information provided in the referenced documents. Documents prepared for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program must meet standards for quality assurance and control measures for chain-of-custody, laboratory procedures, and data reporting. The environmental data reviewed for this PHA are primarily from EPA=s contractor. Based on our evaluation, PADOH and ATSDR have assumed that the quality of environmental data currently available were adequate for making the public health decisions presented in this PHA.

Demographics

The Watson Johnson Landfill lies approximately 0.75 mile north of the city of Quakertown in Richland Township, Bucks County, Pennsylvania. Approximately 8900 people live in Quakertown. As part of the total population, 7.6% (682/8900) are children ages 10 to 14 and 6.7% (601/8900) are children ages 15 to 19. Richland Township has a total population of approximately 9900. As part of the township population, 7.0% (696/9900) are children ages 10 to 14 and 6.3% (628/9900) are children ages 15 to 19. The Joseph S. Neidig Elementary School lies within one mile south of the site. Approximately 400 students are enrolled in this elementary school [10].

Land Use

The landfill is currently not in use and is presently covered with soil and vegetation. Access to the landfill is unrestricted (e.g., the site does not have a perimeter fence) and several residents said that they had routinely played on the landfill when they were children. We do not have information on surface conditions when the landfill was actively accepting wastes.

The landfill is located within one watershed. Overland flow from the site probably enters a wetland that is adjacent to the landfill=s southwestern border. Portions of surface water flow through this wetland and eventually discharge to the Tohickon Creek [1]. Frontier Wood Products, a composing facility, is located to the west of the site. The landfill is bordered by agricultural properties to the north and to the south. Residential subdivisions, Heather Valley/Richland Farms, border the landfill to the east. Several residential properties are located northeast of the landfill along the East Pumping Station Road and southeast of the site along Richlandtown Pike. Residential properties along Heller Road lie both east and south of the site and residential properties in the area of Penrose Street, Highland and Woodland Avenues lie south of the landfill and south of the Tohickon Creek.

Natural Resource Use

Groundwater Use

Both municipal and private groundwater wells within four miles of the site are used as potable water supplies. The Quakertown Borough Water Department uses 11 municipal wells to supply

service to its customers. Two QBWS wells (#10 & 17) lie southwest of the site (Figure 2). Water from these two wells is combined (blended) with each other and then possibly mixed with water from other QBWS wells before providing service to approximately 12,800 people. There are approximately 653 persons within a one-mile radius of the site and 10,869 persons within a four-mile radius of the site using private, residential wells [11].

The WBFD lies southeast of the site along Heller Road (Figure 8). Historically, water was provided to this residential community from a single public WBFD well. The WBFD well supplied water to the development from 1990 to 2000. During its operation, the well supplied water to approximately 562 people [11]. Currently, the WBFD is supplied water from the Richland Township Water Authority.

Homes northeast of the site along East Pumping Station Road, east of the site along Richlandtown Pike, west of the site along Heller Road, and south of the site in the area approximately bounded by Heller Road, Highland Avenue, Penrose Street, and Woodland Avenue use private wells for their source of potable water.

Surface Water Use

PADEP designated Tohickon Creek as a warm-water fishery. The Pennsylvania Fish and Boat Commission (PFBC) does not stock the Tohickon Creek with trout in the Quakertown area. However, there may be some naturally occurring fish, such as sunfish and small mouth bass that might be of interest to local anglers [12].

Site Visits

PADOH and ATSDR have conducted numerous visits to the site. During November 1999, representatives from PADOH and EPA conducted an initial site visit and surveyed the topography around the site to aid in determining the direction of groundwater flow. A portion of the Tohickon Creek that borders the site was observed. Signs prohibiting swimming or fishing were not observed and it appeared the stream may be used for recreation. Homes near the landfill were observed that were previously found by EPA to have arsenic present in their private, residential well water. Information gathered during this visit was evaluated and findings were published in PADOH/ATSDR=s first HC for this site [2].

During February 2001, PADOH sent letters to residents who had their well water sampled informing them of the public health significance of EPA=s sampling results, and conducted follow up door-to-door meetings at the resident=s home to answer any remaining questions. Additionally, PADOH hosted a Public Availability Meeting to answer questions from residents whose wells were not included in EPA=s initial sampling.

PADOH representatives conducted an additional site visit in August 2001 to obtain updated information, evaluate site conditions for PADOH/ATSDR=s second HC for this site [3], and share with residents the public health implications of their exposure to contaminants in their well water. On August 28 and 31, 2001, PADOH representatives met with residents living south of

the site along North Ambler (RW-31), Woodland Avenue (RW-14 and RW-20), North Penrose (RW-16), and Richlandtown Pike (RW-30), where TCE was detected in their private wells. PADOH discussed possible health implications with the residents based on the scenario that their exposure to TCE went unabated and occurred for a lifetime. During the visit, residents living in the homes served by RWs 14, 16, 20, 30, and 31 informed PADOH that they use bottled water for cooking and drinking. Residents living in the home served by RW-20 also have an in-line carbon filtration unit. This in-line filtration eliminates VOCs before the water is distributed throughout the home to the taps. Health issues and concerns that were expressed by the residents to PADOH during this and other site visits are discussed in the ACommunity Health Concerns@ section of this PHA.

On July 22 and 23, 2002, PADOH and ATSDR collaborated with the Bucks County Health Department in an educational effort to discuss with residents living in homes south of the site the public health implications of EPA=s March-April 2002 analysis of their private well water and share with them ways they could mitigate or abate their exposure to arsenic and TCE in their well water.

On August 23, 2002, PADOH representatives observed on-site conditions and surveyed the Tohickon Creek for any signs of recreational use that were not noticed during previous visits, located an area where residents claimed that people used as a dump for lawn clippings and possible disposal of household products, met with residents and answered health questions, and observed homes south of the site that have private wells that were not yet sampled by EPA. The site was observed to drain through wetlands into the Tohickon Creek. No signs of children playing on the site or using the Tohickon Creek for recreational activities downstream of the site were observed during the visit. However, there were no barriers observed that would prevent children from accessing the site and there were several locations along the Tohickon Creek that appeared as possible access areas where anglers could fish or children could recreate in the creek. The neighborhood disposal area appeared to only be used for lawn clippings; however, it was highly vegetated and one could not rule out the possibility that other activities occurred in areas that were not observable.

DISCUSSION

In this section, PADOH and ATSDR evaluate whether the community near the site have been, is, or may be exposed to harmful levels of contaminants in the environment. PADOH and ATSDR consider how individuals might come into contact with contaminated media, as well as the duration and frequency of their exposure.

Pathway Analysis (Environmental Exposure Scenarios)

To estimate whether nearby residents have been exposed to contaminants migrating from the site, we evaluated the environmental and human components of contaminant exposure pathways. Exposure pathways consist of five elements: a source of contamination (e.g. landfill), an environmental medium (e.g., groundwater), a point of exposure (e.g., private or public well water at the tap), a route of human exposure (e.g., ingestion), and a receptor population (e.g., area

residents).

We eliminate an exposure pathway if at least one of the five elements is missing and will never be present. Exposure pathways that we do not eliminate are either potential or completed. A pathway is classified as potential if at least one of the five elements is missing, but may be present in the future. With completed pathways, all five elements exist and exposure to a contaminant has occurred, is occurring, or will occur. Table 3 summarizes the potential, completed and eliminated exposure pathways.

Public and Private Well Water

Groundwater beneath the site moves along flow paths toward discharge points (e.g., Tohickon Creek) in down gradient areas. Normally, the Tohickon Creek would be expected to act as a shallow groundwater divide, such that wells south and southwest of it would not likely be affected by contaminated groundwater from the site. However, when active, two of the Quakertown Borough Water Supply (QBWS) wells (#10 and 17) may shift the divide southwestwardly, altering groundwater flow, and putting its wells and residential pumping wells in the area of Woodland Avenue and North Ambler Street at greater risk of receiving contaminants. Figure 11 presents a generalized, conceptual view of anticipated groundwater flow under a pumping scenario [13].

Raw water in the QBWS municipal wells along Heller Road contained varying concentrations of TCE and other VOCs. To prevent exposure to VOCs, the QBWS operates air strippers to remove VOCs before water distribution and conducts regular monitoring to ensure that drinking water regulations are met. *Therefore, past exposure to these contaminants in municipal well water was a completed exposure pathway. However, we have presently eliminated this pathway since current and future exposures are no longer issues.*

Water in WBFD well contained arsenic. To prevent exposure to the contaminated water, the well was taken out of service on May 16, 2000 [8]. *Therefore, past exposure to arsenic in water from this public well was a completed exposure pathway. However, we have presently eliminated this pathway since current and future exposures are no longer issues.*

Water in private residential wells surrounding the site is contaminated with varying concentrations of arsenic (believed to be naturally occurring) and VOCs (primarily TCE-believed to be site related). Residents using the wells that are contaminated can be exposed to the arsenic by ingesting (drinking and cooking) the well water. Residents can be exposed to the VOCs by ingestion and also by inhaling the contaminants during showering. Some of the homes were constructed in the 1940s through the 1960s, so the potential for lifetime exposure to arsenic is possible. However, for a variety of reasons, (length of time of home ownership, use of filter/bottled water, etc.), none of the residents using private well water in the area south of the site were exposed to TCE for a lifetime. However, lifetime exposure to TCE is also possible if corrective measures are not implemented. *Exposure to these contaminants in private well water* *is a completed exposure pathway. Its public health significance will be addressed later in this PHA.*

As seen in Figure 12, with respect to anticipated shallow groundwater flow under natural gradients, the site is cross gradient from residential wells located along Heller Road and Richlandtown Pike and down gradient from residential wells located along East Pumping Station Road. Shallow groundwater beneath the landfill is expected to move toward the south-southwest, to discharge points in the Tohickon Creek. As a result of this flow direction and subsequent discharge into the Tohickon Creek, site-related shallow groundwater is not likely to impact cross gradient residential areas along Heller Road and Richandtown Pike. Although it is not possible to clearly determine the flow direction of deeper groundwater beneath the site, groundwater movement is expected to be influenced by pumping of QBWS wells and may be impacting wells south of the site [13].

There are at least two homes south of the site that did not respond to EPA mailings or phone calls or were not interested in having their wells sampled. This represents a significant data gap because other private wells in close proximity to these wells were contaminated with TCE. *Exposure to contaminants in the private well water in these homes is a potential exposure pathway because residents may be using well water from a known contaminated groundwater plume.* Because there is presently insufficient data, the public health significance of residents in these homes using their well water cannot be determined at this time.

Surface Soil and Sediment

We do not have information on surface conditions at the site during operation and there are insufficient sampling data to fully evaluate current surface soils at the site. This represents a significant data gap because children or trespassers could have been potentially exposed to contaminated site soils. *We classify exposure to on-site surface soil as a past, completed pathway for workers and trespassers. We also classify exposure to off-site sediments in the Tohickon Creek by anglers and children recreating in the creek as a potential exposure pathway because creek sediments could possibly contain site-related contaminants.*

Surface Water

Surface water drains from the site toward the Tohickon Creek and contaminated groundwater beneath the site discharges into the Tohickon Creek in downgradient areas. Children and others may be exposed to site-contaminants in surface water while fishing or recreating in the stream. *We classify exposure to on-site surface water (puddles) by workers and trespassers and off-site exposure to surface water in the Tohickon Creek by anglers and children recreating in the creek as potential exposure pathways because these media could possibly contain site-related contaminants.*

Public Health Implications

In this section, PADOH evaluates existing environmental data and determines whether community members have been, are, or could be exposed to harmful levels of contaminants. PADOH considers how individuals might come into contact with contaminated media, as well as the duration and frequency of exposure.

To determine the possible health effects of site-specific chemicals, ATSDR has developed health-based comparison values (CVs). These CVs include environmental media evaluation guides (EMEGs) and reference dose media evaluation guides (RMEGs) for noncancerous health effects and cancer risk evaluation guides (CREGs) for cancerous health effects. Chemicals that are below any of the ATSDR=s comparison values are unlikely to pose a health threat and are not discussed further in this PHA document. Chemicals above a CV do not necessarily represent a health threat but warrant further investigation. If environmental media guides cannot be established because of a lack of available health data, other comparison values may be used to select a contaminant for further evaluation. EPA has established Maximum Contaminant Levels (MCLs) for various chemicals. MCLs are the maximum permissible level of a contaminant in water delivered to users of a public water system.

Once contaminants of concern are identified, PADOH uses the ATSDR=s Minimal Risk Levels (MRLs), the EPA=s reference doses (RfDs), and the EPA=s cancer slope factors (CSFs) as well as researches scientific and medical literature in determining a public health threat. MRLs are estimates of daily exposure to contaminants below which noncancerous adverse health effects are unlikely to occur. RfDs are estimates of daily exposure to a contaminant that is unlikely to cause adverse health effects. Doses below the MRL or RfD are not likely to cause any noncancerous adverse health effects. Doses above the MRL or RfD require further evaluation to determine if adverse effects are likely to occur. When MRLs or RfDs are not available, a no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) may be used to estimate levels below which no adverse health effects (noncancerous) are expected. To evaluate the risk of developing cancer, EPA=s CSFs are used to calculate the excess cancer risk over a lifetime (70 years). PADOH and ATSDR assume a worse case lifetime exposure scenario in determining health effects.

Because children generally receive higher doses of contaminants than adults under similar circumstances, the PADOH uses the higher doses in forming its conclusions about the health effects of exposures to site-related contaminants when children are known or thought to be involved. Readers should note that researchers conduct animal studies using doses at levels much higher than those experienced by most people exposed to contaminated groundwater originating from hazardous waste sites.

Toxicologic Evaluation of Arsenic Exposure

Arsenic does not readily transfer from water to air so significant respiratory exposure from the arsenic in the private well water is unlikely. Arsenic in water is also not readily absorbed through the skin. Therefore, the dermal and respiratory exposure pathways are not a health concern and these pathways are not addressed in this PHA.

<u>Public and Private Well Water</u>

Arsenic in potable water is a public health concern and levels of arsenic that are protective of public health are controversial. The historical standard of 50 parts per billion (ppb, which is the same as Φg/L) was set by EPA in 1975, based on a Public Health Service standard originally

established in 1942. In 1996, the World Health Organization established a provisional guideline value for drinking water of 10 Φg/L. EPA set the new arsenic standard (effective 2006) for drinking water at 10 ppb to protect consumers against the effects of long-term, chronic exposure to arsenic in potable water [6].

One of the most common and characteristic effects of arsenic ingestion is a pattern of skin changes that include generalized hyperkeratosis (i.e., skin lesions) and formation of hyperkeratotic warts or corns on the palms and soles, along with areas of hyperpigmentation interspersed with small areas of hypopigmentation on the face, neck, and back [14].

ATSDR has developed a chronic oral MRL of 0.0003 mg/kg/day for noncancerous health effects based on epidemiology (human health) studies that demonstrate skin lesions in people orally exposed to arsenic. Doses below the MRL are not likely to cause adverse health effects. Doses above the MRL require further evaluation to determine if adverse effects are likely [14].

If young children (10 kg or 22 pounds) were exposed to arsenic at concentrations ranging from 3.0 Φg/L to 41.0 Φg/L, then the estimated exposure dose (0.0003-0.003 mg/kg/day), would be equal to and up to approximately ten times higher than ATSDR's chronic oral MRL. However, based on a study by Mazumder et. al., even at the highest detected arsenic concentration (41.0 Φg/L), the dose is approximately 3 times lower than the dose expected to cause adverse health effects [15]. Therefore, exposure to arsenic (at concentrations ranging from 3.0 Φg/L to 41.0 Φg/L) in the private well water is not likely to cause noncancerous health effects (skin lesions) in children.

If adults were exposed to arsenic in their well water at concentrations ranging from 10.5 Φg/L to 41.0 Φg/L (levels above the revised federal drinking water standard), the estimated average daily exposure dose (0.0003 mg/kg/day to 0.0009 mg/kg/day) is equal to and up to three times ATSDR's chronic oral MRL of 0.0003 mg/kg/day, respectively. In deriving the MRL, ATSDR used a No Observable Adverse Effect Level (NOAEL) in human studies and skin lesions as a health endpoint. Also, an uncertainty factor of 3 was used for human variability. This suggests that even at the level corresponding to the maximum exposure dose (0.0009 mg/kg/day), it is unlikely that adults would develop symptoms associated with ingestion of arsenic.

A review of scientific and medical literature by ATSDR provides further evidence that exposure to arsenic at the levels evaluated in this PHA would not cause noncancerous health effects. ATSDR reviewed human studies to determine the threshold arsenic dose for hyperpigmentation and hyperkeratosis and reported that collectively, the epidemiology studies indicate that the threshold arsenic dose for these conditions is approximately 0.01 mg/kg/day [14]. Even with consumption of private well water containing the highest concentration (41.0 Φg/L) of arsenic, the dose is approximately 11 times lower than the threshold dose determined by the studies. Therefore, exposure to arsenic in private well water in all the residences evaluated in this PHA is not likely to cause noncancerous health effects in children or adults.

Arsenic is recognized as a human carcinogen by the federal Department of Health and Human

Services and the World Health Organization's International Agency for Research on Cancer.

EPA has also classified arsenic as a human carcinogen [14].

In order to evaluate the possible cancer risk associated with human ingestion of arsenic contaminated water, we calculated the theoretical cancer risk using EPA's cancer slope factor (CSF) of (1.5 mg/kg/day)-1 for arsenic [16] and reviewed current epidemiologic studies. The CSF is an estimate of a chemical's carcinogenic potency or potential for causing cancer.

Calculations based on EPA=s CSF, show that residents have varying degrees of theoretical increased risk of developing cancer as a result of exposure to arsenic in their water. The risk ranges from no apparent to moderate increased risk.

Residents exposed to well or tap water containing 2.1 Φg/L (or less) of arsenic would have no apparent increased risk of developing cancer. No apparent increased risk corresponds to approximately one additional person developing cancer out of 100,000 people exposed to the arsenic over a lifetime of 70 years. Residents exposed to water containing 2.4 Φg/L to 22.0 Φg/L of arsenic have a low increased risk of developing cancer (1 to 9 additional cancers per 10,000 people). Residents exposed to well water containing 22.5 Φg/L to 41.0 Φg/L of arsenic have a moderate increased risk of developing cancer (1 to 2 additional cancers per 1,000 people). These calculated theoretical risks are very conservative and tend to overestimate actual cancer risk. The true risk may be lower.

When evaluating exposure to a carcinogen, we do not simply base our assessment on theoretical risk, but more importantly, we consider the results of epidemiology studies and use professional judgment that considers a number of site-specific factors.

Reviews of epidemiology studies provide additional information about the risk of cancer associated with the ingestion of arsenic. Studies have demonstrated an association of cancer of the skin, bladder, kidney, lungs and liver tumors with long-term exposure to arsenic. With arsenic levels of less than 10 Φg/L, a weak, non-statistically significant association existed, while exposure levels of 30-40 Φg/L and 50-100 Φg/L showed moderate to strong associations with some statistically significant comparisons [17, 18]. A cancer effect level (CEL) determined for an earlier study of the same Chilean population showed a similar effect level (0.0011 mg/kg/day or about 39 Φg/L) [19]. While there is uncertainty regarding whether such effects would also occur in U.S. populations, a study by Lewis et al 1999 did demonstrate an increased risk for prostrate cancer from arsenic in drinking water (range 14-166 Φg/L) in a Utah population [20]. This study supports the need for additional research regarding the relationship between levels of exposure to arsenic in drinking water in the U.S. and cancer. However, given that effects have been seen in relatively diverse populations in Taiwan and Chile [17, 18], we cannot exclude the possibility of a dose-related increased of cancer at the highest levels of exposure (41.0 Φg/L) or at levels above EPA’s proposed MCL of 10 Φg/L near the Watson Johnson Landfill.

Past exposure by residents to arsenic originating in QBWS wells # 10 & 17 may theoretically result in a low increased risk of developing cancer over a lifetime of exposure if the concentration of arsenic (6.0 Φg/L) in the water reached residential taps unchanged. Because water from wells 10 & 17 was likely mixed with water from the other QBWS system wells prior

to reaching consumer taps, it is not possible to assess the exact likelihood of a health threat from exposure to arsenic in residential water originating from QBWS wells 10 & 17 due to the lack of historical information on water quality at residential taps.

Past exposure by residents to arsenic (7.0 Φg/L and 10.0 Φg/L) in two homes receiving water from QBWS wells where tap water was tested may theoretically result in a low increased risk of developing cancer over a lifetime of exposure. However, due to the lack of historical information, we do not know if the arsenic concentrations in the QBWS system (and ultimately at residential taps) fluctuated over time as various wells were brought on and offline to meet season water demands. Assuming the arsenic concentrations of 7.0 µg/L at the residential taps were consistent over time, then continuous (future) exposure (ingestion) to the arsenic by residents receiving municipal water from QBWS wells could theoretically over a lifetime (70 years) cause a low increased risk of cancer; thereby, potentially threatening the health of people using their tap water. However, based on human studies it is unlikely that even a lifetime of exposure to arsenic in tap water at these concentrations would actually cause cancer.

Continuous (future) exposure to arsenic by residents using the WBFD well (17.3 & 23.9 µg/L) would result in a low to moderate increased risk of people developing cancer over a lifetime of continuous exposure. However, this well was taken out of service after 10 years of use and no longer represents a public health threat. Exposure to arsenic in water in the WBFD well by residents prior to its closure would not threaten the health of people who used the water.

Surface Soil

In order to evaluate the cancer risk to children that may have played on the site and were possibly exposed to arsenic in the surface soil at the maximum concentration (24 mg/kg), we calculated the theoretical cancer risk using the cancer slope factor (CSF) of $(1.5 \text{ mg/kg/day})^{-1}$ [16]. These calculations are based on the assumptions that 1) there is no safe level of exposure to a chemical that may cause cancer, 2) children ages 11-16 (weighing 50 kg) were most likely to play on the site, 3) children are exposed for 5 years to the chemical and, 4) the children came in contact with and ingested the surface soil (200 mg/day) from the area with the highest concentration of arsenic for 5 days a week for 3 months (summer) each year. Dermal absorption of arsenic is minimal so we do not consider it to be a risk factor.

The calculated lifetime cancer risk for exposure to arsenic is 1.7×10^{-6}. This means that there is an increased likelihood of 1 to 2 persons per 1,000,000 people developing cancer sometime during their lifetime because of their exposure to surface soil. However, these calculated risks are very conservative and tend to overestimate the risk associated with actual exposures that may have occurred. The site is highly vegetated and daily exposure to the single area (hotspot) where the arsenic was detected at 24 mg/kg is very unlikely. Therefore, it is our opinion that past exposure to arsenic via ingestion posed no significant cancer risk for children who may have played on the site.

The calculated exposure dose (0.0000157 mg/kg/day) is over an order of magnitude less than ATSDR=s MRL of 0.0003 mg/kg/day and exposure to arsenic in soils also posed no significant

non-cancer health risks for children who played on the site.

Surface Water and Sediments

The maximum concentration of arsenic in interim surface water (estimated at 2.4 Φg/L) and surface sediments (9.1 mg/kg) samples for the areas evaluated in this document were below ATSDR CVs. Exposure by children playing in these areas would not threaten their health. However, since surface water and sediment sampling was not obtained adjacent to the site along the Tohickon Creek where children may play and anglers may fish, it is not possible to evaluate this potential point of exposure. Therefore, exposure to surface water and sediments in the Tohickon Creek represents an indeterminate public health hazard due to the lack of data necessary to evaluate these potential pathways. EPA will be conducting sampling of these areas as part of the Remedial Investigation and Feasibility Study for the site and PADOH and ATSDR will evaluate the sampling results and determine the public health significance of anglers and children exposure to these media when the data becomes available.

Toxicologic Evaluation of Trichloroethene (TCE) and Tetrachloroethene (PCE) Exposure

TCE and PCE are chemicals that readily transfer from water to air, making them a concern in residential water from both the ingestion and inhalation pathways. Because TCE and PCE are volatile in water, respiratory exposure from these compounds is likely during showering.

Residents are exposed at this site to low levels of TCE. The main symptoms appearing after chronic exposure to low levels are neurological changes represented by subjective symptoms relating to central and autonomic nervous systems, or by a lowered conduction velocity of the nerves or prolonged latency of the nerve responses [21]. In this section, we evaluate the public health significance of exposures to TCE and PCE at this site.

Public and Private Well Water

Raw water in two QBWS wells along Heller Road contains varying concentrations of TCE. These wells are brought online periodically throughout the year. The water from these wells is passed through air strippers to remove or reduce the TCE prior to its addition to other water in the QBWS system and must meet federal regulations.

In evaluating the residential exposures from private wells, PADOH estimated doses for children and adults from the three routes of exposure (inhalation, ingestion, and dermal). To evaluate for noncarcinogenic acute exposure (up to 14 days), we assumed that children living near the site weighed 15 kilograms and consumed one liter of water per day contaminated with TCE at the highest detected level of 33.3 Φg/L. In this scenario, PADOH believes that children would not have experienced noncancerous adverse health effects because the child=s estimated total dose (0.00666 mg/kg/day) is less than the ATSDR=s acute oral MRL of 0.2 mg/kg/day. Similarly, assuming that adults living near the site consumed two liters of water per day contaminated with

33.3 Φg/L of TCE, the estimated total adult dose (0.00285 mg/kg/day) at this level from all exposure routes (i.e., ingestion, inhalation and dermal) is also lower than ATSDR=s acute oral

MRL. (We estimated the oral and dermal doses and assumed the inhalation dose is equal to the ingestion dose). Therefore, *we do not expect any noncancer adverse health effects to occur from short-term exposure to TCE at this site.*

For chronic exposure (greater than one year), ATSDR has not developed a chronic oral MRL for TCE [22]. The EPA=s RfD for TCE is 0.0003 mg/kg/day [16]. The estimated total dose for children and adults would be 0.00666 and 0.00285 milligrams per kilogram per day (mg/kg/day), respectively. Considering all possible routes of exposure, the total exposure doses are approximately 22 (children) to 10 (adults) times higher than EPA=s RfD for TCE. However, both estimated total doses are several orders of magnitude (several thousand times) below doses at which no observable adverse health effects are seen in some animal studies [22]. Additionally, based on a recent evaluation of noncancer effects of TCE by Barton, et al. the authors suggest an RfD range of 0.06-0.12 mg/kg/day [23]. Our estimated exposure doses for children and adults are also lower than this RfD range. Therefore, *we do not expect any noncancer adverse health effects to occur from chronic exposure to TCE at this site.*

To evaluate carcinogenic effects of exposure to TCE, PADOH reviewed current scientific literature. In studies using high doses (parts per million range) of TCE in animals, tumors in the lungs, liver and testes were found, providing some evidence that a high dose of TCE can cause cancer [22,24]. Based on the limited data in humans regarding TCE exposure and cancer, and evidence that high doses of TCE can cause cancer in animals, the International Agency for Research on Cancer (IARC) has determined that TCE is probably carcinogenic to humans. Recently, the Department of Health and Human Services (National Toxicology Program) determined that TCE may reasonably be anticipated to be a carcinogen [24]. This was based on limited evidence from studies in humans, sufficient evidence of malignant tumor formation in experimental animals, and convincing relevant information that TCE acts through mechanisms indicating it would likely cause cancer in humans. Currently, the National Toxicology Program is considering upgrading TCE to a known human carcinogen [25]. The EPA is also reviewing its classification for TCE=s carcinogenicity in humans.

We evaluated the theoretical cancer risk for people who were exposed to TCE in their well water at the maximum concentration (33.3 Φg/L) that occurred to during this investigation. The home with the private well containing 33.3 Φg/L of TCE is a newer home and the family has only been potentially exposed to the TCE for about 5 years. Currently this family uses point of use filters for drinking water and future exposure would only occur through inhalation.

We calculated the theoretical cancer risk using the EPA=s CSF range of 0.02-0.4 $(mg/kg/day)^{-1}$ and a calculated oral dose of 0.000951. The lifetime risk associated with inhalation of volatile TCE is essentially the same as that for exposure through ingestion. These calculations are based on the assumptions that 1) there is no safe level of exposure to a chemical that may cause cancer and, 2) a person is exposed for a lifetime to the chemical. However, these calculated risks are not exact and tend to overestimate the risk associated with exposures that occurred. Based on the theoretical cancer risk estimation, if people living in the home with the maximum concentration of TCE (33.3 Φg/L) in their well water would continue to live in their home and be exposed to this contaminant through inhalation for a lifetime (70 years), the predicted cancer occurrence

would be about 2 additional cancers per 100,000 people to about 4 additional cancers per 10,000 people. This corresponds to a low increased risk of developing cancer. Occupational health studies have shown an association between inhalation of TCE and cancer [26]. However, these exposures were to relatively high concentrations of TCE. Although we do not know the exact levels where inhalation of TCE is associated with cancer, the exposure to TCE is low and it is our opinion that future inhalation exposure (over a lifetime) would not threaten the health of residents living in this home. Residents in the other homes with TCE in their well water above the MCL also use filters or bottled water. None of the residents had inhalation exposure to TCE from their private well water at levels that would threaten their health. Exposure to TCE through inhalation poses no apparent health hazard for the people living in the homes evaluated in this document.

To evaluate for non-carcinogenic acute exposure (up to 14 days) to PCE, we assumed that children living near the site weigh 15 kg and consumed one liter per day of water contaminated with PCE at the highest detected level of 6.1 Φg/L. In this scenario, PADOH believes that children would not have experienced noncancerous adverse health effects because the child=s estimated total dose (0.0012 mg/kg/day) is less than the ATSDR=s acute oral MRL of 0.05 mg/kg/day. Similarly, assuming that adults living near the site consumed two liters of water per day contaminated with PCE at a level of 6.1 Φg/L, the estimated total adult dose (0.000522 mg/kg/day) experienced at this level from all exposure routes (i.e., ingestion, inhalation and dermal) is also lower than ATSDR=s acute oral MRL (we estimated the oral and dermal doses and we assumed the inhalation dose is equal to the ingestion dose). Therefore, we do not expect any noncancer adverse health effects to occur from short-term exposure to PCE at this site.

For chronic exposure (greater than one year), ATSDR has not developed a chronic oral MRL for PCE [27]. The EPA=s RfD for PCE is 0.01 mg/kg/day [16]. The estimated total doses for children and adults would be 0.0012 and 0.000522 mg/kg/day, respectively. Considering all possible routes of exposure, the total exposure doses are approximately 8 (children) to 19 (adults) to times lower than EPA=s RfD for PCE. Therefore, we do not expect any noncancer adverse health effects to occur from chronic exposure to PCE at this site.

Surface Soil

TCE and PCE were not detected in the interim surface soil sampling and therefore will not be discussed.

Surface Water and Sediments

TCE and PCE were not detected in surface water and sediments during the interim surface water sampling. However, since surface water and sediment sampling was not obtained adjacent to the site along the Tohickon Creek where children may play and anglers may fish, it is not possible to evaluate this potential point of exposure. Therefore, potential exposure to TCE and PCE in surface water and sediments in the Tohickon Creek represents an indeterminate public health hazard due to the lack of data necessary to evaluate these potential pathways. EPA will be conducting sampling of these areas as part of the Remedial Investigation and Feasibility Study

for the site, and PADOH and ATSDR will evaluate the sampling results and determine the public health significance of anglers and children's exposure to these media when the data becomes available.

Childern's Health Considerations

PADOH and ATSDR recognize that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity results from a number of factors. Children are more likely to be exposed because they play outdoors and often bring food into exposed areas. Children are shorter than adults, therefore, they breathe dust, soil, and heavy vapors close to the ground. Children are smaller, potentially resulting in higher doses of chemical exposure per unit 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.

Like other people living or working at or near the site, children may contact contaminated site media. The most likely media associated with this site that children would come in contact with are the surface water of the Tohickon Creek and groundwater accessed through a municipal well and private residential wells. Although the site is unrestricted, it is unlikely that significant exposure to on-site soils occurred. The site is somewhat insulated from the public by the Tohickon Creek on the west and south and a farm and residential development to the north and east, respectively.

The borough of Quakertown, which is south and adjacent to the site, has a population of approximately 1,893 children, ages 14 and younger, which are the most likely population to play or trespass on the landfill. PADOH and ATSDR are committed to evaluating their special interests at sites such as the Watson Johnson Landfill.

Physical Hazards

There were no physical hazards observed at the site except perhaps the remains of a cement pillar from a bridge that formerly crossed the Tohickon Creek. It is possible that children could become injured while playing on the cement remains while recreating in and around the Tohickon Creek.

HEALTH OUTCOME DATA EVALUATION

Based on our review and analysis, current exposure estimates are not high enough or of long enough duration to cause adverse health effects and the presently known exposed populations (approximately 50 for VOCs and 300 for arsenic) are too small for epidemiological investigations to yield any meaningful data that could be used for public health purposes. Therefore, no adverse health outcome databases have been searched and no epidemiological studies (i.e., evaluations of disease patterns with respect to exposure patterns) have been conducted. PADOH and ATSDR representatives did meet with residents in their homes to

discuss their health concerns. No similarities or patterns of health complaints were identified.

Additional sampling data will be forthcoming on groundwater and other environmental media near the site. Should evaluation of future information suggest that significant numbers of people have been exposed to sufficient concentrations of contaminants for a long enough period of time for health effects to be possible, then further investigation may be warranted.

COMMUNITY HEALTH CONCERNS

PADOH and ATSDR identified community health concerns during public meetings and numerous individual meetings with residents in their homes. The primary health concern expressed by the community near the site focused on the quality of their private residential well water. Specific community questions/comments and PADOH/ATSDR=s responses follow:

1. **Question:** ***Have we been exposed or could we become exposed to arsenic, TCE, or other contaminants in water from our private wells at levels that would harm our health?***

   Response: As described in the ADiscussion@ section of this PHA, PADOH reviewed information on detected concentrations, potential exposure situations, and contaminant toxicology. Based on it=s evaluation of this information, PADOH concluded that although past exposures to VOCs occurred, they were below levels expected to result in illness or other adverse health effects or the residents used bottled water or filters to mitigate their exposures.

   Most of the homes discussed in this PHA had arsenic in their private well water. Continuous, lifetime (70 years) exposure by residents to arsenic in groundwater would theoretically increase the risk of the residents developing cancer for those people drinking the contaminated well water. However, the method of determining the risk is very conservative and most likely overestimates actual risk. Based on human health studies, it appears that actual risk for developing cancer does not exist until the concentration of arsenic in the well water exceeds the proposed MCL of 10.0 Φg/L. When the concentration of arsenic reaches about 39.0 Φg/L, the evidence (from human health studies) for carcinogenicity (lung cancer) becomes stronger. Continuous exposure to arsenic at any of the concentrations in the well water discussed in this document, even over a lifetime, is not likely to cause non-cancer health effects.

   Some of the homes had TCE in their well water. Continuous, lifetime exposure by residents to TCE would theoretically increase the risk of the residents developing cancer. However, the method of determining the risk is very conservative and most likely overestimates actual risk. Continuous exposure to TCE at concentrations below 10.5

Φg/L, even over a lifetime, is not likely to cause noncancer health effects.

Most of the residents have purchased bottle water or use carbon filters to mitigate their exposure to arsenic and VOCs. However, bottled water will not prevent the potential health threat that may occur following breathing VOCs that become airborne from water, especially during showering. Carbon filters will only prevent airborne VOCs during showering if they are installed inline and filter all the home=s water or if they are installed as a point of use filter at the shower head.

The PADOH contacted all residents whose well water contained contaminants above their MCL and recommended that an alternative water source be used. PADOH also sent letters to the residents near the site that had their well water sampled. The public health significance of their exposure to contaminants in their well water was discussed. PADOH followed-up by meeting with the residents in their homes to answer any additional health related questions.

2. **Question:** ***My private well (RW-53) is located in the basement of my home (Figure 9). Is it possible that contaminated surface water could seep through my yard and ultimately impact the quality of my well water?***

   Response: The well casing for RW-53 extends a few inches above a concrete slab and appears to be properly sealed. Therefore, there should be no surface water contamination problem unless the basement suffers catastrophic flooding that submerges the well for several hours. This information was discussed with the homeowner during the August 23, 2002 site visit.

3. **Question:** ***Could exposure to contaminants in the surface water and sediments in the Tohickon Creek adversely affect children and other residents of Quakertown and surrounding communities who have recreated in the creek?***

   Response: Potential exposure to surface water and sediments in the Tohickon Creek by children and others who may have recreated or may recreate in the creek represents an indeterminate public health hazard due to lack of sufficient data. PADOH and ATSDR will evaluate the results of future EPA sampling of these media when it is available and, if necessary, will address any public health issues associated with exposure to surface water or sediments in the Tohickon Creek at that time.

4. **Question:** ***Are the arsenic and TCE present in residential wells near the Watson Johnson landfill site originating at the landfill?***

   Response: Groundwater beneath the landfill contains TCE and arsenic. Based on the anticipated direction groundwater flow, the TCE in the groundwater south of the site appears to be the result of past disposal practices at the site; however, the source of arsenic contamination is not clear. While arsenic is present in both on-site and off-site groundwater, the Watson Johnson landfill has not been determined to be the source of this contaminant in nearby residential wells. The maximum concentrations of arsenic (3.9 Φg/L) in shallow on-site and in deeper on-site ground water (4.2 Φg/L) contrasts with a maximum off-site concentration of arsenic of 33.5 Φg/L. In the absence of a concentration gradient (higher levels of on-site arsenic and lower levels of off-site arsenic), it would be most unusual that the lower levels of arsenic in on-site groundwater are responsible for the higher concentrations of arsenic in some nearby residential wells.

5. **Question:** ***Could the arsenic in my well water be causing my skin conditions?***

   Response: As discussed in the *Public Health Implications* section, ingestion of high levels of arsenic can cause certain types of skin conditions on the palms of the hands and soles of the feet along with areas on the face, neck, and back where the skin does not contain normal amounts of pigment. However, the levels of the arsenic (and other contaminants) in the private wells are not likely to cause these symptoms or any other type of abnormal skin condition (e.g. acne, skin irritations, etc.). The primary health threat associated with lifetime exposure (70 years) to arsenic in the private wells near the site is an increase in the theoretical risk of developing cancer.

6. **Question:** ***Have all the homes south of the site in the area where a potential groundwater plume exists had their private well water sampled for TCE?***

   Response: No. There are at least two residences that have either refused EPA=s offer to have their well water sampled or who EPA has been unable to contact after numerous attempts. There may be other residents that use private wells that EPA is unaware of. EPA has attempted contact with all residents known to use private wells and believed to be in areas potentially impacted by the site. However, the extent of the plume has not yet been fully determined. Therefore, there may be additional residents exposed to TCE in their private well water that, to date, have not had their well water sampled. If warranted, EPA will sample additional wells when they determine the exact location(s) of the plume.

7. **Comment:** ***The PHA is incomplete because of the lack of historical information on environmental conditions at the site.***

   Response: PADOH and ATSDR reviewed EPA=s environmental sampling data to identify the presence of contaminants (and their respective concentrations) in various media associated with the site, including groundwater, surface water, soil, and sediments. When additional data was needed, PADOH recommended EPA to conduct further sampling. PADOH then based its risk evaluation and subsequent assessment on *lifetime exposure* to the *maximum concentration* of contaminants detected in each medium. PADOH assumed that people were exposed to the maximum concentration of the contaminants for a lifetime of 70 years. As stated in the document, this is a very conservative approach that tends to overestimate true (actual) risk. The most significant exposure pathway at this site is the groundwater pathway where exposure to contaminants in drinking water is known to have occurred. If the arsenic that was detected in groundwater is naturally occurring, as is currently believed, it is unlikely that those concentrations fluctuated significantly over the years. While it is possible for some fluctuation in the concentrations of VOCs leaving the site in groundwater, it is unlikely that historical concentrations would have been high enough to alter our conclusions.

8. **Comment:** ***The health effects from the apparent widespread contamination on the local residents are not known - many years have elapsed without any statistical medical health documentation relating to the landfill.***

Response: VOC contamination (associated with the landfill) in private well water is primarily in the area south of the site and is not widespread. Arsenic that is present in the drinking water of private wells throughout the area that was sampled by EPA is not site-related. PADOH and ATSDR determined that even a lifetime of exposure to the levels of TCE evaluated in this PHA would not cause noncancerous health effects. PADOH and ATSDR also determined that cancer is the only health effect that may have an environmental component. A lifetime of exposure to TCE at the levels discussed in this PHA would cause a theoretical low increased risk of a person developing cancer. However, as stated earlier, our risk calculations are very conservative and tend to overestimate actual risk**.**

9. **Comment:** ***TCE is of great concern because of its ability to pass as a vapor (from groundwater and soils) into buildings and the resulting inhalation of this vapor would be a health risk.***

Response: The highest concentrations of TCE vapor that residents would likely be exposed to is from groundwater (private well water). The potential for the occurrence of adverse health effects following inhalation of volatile TCE during showering and bathing has been discussed in this PHA. It is unlikely that volatile TCE (that might be in residential soils) would pass through basement walls into the indoor air environment of the homes at higher concentrations than those evaluated in this PHA. Nevertheless, EPA is conducting soil gas monitoring to determine the presence or absence of TCE in residential soils and will report its findings to the residents.

10. **Comment:** ***The American Olean Tile Landfill and other sites near the Watson Johnson Landfill need to be considered as possible sources of contaminants found in EPA=s investigation of the Watson Johnson site.***

Response: The American Olean Tile Landfill was closed under state regulations and as part of the closure plan the facility is required to conduct ongoing groundwater sampling and report those results to PADEP. EPA will review the results of that monitoring and collaborate with PADEP in the event that groundwater contaminants are identified and further action is needed.

11. **Question:** ***Are there any studies being conducted regarding the impact of site-related contaminants on the Tohickon Creek and wetlands adjacent to the site? If so, what are the findings in relationship to wildlife habitat?***

Response: EPA is conducting soil, surface water and sediment sampling in and around the Tohickon Creek as part of EPA=s data gathering process for the preparation of the EPA

Ecological Risk Assessment. The data will be used to determine if plant and animals have been impacted.

12. **Question:** ***Are there plans to clean up the Tohickon Creek?***

Response: The Tohickon Creek will be evaluated as part of EPA=s Ecological Risk Assessment. If necessary, EPA will take appropriate clean up actions.

13. **Comment:** ***In the Public Health Implications section of the PHA, PADOH and ATSDR state that the calculated theoretical risks associated with exposure to TCE, PCE and arsenic are very conservative, tend to overestimate actual cancer risk and that the true cancer risk may be lower. Please share information that supports these statements.***

Response: PADOH uses worse case, lifetime, exposure scenarios in determining the risk of developing adverse health effects. Specifically, PADOH evaluates the potential for adverse health effects based on lifetime exposure to the maximum concentrations of TCE, PCE, and arsenic and assumes maximum consumption of the contaminated media. When calculating cancer risk, if EPA has a range for it=s CSF, we used the most conservative number in the range even though this does not yield a realistic cancer risk for the majority of the population. Also, when researchers conduct animal studies to identify adverse health effects, they use doses at much higher levels than those experienced by most people and place safety factors in their risk assessment methods to protect sensitive populations. All of these factors combine to result in very conservative risk estimates.

14. **Question:** ***Should residents who have used their private well water for 30+ years or who used municipal water originating in public wells #10 and 17 (prior to its discovery and subsequent removal via air-stripping) be concerned that exposure to potentially contaminated water from these sources may threaten their health? Please comment on the possibility that the concentrations of contaminants in the water fluctuated over time.***

Response: As stated in the Conclusions, past exposure to arsenic in private well water for less than a lifetime (any amount of time less than 70 years) would have varying degrees of theoretical risks for the development of cancer based on the concentrations of arsenic in the water and the lengths of exposure. It is unlikely, however, that past exposure to arsenic in water would result in noncancerous harmful health effects. We do not know if the arsenic concentrations in the QBWS system (and ultimately at residential taps) fluctuated over time as various wells were brought on and offline to meet seasonal water demands. Assuming the arsenic concentrations at the residential taps were consistent over time, then continuous (past, present, & future) exposure (ingestion) to the arsenic by residents receiving municipal water from QBWS wells could theoretically, over a lifetime, cause a low increased risk of developing cancer to the people using their tap water. However, based on human studies it is unlikely that even a lifetime of exposure to arsenic in the tap water at these concentrations would cause cancer. It is also unlikely that a lifetime of exposures to arsenic in the tap water would result in noncancerous health effects. Past and present

exposures (ingestion & inhalation) to TCE and PCE at levels above their Maximum Contaminant Levels (MCL) in residential wells south of the site along North Ambler Street, Highland Street, Penrose Street, Woodland Avenue and southeast of the site along Richlandtown Pike are not expected to result in adverse health effects for the residents using their well water. Past exposure to TCE in residential tap water from QBWS wells #10 & 17 represents an unknown threat to public and cannot be further evaluated. It is not possible to assess the likelihood of a health threat from past exposure to TCE in residential tap water prior to the installation and operation of air strippers on wells #10 and 17 due to the lack of historical information identifying when these wells first became contaminated, the number of days per year the wells were in service, and the water quality at the tap.

15. **Question:** ***Are residents who played on the active landfill as children prior to its closure at risk for developing adverse health effects as a result of being exposed to landfill wastes?***

Response: We recognize that children who trespassed on the site and on-site workers were exposed to refuse and other wastes. However, as stated in the Pathway Analysis section of the Discussion, we do not have information on the surface conditions at the site during years of operation. Therefore, we cannot assess the likelihood of any adverse health effects that may have resulted from children or on-site workers being exposed to site-contaminants.

16. **Comment:** ***A health study should be conducted that would include liver, kidney, gallbladder, immune system, etc. function tests to determine the current health status of people who were potentially exposed to contaminants.***

Response: As discussed earlier in the Health Outcome Data Evaluation section, based on the exposure estimates and the duration of exposures, we do not expect any adverse health effects. In addition, the exposed populations are too small for epidemiological investigations to yield any meaningful data that could be used for public health purposes. An evaluation of the status of residents current health is best addressed by their family physician who is authorized to request clinical tests he or she feels warranted. We recommend that residents concerned about their current health status contact their family physician for a physical examination and assessment.

17. **Question:** ***Has the arsenic detected during EPA=s sampling near the site been determined to be naturally occurring?***

Response: Based on the information that is available at the time of the publication of this PHA, PADOH believes that the arsenic in the private wells sampled by EPA is not site-related and most likely naturally occurring. EPA has contracted with the United States Geological Service (USGS) to evaluate the presence of arsenic in groundwater near the site and throughout the area to determine whether it is naturally occurring.

18. **Question:** ***Why haven't individual residents been interviewed about their health problems that they believe might be related to the landfill?***

Response: As you can see from this PHA, we follow an approach where we carefully review all of the available environmental data associated with a hazardous waste site, identify chemicals of concern, and evaluate whether the levels are high enough to possibly cause any health problems in a community. Using the scientific and medical literature, we narrow our focus only to health effects that could plausibly be related to the chemicals of concern from the site. We need to use this approach if we are to succeed in drawing connections between population-wide adverse health effects and concentrations of contaminants that could plausibly cause those effects. Our experience has been that it is exceedingly difficult to draw conclusions about a site based on approaches that start by cataloguing individual health complaints. Nevertheless, we did hear residents health concerns while meeting with them in their homes. During those meetings, there were no similarities or patterns of health complaints identified by PADOH or ATSDR. Other than the theoretical increased risk of developing cancer if exposure continued for a lifetime of 70 years, we do not believe that exposure to site-related chemicals caused adverse health effects in the nearby community.

19. **Comment:** ***The EPA now believes TCE to be from 5 to 65 times more toxic than previously believed.***

Response: PADOH is aware of the current school of thought regarding the toxicity of TCE and has calculated carcinogenic risk based on the most conservative number in the range of CSFs for TCE. Therefore, our conclusions are very conservative and are based on worst-case scenarios.

CONCLUSIONS

ATSDR and PADOH conclude the following regarding area and media-specific exposures (For a description of ATSDR=s hazard categories, see the Glossary, Appendix B):

1. Past and present exposures (ingestion) to arsenic in well water for less than a lifetime (any amount of time less than 70 years) would have varying degrees of theoretical risks for the development of cancer based on concentrations of arsenic in the water and the lengths of exposure. It is unlikely, however, that past and present exposure to arsenic in the water would result in noncancerous harmful health effects.

2. Continuous (past, present, & future) exposures (ingestion) to arsenic in water over a lifetime (70 years) in homes near the site could theoretically cause a no apparent to moderate increased risk of cancer. Human health studies provide additional evidence of a possible association of a dose-related increased risk of cancer; thereby, potentially threatening the health and posing a public hazard to the people who use their well water. Although there is

a theoretical increased risk for developing cancer, the levels of arsenic necessary to cause cancer are generally higher than those observed at this site. It is unlikely, however, that continuous exposure to arsenic in water, even over a lifetime, would result in noncancerous harmful health effects.

3. Past, present, and future exposures (ingestion and inhalation) to trace (very low) levels of VOCs in homes to the east and west of the site along Richlandtown Pike and Heller Road do not threaten the health of the residents using their well water and represent no apparent public health hazard.

4. Past and present exposures (ingestion & inhalation) to TCE and PCE at levels above their MCLs in residential wells south of the site along North Ambler Street, Highland Street, Penrose Street, Woodland Avenue, and southeast of the site along Richlandtown Pike that were evaluated in this document are not expected to result in adverse health effects and represent no apparent public health hazard for the residents using their well water.

5. Inhalation of TCE (if unabated and over a lifetime) by some residents living south of the site could theoretically cause a low increased risk of their exposure resulting in cancer. If unabated, lifetime inhalation exposure represents a public health hazard.

6. The public health significance of potential exposure to VOCs in additional wells south of the site that were not sampled because residents either refused EPA=s offer to sample or because EPA was unable to contact them after repeated attempts is unknown due to lack of data and represents an indeterminate public health hazard.

7. Past exposure to TCE in residential tap water from QBWS wells #10 & 17 represents an unknown threat to public health and cannot be further evaluated. It is not possible to assess the likelihood of a health threat from past exposure to TCE in residential tap water prior to the installation and operation of air strippers on wells #10 and 17 due to the lack of historical information identifying when these wells first became contaminated, the number of days per year the wells were in service, and the water quality at the tap.

8. We do not know if the arsenic concentrations in the QBWS system (and ultimately at residential taps) fluctuated over time as various wells were brought on and offline to meet seasonal water demands. Assuming the arsenic concentrations at the residential taps were consistent over time, then continuous (future) exposure (ingestion) to the arsenic by residents receiving municipal water from QBWS wells could theoretically over a lifetime (70 years) cause a low increased risk of cancer to the people using their tap water. However, based on human studies it is unlikely that even a lifetime of exposure to arsenic in the tap water would actually cause cancer. It is also unlikely that a lifetime of exposure to arsenic in the tap water would result in noncancerous harmful health effects. Therefore, exposure to arsenic in tap water would not threaten the health of residents and represents no apparent health hazard.

9. Past exposure to concentrations of arsenic in water from the WBFD well would not threaten

the health of the residents who used this water because of the brevity of their exposure prior to the well=s closure. Therefore, past exposure to water from the WBFD well represents no apparent public health hazard.

10. The public health significance of potential exposure to VOCs or other contaminants in landfill surface soil and surface water and sediments in the Tohickon Creek is not known due to inadequate sampling data and therefore, at this time, represents an indeterminate public health hazard. However, based on the limited data collected during the 2002 interim sampling effort, exposure to low levels of arsenic or VOCs detected in surface soil, surface water and sediments in the few areas that were sampled would not threaten the health of people who may come in contact with them. Additional, comprehensive sampling and evaluation of these media are necessary to determine if contaminants are present that could impact public health.

RECOMMENDATIONS

1. Encourage residents with levels of arsenic in their drinking water above it=s MCL to take measures such as using bottle water to abate their exposure to the arsenic.

2. Provide inline carbon filtration units or connection to municipal water for residences south and southeast of the site where TCE or PCE is present in private well water at levels above it=s MCL.

3. Proceed with the additional sampling of environmental media associated with this site. Upstream surface water and sediment samples should be collected (0-3 inch range) to determine background concentrations of contaminants.

4. Conduct periodic monitoring of area private wells to ensure that no exposure is occurring to hazardous substances at levels of public health concern.

5. Evaluate the results of future environmental sampling and determine the public health significance of people being exposed to environmental contaminants.

6. Do not reopen WBFD well without the implementation of corrective measures to reduce the levels of arsenic in the water below its MCL because lifetime exposure to arsenic in the water increases the risk of developing cancer.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Watson Johnson site describes actions taken and those to be taken by PADOH and the EPA subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing 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. The public health actions that are recommended, completed, ongoing, or planned are listed below.

Completed Actions

1. EPA has conducted environmental investigations to identify possible areas of contamination and to characterize the nature and extent of contamination at these areas. Investigation results have been reported in the February 9, 2001 and December 20, 2001 ATSDR Health Consultations for the Watson Johnson Landfill. Based on the results of these investigations, the PADOH and ATSDR recommended additional sampling to assess the nature and extent of potential contamination in private well water south of the site. This PHA addresses our evaluation of the additional sampling conducted by EPA.

2. PADOH sent letters and met individually with residents to explain the public health significance of EPA=s sampling of their private well water.

3. Residents who expressed concerns about their current health status have been encouraged during one-on-one conversations to contact their family physician for a physical examination and assessment.

4. PADOH and ATSDR conducted a Public Availability Session on November 13, 2003 with residents. During the meeting PADOH and ATSDR answered questions regarding the Public Comment Version of the PHA, listened to community concerns, and provided health education and other information to the community on potential health effects that could result if they were chronically exposure to contaminants in the environment near the site. EPA updated the residents on its efforts to obtain municipal water and answered questions regarding its activities at the site.

Ongoing or Planned Actions

1. EPA is in the process of conducting comprehensive additional sampling of environmental media associated with this site. PADOH will review this information when it becomes available and determine the public health significance of the data, and report its findings in a health consultation, if warranted. PADOH will recommend public health actions, as necessary, in light of the degree of public health hazard posed by the environmental contamination.

2. PADOH will inform residents who have not responded to EPA=s request to sample their private well water that the well water may be contaminated and a potential health threat may exist.

3. PADOH will continue to provide health education, as necessary.

4. EPA is considering providing residences with elevated levels of TCE in their private wells an alternative water supply.

5. Richland Township Water Authority has agreed to take measures to ensure that residents are not exposed to arsenic at levels above its MCL in the event that the WBFD well is reopened.

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CERTIFICATION

The Watson Johnson Landfill Public Health Assessment was prepared by the Pennsylvania Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the public health assessment was initiated.

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Technical Project Officer, SSAT, SSAB, DHAC

The Superfund Site Assessment Branch of the Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

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Cooperative Agreement Team Supervisor, SSAT, SSAB, DHAC, ATSDR

TABLES

TABLE 1 – Summary of Contaminants in On-site Groundwater

Chemical	**Maximum Concentration in Shallow Onsite Groundwater (µg/L)**	**Maximum Concentration in Deeper Onsite Groundwater (µg/L)**
Arsenic (As)	**3.9**	**4.2**
Tetrachloroethene (PCE)	**6.9**	**9.9**
Vinyl chloride (VC)	**7.1**	**10.4**
Cis-1,2-dichloroethene (cis-1,2-DCE)	**26.0**	**44.6**
Trichloroethene (TCE)	**1560.0**	**14.3**
Methyl ethyl ketone (MEK)	**0**	**3.0**

Table 2: Summary of Data for Selected Inorganics and VOCs From Residential Well Samples, Watson Johnson Landfill Site, September 1998 - September 2003

Contaminant	Sampling Event	Frequency of detection (homes)	Concentrations Detected ug/L = micrograms per liter	ATSDR Comparison Values Value	ATSDR Comparison Values Source
Arsenic	September 1998	10/17	3.0 - 33.5 + NR	0.02 ug/L 0.0003 mg/kg/day 10.0 ug/L	CREG MRL (c) MCL
	July 1999	10/18*	3.3 - 28.8		
	June 2001	40/40	1.0 - 25.0		
	March/April 2002	28/31	ND - 28.0		
	November 2002	73/74	2.1 - 41.0		
	August/Sept. 2003	28/33	1.0 - 22.0		
Trichloroethene (TCE)	September 1998	0/17	ND	0.009 ug/L 5.0	CREG (ur) MCL
	July 1999	0/18	ND		
	June 2001	9/40	0.1J - 15.0		
	March/April 2002	15/31	0.08J - 33.3		
	November 2002	9/74	0.06J - 24.0		
	August/Sept. 2003	13/25	0.05J - 14.9		
Tetrachloroethene (PCE)	September 1998	0/17	ND	5.0	MCL
	July 1999	1/18	ND - 0.3		
	June 2001	0/40	ND		
	March/April 2002	14/31	0.06J - 1.1		
	November 2002	8/74	0.2J - 6.1		
1,1 Dichloroethane (1,1-DCA)	September 1998	1/17	ND - 0.5	n/a	n/a
	July 1999	1/18	ND - 0.5		
	June 2001	0/40	ND		
	March/April 2002	2/31	0.09J - 0.09J		
	November 2002	12/74	0.06J - 2.0		
1,1,1 - Trichloroethane (1,1,1 - TCA)	September 1998	3/17	ND - 1.0	200.0	MCL
	July 1999	2/18	ND - 0.4		
	June 2001	0/40	ND		
	March/April 2002	2/31	0.07J - 0.1J		
	November 2002	16/74	0.06J - 5.9		
1,1- Dichloroethene (1,1- DCE)	September 1998	1/17	ND - 1.0	7.0	MCL
	July 1999	0/18	ND		
	June 2001	0/40	ND		
	March/April 2002	1/31	0.09J - 0.09J		
	November 2002	9/74	0.06J - 3.9		
Carbon Tetrachloride (CCl4)	September 1998	1/17	ND - 1.0	5.0	MCL
	July 1999	0/18	ND		
	June 2001	0/40	ND		
	March/April 2002	0/31	ND		
	November 2002	7/74	0.08J - 1.1		
Methyl Ethyl Ketone (MEK)	September 1998	2/17	ND - 13.0	n/a	n/a
	July 1999	0/18	ND		
	June 2001	0/40	ND		
	March/April 2002	0/31	ND		
	November 2002	0/74	ND		
Methyl Butyl Ketone (MBK)	September 1998	2/17	ND - 9.0	n/a	n/a
	July 1999	0/18	ND		
	June 2001	0/40	ND		
	March/April 2002	0/31	ND		
	November 2002	0/74	ND		

NR = Data unreliable and not identified in table
mg/kg = milligrams per kilogram
ug/L = micrograms per liter
J = Analyte present. Reported value may not be accurate or precise
n/a = not available
ur = under review
MRL (C)= Chronic Minimal Risk Level
MRL (I)= Intermediate Minimal Risk Level
CREG = Cancer Risk Evaluation Guide
ND = Non-Detect
* 2/18 Walnut Bank Farm Development Well

TABLE 3 – Summary of Potential, Completed and Eliminated Exposure Pathways

Pathway Name	Exposure Pathway Elements					Pathway Status and Time Frame
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Public water:						
off-site	landfill (VOCs)	potable water	tap and shower	dermal contact, breathing and ingestion	residents using public water from the QBWS wells B>	**completed** past
					residents using public water from QBWS wells B>	**eliminated** current future
off-site	Unknown (arsenic)	potable water	tap	ingestion	residents using public water from QBWS wells B>	**completed** past present
off-site	Unknown (arsenic)	potable water	tap	ingestion	residents using public water from WBFD well B>	**completed** past **eliminated** current future
Private Well Water:						
off-site (south of site)	landfill (VOCs)	potable well water	tap and shower	dermal contact, ingestion & inhalation	residents using water from their private wells B>	**completed** past current **potential** future
	Unknown (arsenic)	potable well water	tap	ingestion	residents using water from their private wells B>	**completed** past current **potential** future
off-site (north, east,	Unknown (VOCs &	potable well water	tap and shower	dermal contact,	residents using water from their	**completed** past

and west)	arsenic)			ingestion & inhalation	private wells B>	current potential future
Surface soils: on-site off-site	 landfill (VOCs) landfill (VOCs)	 wastes/soils/ sediments creek sediments	 wastes/ soils Tohickon Creek	 dermal contact, incidental ingestion dermal contact, incidental ingestion	 on-site workers, trespassers B> anglers and children recreating in the Tohickon Creek B>	 **completed** past **potential** past current future
Surface Water: on-site off-site	 landfill (VOCs) landfill (VOCs)	 puddles surface water	 water Tohickon Creek	 dermal contact, incidental ingestion dermal contact, incidental ingestion	 on-site workers, trespassers B> anglers and children recreating in the Tohickon Creek B>	 **potential** past current future **potential** past current future

APPENDICES

APPENDIX A:

Comparison Values
The conclusion that a contaminant exceeds the comparison value does not mean that it will cause adverse health effects. Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects.

Cancer Risk Evaluation Guides (CREGs)
Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span. The Agency for Toxic Substances and Disease Registry=s (ATSDR=s) CREGs are calculated from the U. S. Environmental Protection Agency=s (EPA=s) cancer slope factors (CSFs).

Environmental Media Evaluation Guides (EMEGs)
EMEGs are based on ATSDR minimal risk levels (MRLs) and factor in body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in milligrams of chemical per kilogram of body weight per day [mg/kg/day]) that is likely to be without noncarcinogenic health effects over a specified duration of exposure.

Maximum Contaminant Level (MCL)
The MCL is the drinking water standard established by EPA. It is the maximum permissible level of an individual contaminant in water that is delivered to a free-flowing water supply. MCLs are derived for individual contaminants based on toxicity. MCLs are considered protective of public health over a lifetime (70 years) for people consuming 2 liters of water per day.

Reference Dose Media Evaluation Guides (RMEGs)
ATSDR derives RMEGs from EPA=s oral reference doses (RfDs). The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

Soil Screening Level (SSL)
Generic SSLs were derived by EPA for nationwide application to sites used for residential areas. SSLs are estimates of contaminant concentrations that would be expected to be without noncancer health effects over a specified duration of exposure or to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span.

Risk-Based Concentration (RBC)
The RBCs were developed by EPA Region III. RBCs for tap water, air, and soil were derived using EPA RfDs and cancer potency factors combined with standard exposure scenarios, such as ingestion of 2 liters of water per day, over a 70-year life span. RBCs are contaminant concentrations that are not expected to cause adverse health effects over long-term exposures.

APPENDIX B: ATSDR Plain Language Glossary of Environmental Health Terms

(Revised December 15, 1999)

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

ATSDR: The Agency for Toxic Substances and Disease Registry. 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.

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 Comprehensive Environmental Response, Compensation, and Liability Act.

Completed Exposure Pathway: See Exposure Pathway.

Comparison Values (CVs): Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Concentrations or the amount of substances in air, water, food, and soil which 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.

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 Aamount of substance(s) per body weight per day@.

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 chemcials 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.

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

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. Points of Exposure,
4. Routes 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**).

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.

No Apparent Public The category is used in ATSDR=s Public Health Assessment documents for sites where

Health Hazard: 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. The category is used in ATSDR=s Public Health Assessment documents for sites where

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 example: 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.

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**).

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).

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.

Source: 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.

Superfund Site: See **NPL**.

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