Health Consultation

ANALYSIS OF CONTAMINANTS IN DRINKING WATER AND INDOOR AIR

AMPHENOL PRODUCTS COMPANY PLANT, HOUGLAND TOMATO CANNERY,
WEBB WELLFIELD, AND ADJACENT SITES IN NORTHEAST FRANKLIN

FRANKLIN, JOHNSON COUNTY, INDIANA

EPA RCRA ID: IND044587848
EPA RCRA ID: INN000510423

June 7, 2023

Prepared by the

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Community Health and Hazard Assessment
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. To prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Abbreviations

ADAF	age dependent adjustment factor
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CHRR	County Health Rankings and Roadmaps
CREG	Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
CTE	central tendency exposure
DCA	dichloroethane
DCE	dichloroethene
DPM	diesel particulate matter
EJSCREEN	Environmental Justice Screen
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
EWA	Edison Wetlands Association
FCS	Franklin Community Schools
HEC	human equivalent concentration
HRID	Hurricane Road Industrial Development
IAW	Indiana American Water Company
IDEM	Indiana Department of Environmental Management
IDOH	Indiana Department of Health
IIWYC	If It Was Your Child
ISDH	Indiana State Department of Health
IUR	Inhalation Unit Risk
JCHD	Johnson County Health Department
KM	Kaplan-Meier
LOAEL	lowest observed adverse effect level
MC	methylene chloride
MCL	maximum contaminant level
MRL	Minimal Risk Level
$\mu g/m^3$	micrograms per cubic meter
mg/kg/day	milligrams per kilogram per day

NATA	National Air Toxics Assessment
NOAEL	no observed adverse effect level
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
$PM_{2.5}$	particulate matter smaller than 2.5 microns
ppb	parts per billion
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RME	reasonable maximum exposure
RMP	risk management plan
RSL	residential screening level
SSDS	sub-slab depressurization system
TCE	trichloroethylene
TRI	Toxics Release Inventory
VC	vinyl chloride
VOC	volatile organic compound

1. EXECUTIVE SUMMARY

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) protects communities from harmful health effects related to exposure to natural and man-made hazardous substances. We do this by responding to environmental health emergencies; investigating emerging environmental health threats; conducting research on the health impacts of hazardous waste sites; and building capabilities of and providing actionable guidance to state and local health partners.

The U.S. Environmental Protection Agency (EPA) and Indiana Department of Environmental Management (IDEM) are engaged in multiple environmental site investigations and cleanup efforts in the northeast part of the City of Franklin, IN. EPA is addressing contamination at the former Franklin Power Products and Amphenol Corp (Amphenol) site via the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. This program requires facilities that treat, store, or dispose of hazardous waste to investigate and clean up releases into the environment. With EPA oversight, Amphenol is working to characterize and mitigate off-site areas where volatile organic compounds (VOCs) have migrated through a plume of contaminated groundwater and via the sewer system into the adjacent residential neighborhood. IDEM is investigating several other industrial sites near Amphenol that may be impacted by the VOC plume. IDEM also has oversight of characterization and mitigation efforts at the former Webb Wellfield, where VOC contamination historically impacted local drinking water wells which are no longer in use. Although Amphenol was originally considered a possible source of VOCs at Webb Wellfield, EPA determined that the contamination originated at the former Hougland Tomato Cannery (Hougland) site [EPA 2020b].

ATSDR, Indiana Department of Health (IDOH), and Johnson County Health Department (JCHD) are working to evaluate data collected by EPA and IDEM to characterize residents' and workers' potential off-site exposures to contaminants from these sites. VOCs have migrated to indoor air at nearby homes and workplaces through a process called vapor intrusion. We are also evaluating other potential sources of VOC exposures in Franklin in indoor air, outdoor air, and drinking water.

ATSDR drafted this health consultation in response to EPA and IDEM requests for assistance in evaluating community health risks. The purpose of this document is to evaluate the public health significance of exposures to contaminants in indoor air and drinking water in homes and publicly accessible businesses in northeast Franklin. ATSDR used indoor air data collected by EPA around the Amphenol site beginning in 2018. We reviewed indoor air data collected beginning in 2016 at the Hougland site by the property owner with IDEM oversight. Follow-up testing is ongoing at both sites. We reviewed historic drinking water data reported by the Indiana American Water Company (IAW) from the 1980's up to the time that the affected wells were taken off-line in 2007.

Conclusions

Following its review of environmental data provided by EPA and IDEM, ATSDR reached three health-based conclusions.

Conclusion 1

ATSDR concludes that people's health could have potentially been harmed in the past by breathing contaminants from the Hougland groundwater plume that migrated into indoor air at one nearby non-residential property.

Basis for Conclusion 1

- ATSDR evaluated indoor air collected at three commercial properties potentially impacted by the Hougland groundwater plume. The property owner conducted three rounds of indoor air sampling in 2016, 2017, and 2019 as required by IDEM due to their proximity to the underground trichloroethylene (TCE) plume.
- One of the structures, Building 2, which houses a recycling center, had TCE levels in indoor air at levels that could be a higher risk for fetal heart defects if a pregnant employee were exposed. High TCE levels in the sub-slab gas indicated that the contamination was due to vapor intrusion from the groundwater plume. Buildings 3 and 4, including the former gymnastics center, did not have indoor air VOCs at levels of potential health concern.
- IDEM recommended that the property owner install a carbon air filtration unit at Building 2 to remove VOCs from the air and install fans to increase ventilation. The changes were implemented, and follow-up sampling confirmed that TCE levels were reduced. ATSDR does not consider VOCs in indoor air to pose an ongoing health hazard to occupants of this property.

Conclusion 2

ATSDR concludes that people's health could have potentially been harmed in the past by breathing contaminants from the Amphenol groundwater plume that have migrated into indoor air at two residences via vapor intrusion or through the sewer system.

Basis for Conclusion 2

- ATSDR evaluated indoor air data collected by EPA from 37 homes potentially impacted by the Amphenol groundwater plume. In the case of homes where indoor air contaminants could be attributed to subsurface or sewer contamination, there were two homes with TCE levels in indoor air at levels that could be a higher risk for fetal heart defects if a pregnant resident were exposed. EPA has required and implemented engineering controls at these homes to reduce TCE levels in indoor air. Other VOCs were at levels that are unlikely to cause cancer and noncancer health effects.
- There was one home near Amphenol where the indoor concentration of a VOC, which was not related to the underground plume, was reported at a level that is a concern for a potential increase in cancer risk. The presence of 1,2-DCA in this home was likely the result of an indoor source, as this chemical is found in a variety of common consumer products. EPA has advised the resident to safely dispose of older cleaning products that may contain 1,2-DCA.

- To control migration of VOCs from the Amphenol plume to indoor air, EPA has installed sub-slab depressurization systems (SSDS) at 7 homes, performed plumbing repairs at 11 homes, and replaced or re-lined 2,600 feet of damaged sewer pipe along Forsythe Street. EPA has conducted follow-up indoor air testing at homes near Amphenol to ensure the effectiveness of these remedies. ATSDR does not consider VOCs in indoor air to pose an ongoing health hazard to occupants of these properties.

Conclusion 3

ATSDR concludes that people's health is not likely to be harmed by ingesting drinking water in Franklin, both currently and in the past.

Basis for Conclusion 3

- VOCs were discovered by IAW in community drinking water wells at Webb Wellfield in 1988. The utility blended water from contaminated wells with water from unaffected wells to ensure that finished drinking water did not exceed EPA standards.
- ATSDR determined that historic maximum concentrations of VOCs in finished drinking water for the City of Franklin were below levels that could increase the risk of health effects.
- IAW discontinued use of all wells at Webb Wellfield by 2013 and community water is extracted from the three remaining wells not impacted by groundwater contamination. IDEM is currently overseeing investigation and remediation of the source of contamination at the Hougland site.

Recommendations

Following its review of available information, ATSDR recommends that:

1) IDEM continue to oversee the investigation and remediation of properties impacted by the migration of VOC contaminants from the Hougland groundwater plume.
2) EPA continue to oversee the on-site and off-site investigation and remediation of properties impacted by the migration of VOC contaminants from the Amphenol groundwater plume. Conduct future resampling at the former Franklin Power Products site, as conditions change over time and sub-surface VOCs may migrate indoors. Implement a formal operations and maintenance plan for homes adjacent to Amphenol where an SSDS was installed once this becomes feasible.
3) The homeowner at PR32 limit the storage and use of household chemicals that have contributed to VOCs and associated health risks in indoor air. The Consumer Product Information Database (see: https://www.whatsinproducts.com/), which is supported by the National Institute of Environmental Health Sciences, part of the Department of Health and Human Services, provides information on household products and chemicals. Homeowners can also learn how to decrease their exposures by looking up summaries of individual hazardous substances on the ATSDR ToxFAQ page found here: https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsLanding.aspx.
4) IDOH and JCHD continue to promote cancer awareness and recommendations for cancer prevention in the Franklin community as outlined in IDOH's 2018-2020 Cancer Control Plan.

2. BACKGROUND AND STATEMENT OF ISSUES

The City of Franklin is about 20 miles south of Indianapolis. Franklin is the Johnson County seat and one of Indiana's fastest growing cities. It has a historic industrial base, has attracted several international manufacturers, and is experiencing growth in service industries [Franklin 2020]. Some of Franklin's older commercial and manufacturing facilities have been the source of chemical releases to the soil and groundwater [IDEM 2020a]. The community has been concerned about this environmental contamination and the potential for health effects that could result from exposure to residents in the immediately impacted areas and beyond. The community group "If It Was Your Child" (IIWYC) was founded by parents of children with pediatric cancer in response to the perceived elevated rate of childhood cancer in Johnson County which they attribute to exposure to chemicals from Amphenol, Hougland, and other industrial sources [IIWYC 2018].

2.1 Demographics, Environment, and Health Overview

EPA and IDEM are engaged in multiple environmental site investigations and cleanup efforts in northeast Franklin. The outline of the study area, Amphenol, Hougland, and other former industrial and commercial sites are shown on Figure 1. The facilities are described in detail in Section 2.2.

Figure 1. Map of northeast Franklin study area: former industrial sites potentially impacting groundwater

Source: ATSDR Region 5, basemap Esri, HERE, Garmin, FAO, NOAA, USGS, and OpenStreetMap contributors

EPA is addressing contamination at Amphenol under the RCRA Corrective Action Program. IDEM is investigating several industrial sites adjacent to Amphenol. IDEM also has the lead on investigating the nearby Hougland site, where historic contamination impacted community drinking water wells at the former Webb Wellfield, which are no longer in use. Although Amphenol was once considered to be a potential source of groundwater contamination at the Hougland site, EPA has determined that the groundwater plumes at these sites are not connected. Groundwater modeling shows that contaminants from Amphenol are migrating south, in the opposite direction of Webb Wellfield [EPA 2020b]. ATSDR, IDOH, and JCHD are working to evaluate residents' potential exposures to contaminants from these sites.

Franklin is a city of 25,248 residents [Census 2018]. The median household income is $56,367 and the percentage of individuals below the poverty level is 10%. The race of Franklin residents is 96% White, 2% Black, 1% Asian, and 1% two or more races; 3% of residents are Hispanic [Census 2017]. ATSDR used EPA's Environmental Justice Screen (EJSCREEN) tool to evaluate demographic features and identify potential environmental risks. EJSCREEN is an environmental justice mapping and screening tool which uses a nationally consistent dataset and approach for evaluating environmental and demographic indicators. This information is a first step in identifying areas that may require further review of environmental data. As stated by EPA, EJSCREEN results "do not, by themselves, determine the existence or absence of environmental justice concerns in a given location" [EPA 2022a].

Using EJSCREEN, we estimated a population of 3,426 in the 2.4 square mile study area of northeast Franklin shown in Figure 1. EJSCREEN puts demographic and environmental indicators in perspective by reporting them as a percentile. Relatively higher percentiles can be used to identify areas that have higher environmental burdens and vulnerable populations. For example, if an indicator is in the 70th percentile nationwide, it means that 30% of the U.S. population has a higher value. EJSCREEN users typically prioritize areas in the 80th percentile or higher for closer examination. Demographic indicators for northeast Franklin were all below the 80th percentile and they are not included in this document. Environmental indicators and percentiles comparing the study area with the rest of Indiana and the US are shown on Table 1 [EPA 2020a].

There is one EJSCREEN indicator above the 80th percentile, suggesting a potential elevated risk compared to other communities: Risk Management Plan (RMP) Proximity is in the 94th percentile [EPA 2020a]. The RMP Proximity indicator is high because the Premier Agriculture Cooperative Incorporated (Premier Ag) facility, located at 755 East Hamilton Avenue (shown above on Figure 1), stores ammonia on site. Facilities that are subject to the RMP rule, which is required under the 1990 Clean Air Act amendments, must document the potential effects of a chemical accident, the steps they are taking to prevent an accident, and emergency response procedures in the event of a chemical release. EPA reports that there are no Superfund National Priority List or Hazardous Waste Treatment, Storage, and Disposal Facilities sites in the area. Johnson County is currently meeting the National Ambient Air Quality Standard for particulate matter smaller than 2.5 microns ($PM_{2.5}$), ozone, and other air pollutants [EPA 2019a].

According to EPA's 2018 Toxic Release Inventory (TRI), there are no major industrial emitters of air contaminants in the study area. Smaller emitters, such as gas stations and dry cleaners, are not listed in TRI, nor are motor vehicle releases. However, these sources are included in the National Air Toxics Assessment (NATA) referenced on Table 1. NATA is a screening tool for state, local, and tribal air agencies to identify the pollutants, emission sources, and places they may wish to study further to better understand any possible risks to public health from air toxics. EPA suggests using NATA screening results

Table 1. Environmental Justice Screen (EJSCREEN) indicators for northeast Franklin*

Indicator	Value	Percentile in Indiana†	Percentile in US†
Particulate matter ($PM_{2.5}$ in $\mu g/m^3$) in air	8.9	40	67
Ozone (ppb) in air	43	9	44
National-Scale Air Toxics Assessment (NATA) Diesel PM ($\mu g/m^3$)	0.48	63	60-70
NATA cancer risk (lifetime risk per million)	26	54	<50
NATA respiratory hazard index	0.35	61	<50
Traffic Proximity and Volume (daily traffic count/distance to road)	240	60	52
Lead Paint Indicator (% Pre-1960 Housing)	0.37	62	68
Superfund Proximity (site count/km distance)	0.031	16	28
Risk Management Plan Proximity (facility count/km distance)	2.7	94	94
Hazardous Waste Proximity (facilities/km)‡	0.44	49	49
Wastewater Discharge Indicator	0.0011	53	66

* The study area, as shown on Figure 1, includes these census tracts – 180816110001 and 180816111001 – and a portion of 180816108022 and 180816112001. EJSCREEN results are averaged across census tracts for the selected area.

† Percentiles greater than 80 are shaded gray. Fewer than 20% of U.S. census tracts have a higher risk.

‡ Includes Hazardous Waste, Treatment, Storage, and Disposal Facilities and Large Quantity Generators.

cautiously, emphasizing that local air monitoring is needed to better characterize local public health risk [EPA 2022b]. According to EPA's 2014 NATA, the two census tracts within the study area both have an estimated cancer risk from air releases of 30 in a million. This means that, out of a population of one million people exposed over a lifetime, 30 may develop cancer as a result of breathing air pollutants. This is lower than the predicted risk in 50 percent of US census tracts. As reported in NATA, northeast Franklin also has somewhat elevated estimates of $PM_{2.5}$ (67th percentile nationally) and diesel particulate matter (DPM) in air (60 to 70th percentile), which would be expected in an urbanized area with vehicle traffic. Although Franklin is not a large city, it is within the Indianapolis metropolitan area and is subject to urban traffic patterns. DPM is a subset of $PM_{2.5}$ comprised of direct emission from on-road and off-road diesel engines including trucks, trains, and construction equipment. EPA's $PM_{2.5}$ indicator is based on ambient air monitoring data in the region, whereas the DPM indicator is based on NATA's more spatially resolved emissions estimates and dispersion modeling. EPA and IDEM do not currently or historically operate $PM_{2.5}$ air monitoring stations in Johnson County. ATSDR is unable to make a more definitive assessment of PM health risks in Franklin, IN, without community-based air monitoring data.

Northeast Franklin is part of the Hurricane Creek watershed. EPA defines a watershed as "the land area that drains into a stream or other waterbody", thus Hurricane Creek is the drainage path for surface water and groundwater in the study area. In general, groundwater west of the Creek travels eastward and groundwater east of the Creek flows west toward the Creek. There may be short-term, temporary variation to this trend depending on drought or flood conditions [IDEM 2020b; EPA 2020b]. The section of Hurricane Creek in our study area is categorized as an "impaired" water body because it fails to meet water quality standards based on its intended use. The Creek does not meet standards for recreational use (i.e., full body contact) due to bacterial contamination. Bacteria are potentially disease-causing organisms from human or animal waste that enter water from faulty septic systems, sewage discharges, farm and feedlot manure runoff, boat discharges, and pet waste. People can become ill by eating contaminated fish or swimming in contaminated waters [EPA 2020b]. This type of contamination in a community like Franklin is potentially the result of runoff from livestock, failed septic systems, and wildlife [IDEM 2019a].

Statistics on the health of U.S. counties are compiled by the County Health Rankings & Roadmaps (CHRR) program. CHRR is a project of the University of Wisconsin Population Health Institute, which makes health data from a variety of Centers for Disease Control and Prevention (CDC) sources easily accessible to communities. The County Health Rankings provide a snapshot of a community's health and a starting point for investigating and discussing ways to improve health [RWJF 2021]. Overall, Johnson County is among the healthiest counties in Indiana with a rank of 6 out of 92 counties [UW 2020].

Measures for Johnson County are presented on Table 2 in comparison to the whole of Indiana and the U.S. Health outcomes represent how healthy a community is through measures representing length of life and quality of life. Health behaviors are actions individuals take that affect their health, including actions that lead to improved health, such as being physically active, and actions that increase one's risk of disease, such as smoking. For the important measures shown, Johnson County is healthier than Indiana as a whole and largely on par with the entire U.S. [UW 2020].

Additional data for Johnson County and other communities may be accessed at the CHRR website (www.countyhealthrankings.org) or from the original data sources noted on Table 2, which include the National Center for Health Statistics, CDC WONDER, CDC Diabetes Interactive Atlas, and Behavioral Risk Factor Surveillance System. CHRR and other data resources are accessible on the CDC Community Health Assessment website for Data and Benchmarks: www.cdc.gov/publichealthgateway/cha/data.html.

Table 2. Johnson County health outcomes and health behaviors

Measure*	Type	Johnson County	Indiana	United States
Low birthweight†	Health outcome	7%	8%	8%
Life expectancy‡	Health outcome	78	77	79
Child mortality§	Health outcome	52	61	50
Infant mortality ⁋	Health outcome	5	7	6
Adult smoking**	Health behavior	18%	22%	17%
Adult obesity††	Health behavior	31%	33%	29%
Physical inactivity‡‡	Health behavior	24%	27%	23%

*Source: County Health Rankings and Roadmaps program (CHRR) [UW 2020]. CHRR lists the below sources for these data:

† Low birthweight. National Center for Health Statistics (CDC) – Natality files (2012-2018)

‡ Age in years. Source: National Center for Health Statistics (CDC) – Mortality files (2016-2018)

§ Number of deaths among children under age 18 per 100,000. CDC WONDER mortality data (2015-2018)

⁋ Number of all infant deaths (within 1 year) per 1,000 live births. CDC WONDER mortality data (2012-2018)

**Behavioral Risk Factor Surveillance System (CDC) (2017)

†† CDC Diabetes Interactive Atlas (2016)

‡‡ Percentage of adults aged 20 and over reporting no leisure-time physical activity. CDC Diabetes Interactive Atlas (2016)

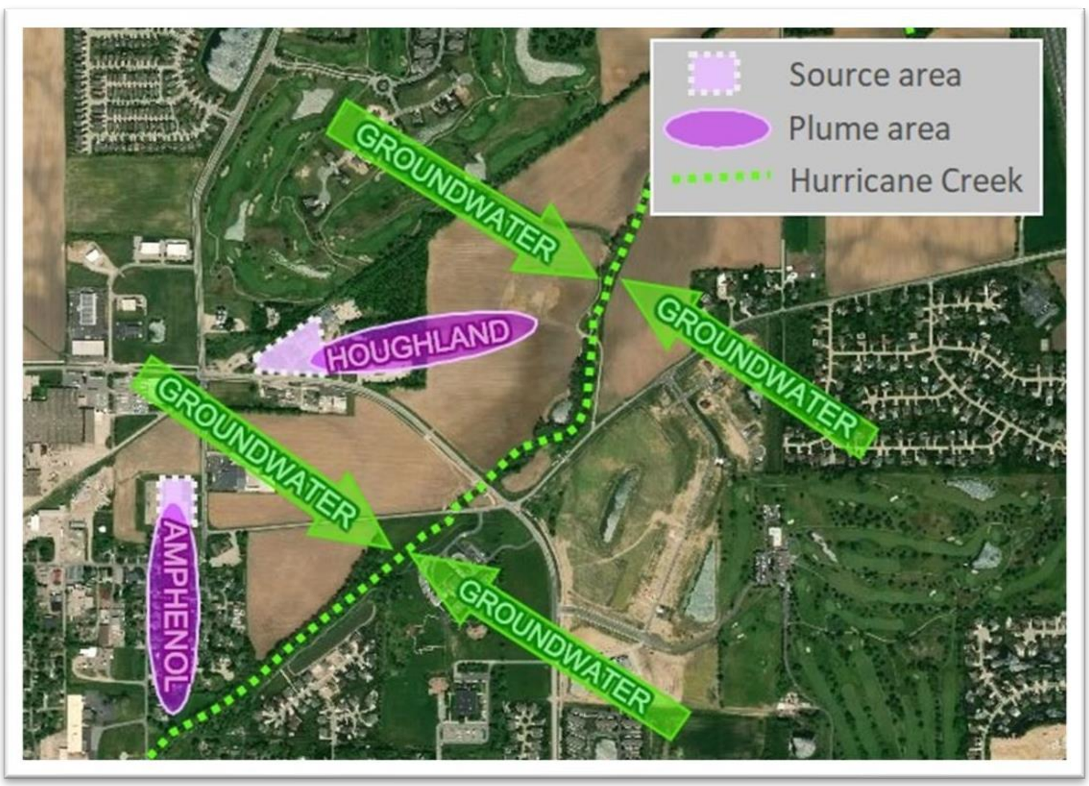
2.2 Historic Chemical Releases and Regulatory Action

ATSDR evaluated the history of industrial sites in northeast Franklin with a focus on chemical releases and potential community exposures. Exposure pathways, environmental data, and potential health effects related to these exposures are discussed in subsequent sections of this document.

<u>Amphenol</u>

The former Amphenol site is located at 980 Hurricane Road. Amphenol no longer operates the site; however, the company is still responsible for addressing historic contamination with EPA oversight. Amphenol conducted an environmental investigation and cleanup under two Administrative Consent Orders issued by EPA's RCRA Corrective Action program in 1990 and 1998. EPA determined that a former site owner, Bendix Corporation – an electrical parts manufacturer, released VOCs into the environment between 1906 and 1983 [EPA 2020c]. VOCs, most notably tetrachloroethylene (PCE) and TCE, migrated off-site in a plume of contaminated groundwater and via the sewer system into the neighborhood to the south. The approximate locations of the contaminant plumes are shown on Figure 2.

Figure 2. Contaminant sources areas, extent of contaminant plumes, and groundwater flow direction



Source: ATSDR Region 5, basemap Esri, Maxar, Earthstar Geographics

EPA required Amphenol to construct and operate cleanup measures, including a groundwater pump-and-treat system, which was installed on-site in 1995. This system was upgraded in 1999 and then expanded in 2010. Amphenol also removed contaminated soil from a source area on-site and replaced a section of contaminated sewer line on the property. In 2011, the facility installed a SSDS to address on-site vapor intrusion issues and initiated soil treatment in the most contaminated area, under the former plating room.

EPA conducted an off-site vapor intrusion risk evaluation near Amphenol in 1996 and, given the methodology in use at the time, concluded that VOCs did not pose a health risk to people via contaminant migration into their indoor air. However, EPA's protocols for vapor intrusion investigations and health risk screening levels for VOCs changed significantly in the years that followed, prompting the agency to reevaluate potential off-site exposures [EPA 2015, 2018].

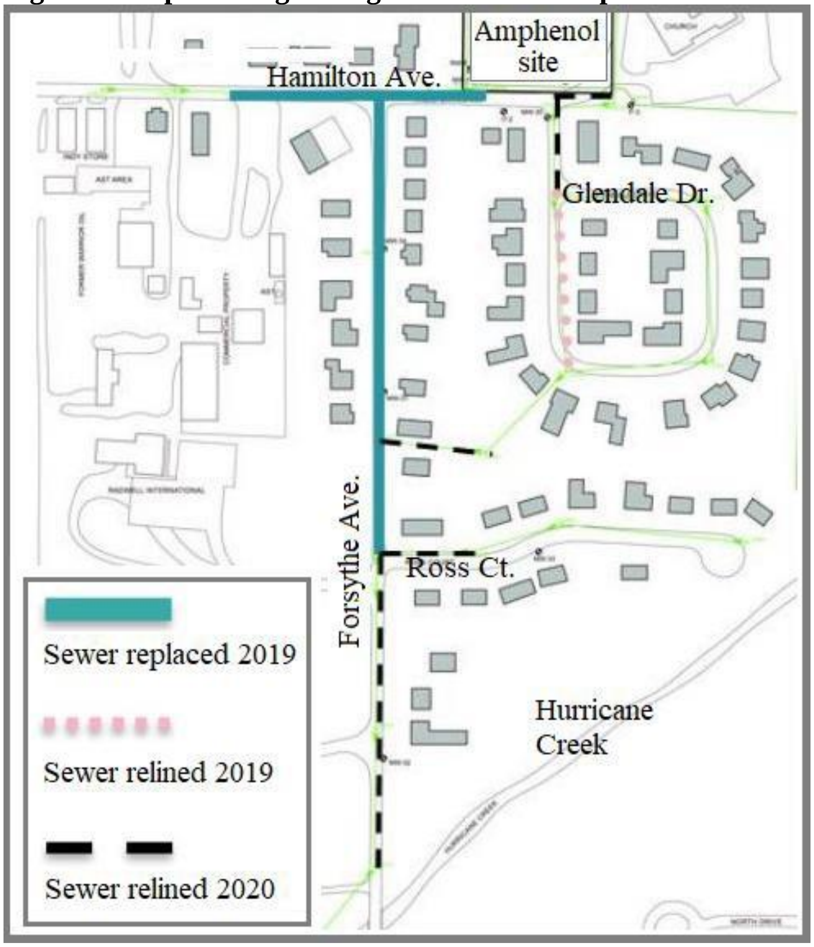
EPA required Amphenol to conduct sampling in 2018-19 to determine the extent of VOC contamination in homes in the adjacent neighborhood. Amphenol initially took air samples from sewer lines and sewer backfill (bedding) and groundwater samples along public rights-of-way. The results identified 37 priority homes along Forsythe Street and Hamilton Avenue to be considered for indoor air testing. Indoor air and sub-slab vapor sampling began in September 2018. The investigation also included sampling vapors in "sewer laterals," which are pipes that connect main sewer lines to individual home sewer systems. At homes where sewer laterals were found to be contaminated, Amphenol performed a pressure test to determine whether their plumbing system is properly sealed. A plumbing contractor made repairs; for example, vapor leaks around toilet flanges were replaced and sump pits were sealed with a sump lid. At properties where VOCs were elevated due to vapor intrusion, Amphenol installed an SSDS to prevent fumes from entering the home. EPA typically implements an operations and maintenance plan with the property owner to ensure proper functioning of the SSDS and allow access for future testing and inspection. At the time of writing of this report, establishment of formal plans were delayed due to EPA's pandemic related health restrictions. Indoor air, sub-slab, and sewer lateral line sampling results are presented in Section 4; health implications are discussed in Section 5.

In 2019, Amphenol replaced damaged sewers and removed contaminated soils along Forsythe Street and Hamilton Avenue. They also relined intact sewers along residential streets, i.e., Glendale Drive and Ross Court. Figure 3 depicts these sewer lines and gives an indication of where residential properties were potentially impacted by VOCs migrating through home sewer systems and via vapor intrusion.

In 2020-21, follow-up off-site indoor air and sewer gas testing continued, and Amphenol worked to characterize and address contaminated soil and groundwater on-site. EPA provides regular updates on these activities on their Amphenol web page: https://www.epa.gov/in/amphenolfranklin-power-products-franklin-ind

In addition to residential properties south and southeast of Amphenol, the groundwater plume may have migrated onto other commercial/industrial properties to the southwest. Potentially impacted sites are discussed below.

Figure 3. Map showing damaged sewers to be replaced and relined near Amphenol site



Source: https://www.epa.gov/sites/production/files/2019-12/documents/fact_sheet_amphenol_neighborhood_cleanup.pdf

Facilities potentially impacted by Amphenol plume

The former **Warrior Oil site (Warrior)** is about 700 feet southwest of Amphenol at 809 Overstreet Street. (See Figure 1) The previous owners operated a petroleum terminal on-site with up to 31 above-ground storage tanks of varying capacities to store diesel, fuel oil, and used oils. In 2010, the current owner collected soil and groundwater samples near the tank area, and water from the existing nonpotable groundwater supply well, to analyze for VOCs and polycyclic aromatic hydrocarbons (PAHs). Analyses revealed trace VOCs on-site in one soil sample location, however results were below IDEM industrial site closure criteria. One groundwater sample was found to contain 8.6 parts per billion (ppb) of 1,1-dichloroethane (1,1-DCA), which is lower than IDEM's Remediation Closure Guide (RCG) Screening Levels and IDEM residential tap drinking water screening levels. Results for the nonpotable supply well and two other groundwater monitoring wells were all non-detects for VOCs and PAHs [Heritage 2010]. In October 2018, IDEM also reported all non-detects for VOCs and PAHs at the non-potable groundwater supply well [IDEM 2018d]. While trace amounts of some PAHs were detected, none have applicable health-based screening levels. Based on the results of on-site sampling and at properties located downgradient of Warrior, IDEM does not consider Warrior to be a source of off-site groundwater contamination, nor is there significant contamination moving across the site from other sources. IDEM issued the property owner a "Close Out Report" letter on November 25, 2019, indicating that no additional investigation or remediation activities on the Warrior Oil property were warranted [IDEM 2019b].

Radwell International (Radwell), located south of Warrior at 600 N Forsythe, repairs industrial electrical equipment. Previous occupants stored electrical transformers and repaired diesel engines. According to a completed Phase I Environmental Site Assessment, there were minor historic on-site releases of polychlorinated biphenyls (PCBs) and diesel fuel hydrocarbons. Sampling conducted in the 1990s found no remaining PCBs or hydrocarbons in surface soil. Based on groundwater sampling conducted by Amphenol's consultant, the only potentially significant contaminants on-site are TCE in groundwater believed to have migrated from Amphenol [Radwell 2018]. The Amphenol plume, which is east of Radwell along Forsythe Street, does not extend to within 100 feet of the building on the west end of the Radwell site; thus, IDEM does not consider vapor intrusion to be a potential issue. IDEM does not require additional investigation or remediation at this site. IDEM intends to issue a site closure letter once an environmental restrictive covenant is placed on the property restricting the extraction of groundwater for any use, restricting the property to commercial use only, and requiring the owner grant access to EPA for any future investigations [IDEM 2020a, 2021d].

The former **Franklin Power Products site (Franklin)** is located south of Radwell at 400 N Forsythe. It was historically used for leather horse harness manufacturing, tomato canning, and most recently for remanufacturing commercial diesel engines. The current occupants use the main building for warehousing and storage, as well as an indoor baseball training facility. A 1996 Phase I Environmental Site Assessment identified soils contaminated with petroleum hydrocarbons on-site as well as TCE contamination in groundwater along the north property line, which is attributed to migration from Amphenol [SMA 2019]. The facility conducted indoor air testing in August 2018 and reported that PCE and TCE were non-detects (less than 3.2 and 1.1 micrograms per cubic meter [$\mu g/m^3$], respectively) in all samples [Keramida 2018]. Additional rounds of testing were conducted in March and June 2020, representing cool-season and warm-season conditions, respectively. Detection limits were the same as sampling performed in 2018 and, again, all indoor air samples were non-detects for PCE and TCE [SMA 2020]. A covenant was finalized on November 3, 2020, restricting use of groundwater for any purpose, and requiring that any future buildings should only be constructed if a vapor mitigation system is installed [IDEM 2020c]. IDEM issued a *No Further Action* letter on December 14, 2020. [IDEM 2020d]

<u>Hougland and Webb Wellfield</u>

The Hougland property is about ¼-mile northeast of Amphenol. Originally this was the site of the Franklin Canning Company, which packaged local-grown tomatoes, sweet corn, and pumpkins. Hougland Packing Company operated the site from 1922 until they went out of business in 1953 [Pfeiffer 2021]. The western half of the Hougland site is now owned by Reed Manufacturing (Reed) and the eastern portion is owned by Hurricane Road Industrial Development (HRID). Commercial activity and environmental contamination at these sites are described in the following sections.

The former Webb Wellfield is about ½-mile northeast of the former Hougland site. The wellfield previously consisted of three wells bordered by farm fields in all directions. Hurricane Creek transected the wellfield and split former Well 5, located on the east side of the Creek, from Wells 2 and 3, west of the creek. Hurricane Creek flowed within 30 feet of the nearest well (Well 2). In 1988, Wells 2 and 3 were found to be contaminated with VOCs, specifically cis- and trans-1,2-dichloroethylene (cis- and trans-DCE). Cis-DCE was as high as 122 and 218 ppb in untreated water from Wells 2 and 3, respectively. Maximum trans-DCE levels were 9.3 and 16 ppb at Wells 2 and 3, respectively [IDEM 2014]. Finished drinking water delivered to customers had VOC levels consistently below EPA's maximum contaminant levels (MCLs) because the water utility blended water from the former Webb Wellfield with unaffected wells elsewhere in Franklin.

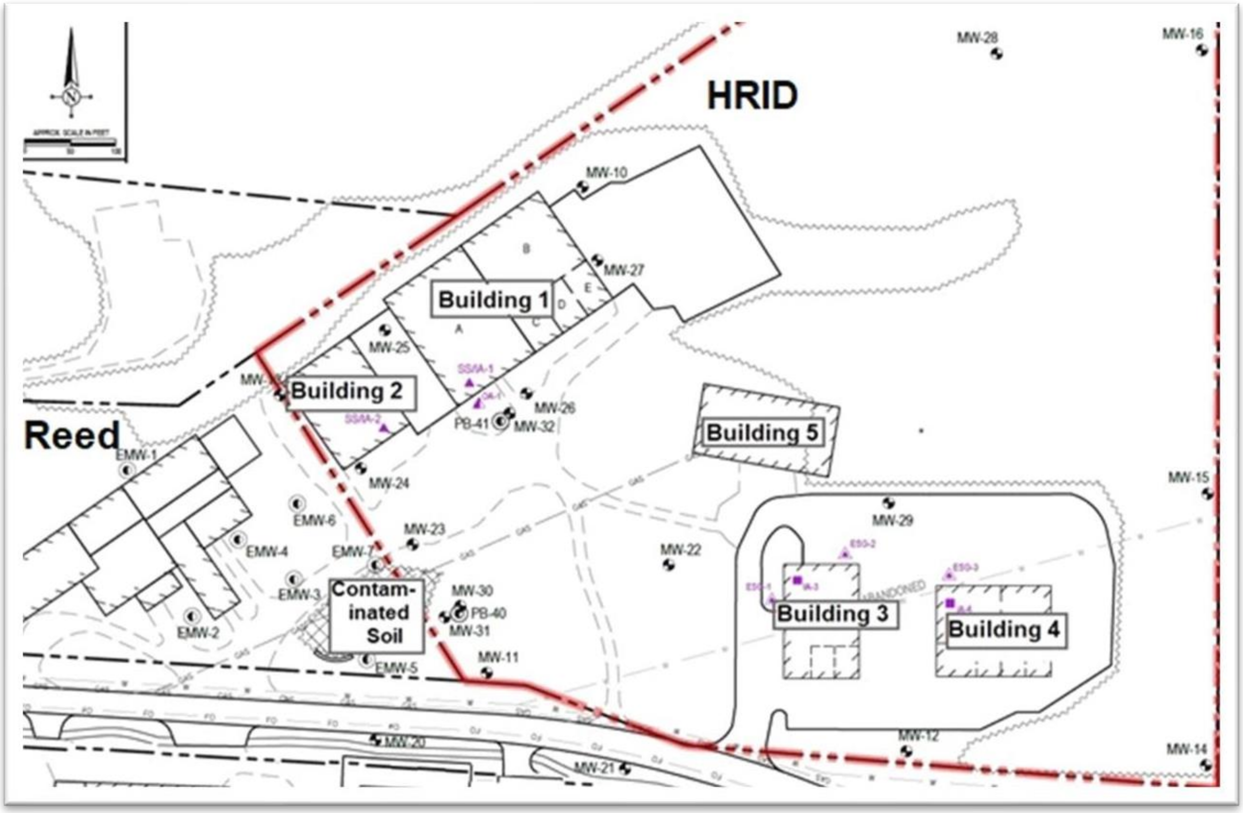
Drinking water testing results are discussed in more detail in Section 4 and potential health effects are assessed in Section 5. The two affected wells were taken offline in 2007 and the third was decommissioned in 2013. In 2007, Amphenol investigated possible migration of VOC-contaminated groundwater from its site to the Webb Wellfield. Amphenol used groundwater computer modeling to demonstrate that the VOCs are not moving in the direction of the wellfield and EPA agreed with this assessment [EPA 2021].

Once EPA determined that Amphenol was not the source of wellfield contamination, IDEM investigated and determined that the Webb Wellfield plume likely originated from the Hougland site, where soil and groundwater are contaminated with PCE and TCE (see Figures 1 and 2). The VOCs found in the Webb Wellfield, cis- and trans-DCE, are chemical breakdown products of PCE and TCE. The Hougland investigation was referred to IDEM's State Cleanup Program and is currently part of an enforcement-led action.

The **Reed site** at 1056 Eastview Drive was historically part of the Franklin Canning Company/Hougland Packing Company and later contained various businesses including Johnson County Oil Company, Shell Oil Company, and Indiana Diecast Tool. The current occupant provides metal machining services and does not use chlorinated solvents on-site. IDEM-mandated site investigations beginning in 2014 have revealed soil and groundwater contamination consisting of PCE, TCE, and cis-DCE in a wooded portion near the boundary of the Reed and HRID properties shown in Figure 4 [Ramboll 2019]. In February 2020, the property owner excavated a 5,200 square foot area of soil down to the water table at a depth of 8-13 feet. A total of 2,524 tons of soil was removed and disposed off-site in a landfill.

Before backfilling the site with clean material, the property owner installed a groundwater treatment system consisting of a PVC pipe infiltration gallery at the bottom of the excavation. The treatment system was used to deliver a single treatment of 3,087 pounds of potassium permanganate solution directly into the groundwater [Ramboll 2020, IDEM 2021a]. A network of 3 on-site and 4 off-site monitoring wells are being sampled quarterly to track the remediation progress. The goal of reaching commercial vapor exposure screening levels for PCE and TCE is expected to take 1 to 2 years of treatment. As of December 2021, well testing results indicated that PCE and TCE concentrations were decreasing throughout the site and concentrations of cis-DCE and vinyl chloride (VC), breakdown products of PCE and TCE, were increasing, indicating that the treatment process was working. Cis-DCE and VC went from non-detects at all monitoring wells in 2019 up to a maximum concentration of 218 and 14.2 ppb, respectively, at

Figure 4. Map showing area of contaminated soil on Reed site and buildings on HRID property



Source: Patriot Engineering and Environmental Inc. Vapor Intrusion Investigation Report, Hurricane Road Industrial Development LLC Property, 1130 East Eastview Drive, Franklin, IN. October 25, 2019.

monitoring well MW-23, shown on Figure 4, in December 2021. [IDEM 2021c, 2022, Ramboll 2020, 2022]. This VC concentration is above ATSDR's health-protective comparison value (CV) of 0.097 ppb for screening groundwater that could potentially migrate indoors via vapor intrusion; ATSDR does not have a similar CV for cis-DCE in groundwater. These findings show the importance of continued monitoring of PCE and TCE breakdown products and their potential migration to indoor air at buildings on the HRID property.

The **HRID site**, at 100 Eastview Drive, contains five buildings leased to various commercial tenants. The property owner has conducted several investigations beginning in 2016 to characterize the extent of soil and groundwater contamination with PCE, TCE, cis-DCE, trans-DCE, and VC. IDEM required indoor air investigations at the on-site buildings because they are within 100 feet of the area where TCE groundwater concentrations are above the IDEM RCG commercial/industrial Groundwater Vapor Exposure Screening Levels. Buildings 1 and 5 are used for storage and are not occupied. Building 2 is used by a recycling company that operates a small, enclosed office as well as a large space for material receiving, sorting, and shipping, where two overhead doors are generally open and provide ventilation during working hours. Per recommendations from IDEM, an air filter system was placed in the recycling office and an interim SSDS was installed in the building. The property owner planned to install a permanent remedial system for Building 2 in the summer of 2022 [IDEM 2020a, 2022]. Building 3 was until recently occupied by a gymnastics training center and Building 4 is rented by an ambulance company and an electrical contractor.

The gymnastics center was accessible to the public until the facility merged with another gym and relocated in April 2020. IDEM has determined that the new occupant of Building 3 will use it as a merchandise sales warehouse and that further air sampling is not required [IDEM 2020a]. The indoor air sampling results and associated health effects for buildings 2, 3, and 4 are discussed in Sections 4 and 5.

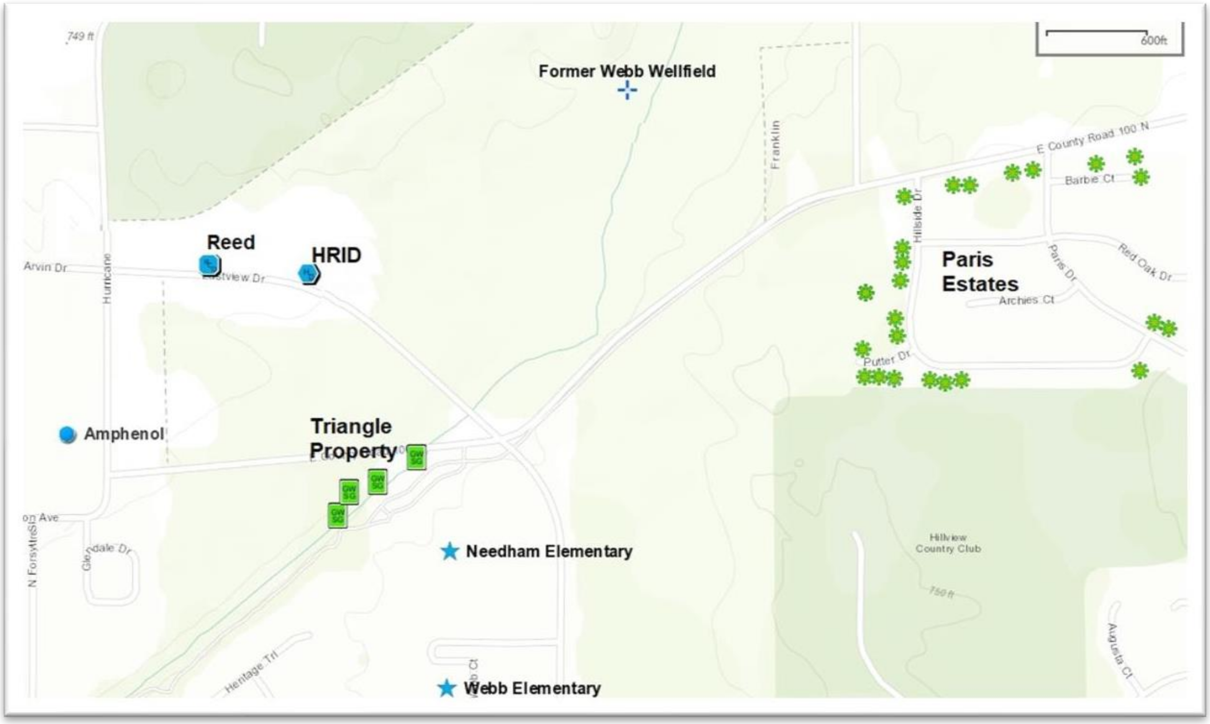
From January to April 2019, the HRID property owner's environmental consultant conducted soil and groundwater sampling to characterize the boundaries of the Hougland site contamination plume. They concluded that soil contamination on the Reed property is mainly limited to the wooded area that is adjacent and partially located on the HRID site (Figure 4). Additionally, there is potentially a second smaller area of contamination near the buildings on the northwest portion of the HRID site. Groundwater testing results from the HRID site indicate that the main plume originates near the Reed site boundary and the smaller, secondary plume merges with the main plume on the HRID property. Results of soil and groundwater sampling completed on farmland located adjacent to the Hougland site to the east shows that the contamination at Hougland degrades as it migrates east across and off-site. Samples collected at the western end of the site (upgradient) contain PCE contamination, but TCE and other daughter products are absent. TCE, the primary break-down product of PCE, appears downgradient of the most contaminated zone with increasing concentrations as the plume migrates east; cis-DCE and trans-DCE are only found at the eastern portion of the site [Patriot 2019].

IDEM's sampling of wells east of HRID, i.e., between the farm fields and residential areas east of Hurricane Creek (including the Paris Estates subdivision), have previously demonstrated that VOCs are below detection limits and contaminants are not migrating beyond the farm fields. Recent sampling adjacent to Hurricane Creek has also shown that the Hougland plume is not migrating beyond the farm fields. As shown on Figure 5, in 2018 IDEM collected soil, groundwater, and soil vapor samples at the "Triangle Property", which is northwest of Hurricane Creek and across the creek from Needham Elementary School. Groundwater and soil sample results at the Triangle Property were non-detects for all VOCs, most notably for PCE, TCE, trans- and cis-DCE; reporting limits for these compounds were 1 ppb in groundwater and 5 parts per million (ppm) for soil [IDEM 2018b]. Soil vapor VOCs were all below IDEM's residential soil gas screening levels. [IDEM 2018c].

During the Webb Wellfield investigation in 2009, IDEM reported that testing of private drinking water wells in and adjacent to Paris Estates, east of Hougland and across Hurricane Creek showed no detections of VOCs. IDEM retested 24 homes in 2018 and found that PCE, TCE, and seven other VOCs were below detection limits, i.e., less than 0.5 ppb [IDEM 2020a].

IDEM continues to oversee remedial actions at the HRID site. The contractor began to inject chemical treatment into the groundwater in the farm field in March 2022 [IDEM 2022]. As noted above regarding the Reed property, levels of PCE and TCE breakdown products, notably VC, could increase in treated groundwater.

Figure 5. Map showing groundwater and soil gas sampling locations east of former Hougland site (now Reed and HRID properties)



Source: https://www.in.gov/idem/cleanups/pages/franklin/map.html

<u>Other potentially contaminated sites near Amphenol and Hougland</u>

The former **Arvin site**, located at 1001 Hurricane Street, is adjacent to Amphenol to the northwest. It is currently used as a multi-unit industrial complex, primarily for manufacturing and warehousing. The Arvin site historically contained a woodworking and furniture manufacturing facility, as well as a manufacturer of ammunition boxes and automotive parts. Multiple incidents were reported between 1983 and 2000 that involved chemical releases to off-site sewers and on-site soil. There were four instances where a petroleum product or lubricant contamination were found in the property's eastern drainage ditch and entering the City of Franklin storm sewer, which discharges to Hurricane Creek. The releases were reported to county and state agencies and the facility removed and disposed of the gross contamination. There were also five separate instances of petroleum chemicals released on-site, requiring the removal and disposal of contaminated soil. Historical waste disposal records indicate that wastes generated and disposed of by Arvin include TCE, PCB-containing liquids, waste paint, waste batteries, corrosive solids, and spent halogenated solvents [Meritor 2019].

In March 2020, the current Arvin property owner conducted soil and groundwater sampling along the property lines and near former on-site industrial process operations, including an assessment of the east drainage ditch where previous releases were reported. The investigation showed that on-site groundwater moves southeast toward Hurricane Creek. Sampling results for VOCs in soil were all below IDEM's Remedial Closure Guide Migration to Groundwater screening levels. There were two groundwater sampling locations that exceeded IDEM's residential tap water screening levels located near the southeast property line, i.e., near the east drainage ditch and adjacent to a commercial property (see Premier Ag below) directly south. One groundwater sample site had VC at 3.4 ppb and one had TCE at 18 ppb. These concentrations are above ATSDR's CVs for drinking water and vapor intrusion; however, they are below IDEM's commercial/industrial screening levels. Adjacent properties are non-residential. All surface water and sediment samples collected from the east drainage ditch resulted in non-detects for VOCs [Meritor 2020]. The property owner has requested *No Further Action* status for the site, which IDEM is currently reviewing.

The former **Premier Agriculture Cooperative Incorporated (Premier Ag) site** is located at 750 East Hamilton Avenue, directly west of Amphenol. It was historically used to store and distribute agricultural products, including chemical fertilizer and anhydrous ammonia. There was also a bulk fuel plant on the site consisting of eight above-ground petroleum storage tanks. The facility performed soil and groundwater sampling in October 2018 to test for VOCs, PAHs, herbicides, and nitrogen constituents. Soil results showed petroleum hydrocarbons exceeding IDEM's Remedial Closure Guide Migration to Groundwater screening levels, but well below the direct contact screening levels. Groundwater concentrations of nitrogen (as a component of nitrate-nitrite and nitrate), naphthalene, and other PAHs exceeded IDEM residential screening levels (RSLs) for drinking water [AEC 2018]. The property owner reported a petroleum hydrocarbon release to IDEM on November 5, 2018 [IDEM 2018]. To remediate the site, the owner removed 1.3 tons of petroleum-contaminated soil for off-site disposal, applied 1,000 pounds of oxygen-releasing material to the excavation site, and backfilled the pit with clean material in December 2018. The owner installed six groundwater monitoring wells in January 2019 [AEC 2019]. Groundwater sampling results show that the well located in the center of the contaminated area exceeds RSLs but not commercial screening levels for benzene, ethylbenzene, and several PAHs. The four wells surrounding the excavation area had non-detects for these compounds. The sixth well is located on the northwest end of the property, near the boundary with the former Arvin site; groundwater in this well exceeded IDEM RSLs for 1,1-DCA and 1,1-DCE. Premier Ag reported that they did not use chlorinated solvents on-site; considering the groundwater flow from Arvin towards Premier Ag, their conclusion was that the substances detected in that well may have migrated off-site from Arvin. The owner submitted a request for site closure on February 7, 2020 [AEC 2020]. IDEM does not require additional investigation or remediation at this site. IDEM issued a site closure letter on December 13, 2021, after an environmental restrictive covenant was finalized for the property restricting groundwater use [IDEM 2021c, e].

Franklin Community Schools

Webb and Needham elementary schools are located on adjacent properties at 1400 Webb Court and 1339 Upper Shelbyville Road, respectively. The schools are about 1/3-mile east of the Amphenol plume and 1/4-mile south of the Hougland plume on the opposite side of Hurricane Creek. Due to concerns about potential impacts from the two plumes, Franklin Community Schools (FCS) collected six soil vapor samples in July 2018 between the school buildings and the west property boundary. Trace levels of PCE and TCE were below ATSDR health-based CVs for soil vapor. FCS proceeded to conduct two rounds of sub-slab vapor testing in August 2018 and March 2019 to determine whether there are VOCs under the buildings with the potential to migrate into indoor air. Several sub-slab samples exceeded IDEM's health screening levels, prompting FCS to conduct two rounds of indoor air sampling paired with sub-slab testing in late March and May 2019, representing cold-season and warm-season conditions, respectively. FCS found that PCE and TCE were below detection limits in all indoor samples, suggesting that VOCs are not migrating from the soil vapor into indoor air. Looking at all four rounds of sub-slab samples, the highest measurements were 952 $\mu g/m^3$ of PCE and 100 $\mu g/m^3$ of TCE at Needham school, 408 $\mu g/m^3$ PCE and 849 $\mu g/m^3$ TCE at Webb school. These maximum sub-slab gas values all exceed the ATSDR sub-slab gas CVs of 127 $\mu g/m^3$ for PCE and 7 $\mu g/m^3$ for TCE. However, the concurrent indoor air sampling confirms that VOCs are not migrating to indoor air and thus underground VOCs do not pose a hazard.

To help identify the source of VOCs under the school building, FCS also tested vapors within five floor drains at each of the schools. They found one floor drain in Webb school with PCE at 9.9 $\mu g/m^3$, and all other samples were non-detects for PCE and TCE. This type of measurement is not comparable to indoor air health CVs; however, it is indicative that VOCs are present in the school sewer system. FCS installed a corrective device on the affected floor drain to prevent VOCs from migrating indoors and committed to improve floor drain maintenance at the schools [FCS 2019].

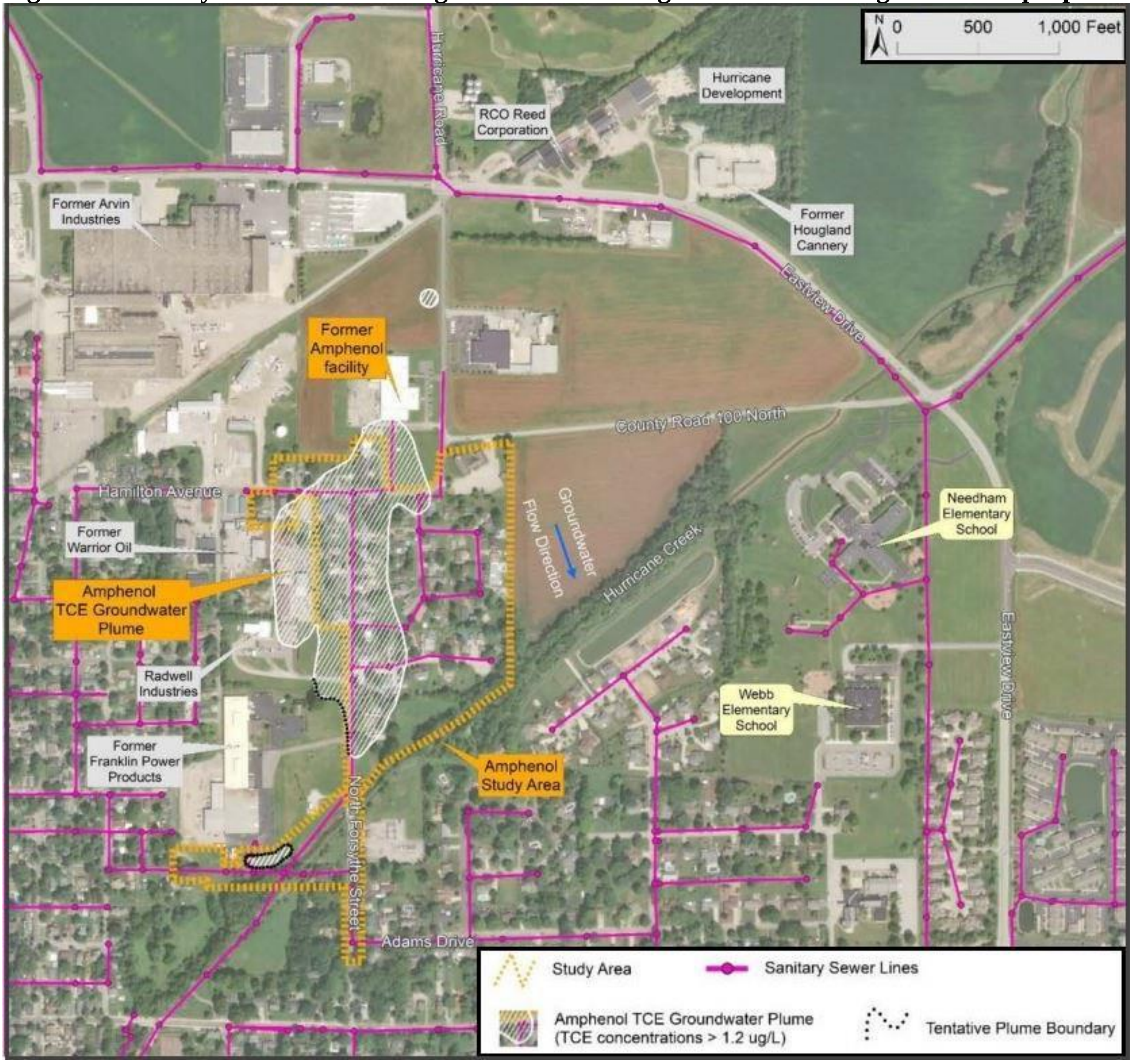
IDEM, FCS, and the City of Franklin worked together to determine whether VOCs are migrating though the sewer system, potentially from the Hougland site, causing the high concentrations in the school sub-slab vapor. Sewer vapor samples and soil gas samples were collected from the backfill of the sanitary sewer utility corridor in March 2019. The study area extended from the sewer line south of the Hougland site and along the north and east perimeter of the school property along Eastview Drive (see Figure 6).

Sewer gas samples collected nearest to the Hougland site had PCE as high as 317 $\mu g/m^3$ and TCE as high as 22 $\mu g/m^3$. VOC levels were about 10 times lower at sample sites southeast of Hougland. Samples collected on school property were even lower, with a maximum of 8.7 $\mu g/m^3$ PCE and below detection for TCE [IDEM 2019c]. These results suggest that the sewer lines are not providing a significant pathway for the migration of VOCs from Hougland towards the school properties.

Soil gas results in the sewer utility backfill were non-detects for all TCE samples, both around Hougland and on school property. PCE was as high as 30 $\mu g/m^3$ in the sample adjacent to Webb Wellfield, non-detect in the sample nearest Needham school, and 22 $\mu g/m^3$ in the sample near Webb school [IDEM 2019c]. Note that Needham is closer to the Hougland site than Webb Elementary is, but sewer backfill soil gas results were non-detects for TCE and PCE.

All sewer gas and backfill soil vapor samples collected on school property were below ATSDR soil vapor CVs for PCE and TCE, as were the on-site soil gas results noted above. Given the significant differences between the low VOC levels in soil gas, sewer gas, and backfill soil gas, as compared with highly elevated sub-slab concentrations beneath the schools, the most likely explanation for the contamination is historic on-site use of chemicals or products containing VOCs at the schools. Based on historic aerial photographs, the school complex appears to have been farmland prior to 1960. Webb school was built around 1965 and then Needham school was constructed in the 1980s [NETR 2020].

Figure 6. Sanitary sewer lines running from former Hougland site and alongside school properties



Source: https://www.epa.gov/sites/production/files/2019-06/documents/2_amphenol_060519mtg_handout_and_poster.pdf

TCE and PCE are found in a wide range of commercial and institutional products, especially those in use in the 1950s-90s. TCE is found in adhesives, paint removers, spot removers, rug cleaning fluids, paints, typewriter correction fluid, and metals parts cleaners. PCE is found in household cleaners and polishes, air fresheners, fabric and leather treatments, cleaners for electronic equipment, adhesive products, paints, as well as oils, greases, and lubricants [ATSDR 2019a, 2019b]. It is possible that these types of products were used at the schools over a period of years and may have been disposed in indoor utility sinks or drains, which would be consistent with the discovery of PCE in floor drain vapor, as noted above.

To prevent VOCs from migrating from the sub-slab vapor into indoor air at the schools, FCS installed a SSDS in the summer of 2019. Indoor air testing results measured in 2018 and 2019 demonstrate that students and staff were not exposed to VOCs prior to installation of the depressurization system and the building improvements will prevent migration to indoor air in the future. Details of the site investigation and protective measures taken are posted on the FCS website: https://www.franklinschools.org/Page/2074.

3. EXPOSURE PATHWAY EVALUATION

To determine whether people are now exposed to contaminants or were exposed in the past, ATSDR examines the path between a contaminant and a person or group of people who could be exposed. Completed exposure pathways have five required elements. ATSDR evaluates a pathway to determine whether all five factors are present. Each of these five factors or elements must be present for a person to be exposed to a contaminant:

1. A contamination source,
2. Transport through an environmental medium,
3. An exposure point,
4. A route to human exposure, and
5. People who may be exposed.

Franklin residents could potentially be exposed to soil and groundwater contamination associated with the former Amphenol and Hougland sites through several environmental media. These potential routes of exposure are summarized on Table 3 and described in detail below.

Table 3. Exposure pathways from Amphenol and Hougland sites to local residents

Environmental Medium	Point of Exposure	Route of Exposure	Completed Pathway?
Indoor air (vapor intrusion)	Air inside homes	Inhalation	Historically and currently complete (near Amphenol and on-site at Hougland)
Community drinking water	Residences, tap	Ingestion Inhalation Dermal contact	Historically complete (from Hougland via Webb Wellfield) Currently incomplete
Groundwater (private wells)	Residences, tap	Ingestion Inhalation Dermal contact	Historically complete (from Hougland to wells) Currently incomplete
Outdoor air	Air outside homes	Inhalation	Historically and currently incomplete
Surface water	Hurricane Creek	Ingestion Inhalation Dermal contact	Historically and currently incomplete
Soil	Residential yards	Ingestion Dermal contact	Historically and currently incomplete

ATSDR considers exposures to contaminants in indoor air at some residential properties near Amphenol to be completed pathways, based on the migration of vapors from the subsurface. Historic exposures to VOCs in groundwater from the Hougland site to community drinking water and to private wells via Webb Wellfield are also completed pathways. Exposure to contaminants in outdoor air, surface water, and soil are not completed pathways. These pathways are described in more detail below.

Indoor air

When the soil vapor or groundwater below a building is contaminated with VOCs, the indoor air may be affected through vapor intrusion. Vapor intrusion is the migration of VOCs from the subsurface-contaminated groundwater and soil through the pore spaces of soil into above buildings. The concentrations of contaminants entering the indoor air from the subsurface are dependent upon site- and building-specific factors such as building construction, number and spacing of cracks and holes in the foundation, and the impact of the heating and air conditioning system on increasing or decreasing flow from the subsurface [ATSDR 2016b]. In addition to VOCs migrating from the groundwater plume, people who live around Amphenol were also potentially exposed to contaminants released from damaged sanitary sewer lines into the surrounding soil and groundwater or contamination that followed plumbing lines into indoor air [EPA 2021].

Drinking water – community and private wells

IAW provides drinking water from a network of groundwater wells to residents of Franklin and the nearby town of Greenwood. IAW discovered increasing concentrations of VOCs beginning in 1988 at two wells at Webb Wellfield. Water from these wells was blended with uncontaminated water from other wells until they were taken offline in 2007. VOC concentrations and potential health effects are discussed in detail in Section 4. There are also a small number of private wells in northeast Franklin. The wells that are located north of Hurricane Creek are generally upgradient (north) of the Amphenol and Hougland plumes and are not expected to be impacted, since the contaminated groundwater is flowing away (south) from these wells. The groundwater flow in the area south of Hurricane Creek is generally to the north and west toward Hurricane Creek, thus the VOC plumes are downgradient of any wells on that side of the creek. There are no known private wells downgradient of the VOC plumes. A few homes in the vicinity of Webb Wellfield switched from private wells to community drinking water at the time that the wellfield contamination was discovered [JCHD 2019].

Outdoor air

Outdoor air may be contaminated with VOCs that migrate from underground. However, unless there are extreme conditions of subsurface contamination, the mixing and dilution into ambient air would result in concentrations that are expected to be very low. Given what we know about the levels of contamination in the subsurface, exposure via outdoor air from underground VOCs plumes in Franklin is not considered to be a completed pathway. To determine whether VOCs measured in indoor air could result from a separate outdoor source, ATSDR and EPA protocols call for outdoor sampling concurrent with indoor air testing, both upwind and downwind of the property. ATSDR reviewed the outdoor air samples collected by EPA concurrently with the vapor intrusion investigation. The peak VOC concentrations in indoor air corresponded to elevated concentrations in the subsurface (indicating that vapor intrusion was occurring). In other cases, an indoor source was suspected because the compound was not measured at high levels either in the subsurface or in outdoor air. In reviewing PCE and TCE concentrations at individual homes, ATSDR found that the outdoor air levels did not show a pattern indicating that VOCs from the Amphenol plume were volatilizing into ambient air enough to impact outdoor air quality.

IDEM conducted a yearlong ambient air monitoring study at 160 E. Adams Street, a public park in a residential neighborhood, to characterize long-term PCE and TCE concentrations. This site is about ½-mile southwest (upwind) of Amphenol in the southwest corner of the study area shown on Figure 1. IDEM collected 24-hour samples on 75 regularly scheduled dates between October 2018 and December 2019 [IDEM 2020a]. ATSDR used EPA's ProUCL software [EPA 2013] and applied the non-parametric Kaplan Meier (KM) method to calculate an average concentration of 0.048 and 0.0055 $\mu g/m^3$ for PCE and TCE, respectively. ATSDR also evaluated EPA's outdoor air sampling results in the residential area near Amphenol as an indicator of long-term outdoor concentration in this neighborhood. For the 98 outdoor air samples, ATSDR calculated KM means of 0.23 and 0.17 $\mu g/m^3$ for PCE and TCE, respectively. These levels are higher than IDEM's park site, which may be expected in a more industrialized area. The mean concentrations for both the IDEM and EPA outdoor samples were below ATSDR inhalation CVs, which are discussed in Section 4. For further context, EPA reported summary data for 273 national air monitoring sites in 2003-05 as follows: the interquartile range (25^{th} percentile site to 75^{th} percentile) for PCE was 0.18-0.41 $\mu g/m^3$ and the interquartile range for TCE was 0.13-0.23 $\mu g/m^3$ [EPA 2009]. The IDEM data were below this range and the EPA data near Amphenol were within this range, showing that outdoor PCE and TCE levels in Franklin are not elevated compared with sites across the U.S.

<u>Surface water</u>

Hurricane Creek bisects the study area as shown on Figures 1 and 2. EPA reports that Amphenol historically released VOCs into their on-site sewer line. As noted above, contaminants in the sanitary sewer have migrated into the indoor air of nearby homes. Additionally, the local storm sewer runs east and south of Amphenol, with an outflow to Hurricane Creek east of the residential area, between Ross Court and Glendale Drive [EPA 2021]. On August 23, 2018, IDEM collected three surface water samples and found no detectable levels of VOCs, but this does not preclude the possibility that there were measurable concentrations of PCE or TCE in the Creek in the past. As noted in Section 2, Hurricane Creek is categorized as an "impaired" water body because it does not meet standards for recreational use due to microbial contamination. Residents are not likely to have significant contact with the water in the portion of Hurricane Creek within ATSDR's study area since it does not appear to have areas for swimming or wading and is not wide enough for recreational boating. Therefore, ATSDR does not consider this to be a completed exposure pathway.

<u>Soil</u>

EPA and IDEM are in the process of characterizing and mitigating groundwater, soil, and soil gas contamination at the Amphenol and Hougland sites, as well as VOCs that have migrated off-site. Residents are not expected to come into *direct* contact with VOCs related to these plumes in off-site groundwater, soil, or soil gas. Contaminated soil and soil gases are several feet below the ground surface along Forsythe Street directly south of Amphenol and in farmland east of the Hougland plume, where people are not likely to be directly exposed, unless there are excavation activities that would bring subsurface contamination to the surface. As noted above, homes in Franklin have access to community drinking water and there are no private wells currently in use that could potentially be impacted by VOCs in groundwater adjacent to Amphenol and Hougland.

4. ENVIRONMENTAL DATA AND HEALTH RISK SCREENING

As a first step to evaluate potential health effects resulting from environmental exposures, ATDSR uses health-based CVs for screening analysis. CVs are contaminant concentrations in environmental media that are set well below levels that are known or anticipated to result in adverse health effects. ATSDR developed these values to help health assessors make consistent decisions about what concentrations associated with site exposures might require additional evaluation. *CVs are not thresholds of toxicity, and they* are not used to predict adverse health effects. Although concentrations at or below the relevant CV may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects [ATSDR 2005a]. The CVs used to screen for potential cancer effects are media-specific cancer risk evaluation guides (CREGs). ATSDR develops CREGs using EPA's cancer slope factor (CSF) or inhalation unit risk (IUR), a target risk level (10^{-6}), and default exposure assumptions. The target risk level of 10^{-6} represents a theoretical risk of one excess cancer case in an exposed population of one million. EPA reports all CSFs and their derivations in the Integrated Risk Information System, available at http://www.epa.gov/iris/. ATSDR's health evaluation approach is described in Appendix B.

4.1 Indoor Air-Residential Properties Near Amphenol Plume

EPA conducted two rounds of sampling for chlorinated compounds in soil vapor (testing beneath the concrete slab, called "sub-slab"), in sewer gas, and indoor air at residential properties near Amphenol. The purpose of this testing was to determine whether people may be exposed to vapors emanating from underneath their homes and/or entering through the lateral sewer lines. EPA offered sampling to 41 property owners potentially affected by the VOC plume: 37 homeowners allowed testing and 4 refused. All samples were analyzed for contaminants and their breakdown products that could potentially be associated with Amphenol: 1,1-DCA, 1,2-dichloroethane (1,2-DCA), cis-DCE, trans-DCE, methylene chloride (MC), PCE, 1,1,1-trichloroethane, TCE, and VC.

ATSDR recommends that homes be tested more than once to characterize seasonal differences and to identify any potential health hazards based on the additional sampling data. In the Midwest, wintertime testing represents a worst-case scenario because people tend to have their windows closed and harmful gases are not diluted by mixing with outdoor air. If a home was sampled only in the summer, then retesting in the winter is advisable [ATSDR 2016a].

ATSDR evaluated data collected indoors at residences because they represent contaminants in air that people are currently exposed to, and some VOCs may be at levels higher than CVs. Measurement of sub-slab VOC concentrations indicate a current or potential future source of contaminants to indoor air. Over time the concrete foundation may crack, or other conditions may change in the structure that would allow vapors to migrate into the home. To investigate whether VOCs may be migrating into homes through a secondary route, i.e., sewer gas, ATSDR reviewed air samples collected from lateral sewer pipes. These results are intended to show whether VOCs in sewer lines are potentially traveling through toilets and drains due to leaks in the system. When VOC levels are higher in underground samples as compared to indoor air, then the source of contamination is likely coming from underground. Situations where indoor concentrations are higher than those measured in sub-slab or sewer gas indicate that the vapors are coming from an indoor source (e.g., paints or solvents). When indoor air solvents are above CVs, it is important to determine whether they are caused by an underground source, and thus may be addressed by the EPA cleanup process, or whether there is an indoor source that should be addressed by the homeowner. ATSDR first reviewed sub-slab gas, sewer gas, and indoor air results for PCE and TCE, i.e., contaminants associated with the Amphenol plume. The highest PCE and TCE concentrations for each type of sample from two sampling rounds and multiple samples at each property are shown on Table 4.

Table 4. Maximum tetrachloroethylene (PCE) and trichloroethylene (TCE) in sub-slab gas, sewer gas, and indoor air at residential properties near Amphenol, micrograms per cubic meter

Site	Sub-slab PCE	Sewer PCE	Indoor PCE	Sub-slab TCE	Sewer TCE	Indoor TCE
PR01	4.8	**~139**	0.13	**~19**	**~118**	0.15
PR02	**~542**	**~563**	**“40**	4.0	**~84**	**“2.8**
PR03	- *	103	0.85	-	**~70**	**“1.0**
PR04	9.5	-	0.68	**~560**	-	**“0.66**
PR05	**~1,010**	**~466**	**“4.1**	**~77**	**~45**	**“0.28**
PR06	1.4	-	0.52	2.5	-	< 0.08
PR08	-	-	**“4.7**	-	-	**“0.29**
PR09	4.7	-	3.0	2.0	-	**“0.98**
PR10	-	43	0.26	-	**~93**	**“0.89**
PR11	4.2	**~418**	**“4.7**	0.26	**~95**	**“1.2**
PR12	68	-	**“7.3**	4.1	-	**“1.0**
PR13	8.0	1.7	0.18	0.5	0.65	< 0.08
PR14	**~5,480**	**~1,680**	**“8.6**	**~2,700**	**~318**	**“4.1**
PR15	0.46	**~627**	3.2	2.6	**~102**	**“0.37**
PR16	-	31	2.5	-	**~70**	**“0.35**
PR19	21†	-	0.52	**~571†**	-	**“0.57**
PR20	7.1	**~156**	**“5.0**	0.096	**~393**	**“6.6**
PR22	**~3,870**	**~1,990**	**“15**	**~5,200**	**~708**	**“9.4**
PR24	-	17	2.7	-	**~20**	**“1.2**
PR25	**~167†**	-	0.44	**~167†**	-	0.19
PR26	-	2.3	2.6	-	0.14	< 0.08
PR28	-	-	0.50	-	-	0.14
PR29	**~2,150†**	**~247**	**“6.3**	**~365†**	**~119**	**“2.8**
PR30	-	9.9	1.9	-	0.84	**“0.46**
PR31	**~3,060**	112	2.3	**~392**	**~63**	**“0.32**
PR32	114†	-	0.21	**~117†**	-	0.11
PR33	27	-	0.92	3.6	-	**“0.42**
PR34	2.1	**~334**	1.4	0.17	**~563**	**“0.78**
PR35	0.29	**~277**	0.23	< 0.08	**~486**	0.098
PR36	4.3	2.5	0.30	**~238**	**~29**	**“1.1**
PR37	0.41	**~275**	0.47	< 0.08	**~559**	0.15
PR38	-	-	1.3	-	-	< 0.08
PR39	0.19	-	0.32	< 0.08	-	< 0.08
PR40	0.35	**~586**	0.21	< 0.081	**~694**	< 0.08
PR41	1.7	6.6	0.77	< 0.08	2.3	**“1.4**

* Cells without data indicate that samples in sub-slab or sewer gas were not sampled at this property.

† This sample was collected in soil gas, not sub-slab.

~ Results are greater than the cancer risk evaluation guide (CREG) for soil vapor intrusion for sub-slab and near soil gas, 127 μg/m^3 for PCE and 7.0 μg/m^3 for TCE.

“ Results are greater than CREGs (μg/m^3) for indoor air: 3.8 μg/m^3 for PCE and 0.21 μg/m^3 for TCE.

ATSDR compared contaminant concentrations with their respective CVs developed for indoor air or for sub-slab/soil gas. EPA research shows that when vapor intrusion is occurring, indoor gas concentrations can be up to 0.03 times the level in the sub-slab or soil vapor [EPA 2015]. For this reason, ATSDR divides air CVs by 0.03 to derive health-protective CVs for building sub-slab and soil gas. Similarly, EPA considers vapor intrusion to be the likely source of indoor VOCs when the ratio of a contaminant concentration in sub-slab gas to indoor air is 33 or higher (the inverse of 0.03). Recent studies show a similar relationship between sewer lateral line gases and indoor air: VOCs in indoor air are up to about 0.03 times the level in the sewer gas [McHugh 2018]. Thus, ATSDR applied the same CVs for sewer gas as those derived for sub-slab and soil gas.

ATSDR also evaluated sub-slab gas, sewer gas, and indoor air results for 1,2-DCA and MC, which are VOCs not associated with the Amphenol plume. Findings are summarized on Table 5.

As shown on Table 4, the properties with the highest indoor PCE (PR02 and PR22) also had elevated PCE concentrations in both the sub-slab and sewer gas. Similarly, the homes with the highest indoor air TCE had elevated concentrations in the sewer gas (PR20) or both sub-slab and sewer gas (PR22). These findings support the conclusion that indoor PCE and TCE at these properties are associated with the Amphenol plume. In contrast, the highest indoor air levels of 1,2-DCA and MC as shown on Table 5 are not aligned with elevated levels in the subsurface. 1,2-DCA is highest in indoor air at PR32, PR12, and PR19; sub-slab 1,2-DCA at PR12 is lower than the indoor maximum result and it is below laboratory detection limits at PR32 and PR19. The highest indoor MC concentrations are at PR28 and PR02; MC was much lower in the subsurface at PR02 but was not sampled at PR28. The main source of 1,2-DCA in a home is likely to be off-gassing from poly-resin molded decorations, as well as polystyrene foam, plastic, nylon, and rubber products [NJDEP 2020]. MC is also likely to have an indoor source, for example paint strippers, adhesive removers, spray shoe polish, adhesives, paint thinners, or other consumer products [ATSDR 2000].

Based on EPA's action criteria for PCE and TCE, SSDS were installed at 7 homes between 2018 and 2020 to address vapor intrusion. To reduce migration through the sewer laterals, EPA performed plumbing repairs at 11 homes near Amphenol. EPA is retesting these properties to confirm that mitigation efforts are effective. Between August and December 2019, EPA required Amphenol to remove or re-line 2,600 feet of damaged sewer pipe and to excavate 4,700 tons of soil from the sewer bed. Work is ongoing to address remaining groundwater contamination on-site at Amphenol.

ATSDR's cancer and noncancer evaluation for PCE, TCE, 1,2-DCA, and MC is presented in Section 5.

Table 5. Maximum 1,2-dichloroethane (1,2-DCA) and methylene chloride (MC) in sub-slab, soil, and sewer gas and indoor air at residential properties near Amphenol, micrograms per cubic meter.

Site	Sub-slab 1,2-DCA	Sewer 1,2-DCA	Indoor 1,2-DCA	Sub-slab MC	Sewer MC	Indoor MC
PR01	< 0.06	< 0.06	**“0.11**	< 5.2	5.4	< 5.0
PR02	**~2.2**	< 0.06	**“0.32**	6.5	6.4	**“549**
PR03	-[*]	< 0.06	**“0.25**	-	6.6	< 5.5
PR04	< 0.06	-	**“3.9**	7.0	-	5.6
PR05	**~5.2**	0.37	**“3.9**	5.3	23	11
PR06	0.15	-	**“1.3**	< 5.2	-	6.7
PR08	-	-	**“0.27**	-	-	5.4
PR09	0.64	-	**“0.87**	< 5.2	-	6.4
PR10	-	**~1.6**	**“0.16**	-	6.7	< 5.4
PR11	0.65	< 0.06	**“0.67**	5.8	8.5	< 5.3
PR12	**~5.5**	-	**“6.7**	101	-	8.9
PR13	< 0.06	< 0.06	**“0.15**	< 5.2	< 5.2	< 5.2
PR14	< 0.06	< 0.06	**“0.45**	< 5.2	19	5.8
PR15	0.37	< 0.06	**“0.79**	< 5.2	107	13
PR16	-	< 0.06	**“0.089**	-	16	< 5.3
PR19	< 0.06[†]	-	**“5.6**	18[†]	-	< 5.3
PR20	0.14	< 0.06	**“0.52**	< 5.2	25	8.5
PR22	**~70**	< 0.06	**“0.41**	< 5.2	177	14
PR24	-	0.29	**“0.16**	-	< 5.2	< 5.5
PR25	< 0.06[†]	-	**“4.2**	6.7[†]	-	7.0
PR26	-	0.10	**“0.12**	-	< 5.2	< 5.3
PR28	-	-	**“0.087**	-	-	**“2,040**
PR29	< 0.06[†]	< 0.06	**“1.4**	< 5.2[†]	73	6.7
PR30	-	0.16	**“0.15**	-	< 5.2	< 5.3
PR31	< 0.06	0.084	**“0.83**	-	-	**“86**
PR32	< 0.06[†]	-	**“13**	< 5.2[†]	-	< 5.3
PR33	0.18	-	**“0.55**	< 5.2	-	7.0
PR34	< 0.06	< 0.06	**“2.4**	12	5.5	7.2
PR35	< 0.06	< 0.06	**“0.31**	< 5.2	8.4	9.9
PR36	0.69	< 0.06	**“2.9**	6.1	7.4	11
PR37	< 0.06	< 0.06	< 0.06	< 5.2	6.1	6.8
PR38	-	-	**“0.64**	-	-	< 5.3
PR39	< 0.06	-	**“1.8**	< 5.2	-	< 5.4
PR40	< 0.06	< 0.06	**“0.096**	< 5.2	< 5.2	< 6.3
PR41	< 0.06	0.81	**“1.8**	< 5.2	24	7.9

* Cells without data indicate that samples in sub-slab or sewer gas were not sampled at this property.

† This sample was collected in soil gas, not sub-slab.

~ Results are greater than the ATSDR cancer risk evaluation guide (CREG). CREGs ($\mu g/m^3$) are 1.3 for 1,2-DCA and 2,100 for MC.

“ Results are greater than the CREG for indoor air. CREGs ($\mu g/m^3$) are 0.038 for 1,2-DCA and 63 for MC.

4.2 Indoor Air: Non-Residential Properties Near Hougland Plume

As noted in Section 2, HRID conducted three rounds of indoor air, sub-slab, and soil vapor testing at Buildings 2 (the recycling center), 3 (gymnastics center), and 4 (ambulance company and electrical contractor) in August-September 2016, December 2017, and August 2019. The gymnastics center was tested again on January 6th and February 17th, 2020 [Patriot 2020a]. ATSDR adjusted indoor air concentrations to reflect typical employee exposure times and to give a protective estimate of the time spent on site by gymnastics center patrons. The indoor concentrations were multiplied by 5/7 (5 working days per week) and 10/24 (working hours per day), resulting in an adjustment factor of 0.30. As summarized on Table 6, adjusted indoor air samples exceeded the ATSDR CVs for TCE and benzene at all three buildings. The indoor air concentrations of naphthalene were below detection limits at Building 2 and exceeded the CVs at Building 3 and 4. Potential health effects associated with TCE, benzene, and naphthalene exposures are discussed in Section 5. The sub-slab concentrations of TCE and PCE both exceeded sub-slab gas CVs at Building 2 and TCE was exceeded at Building 3, indicating that vapor intrusion related to the Hougland plume is likely occurring. Benzene in soil gas at Buildings 3 and 4 also exceeded health screening levels, however the ratio of underground to indoor air concentrations were not high enough to suggest vapor intrusion. The paired results in Table 6 produce a ratio of underground to indoor air benzene concentrations no higher than 13, which is less than the ratio of 33 suggestive of an underground source.

Table 6. Contaminants in sub-slab and soil gas and adjusted* indoor air concentrations at Hougland site, micrograms per cubic meter

Date	Building	Sample type	Benzene	Naphthalene	Tetrachloroethylene	Trichloroethylene
9/16	2	sub-slab	<0.13	<1.1	**~588**	**~10,300**
12/17	2	sub-slab	<0.13	<1.1	<0.25	**~28**
8/19	2	sub-slab	1.1	**~4**	16	**~1,450**
9/16	2	indoor	**~1.0**	<1.1	3.3	**~19**
12/17	2	indoor	**~0.24**	<1.1	0.71	**~29**
8/19	2	indoor	<0.13	<1.1	0.36	**~12**
12/17	3†	soil gas	1.7	<1.1	<0.25	<0.21
8/19	3†	soil gas	**~9.8**	**~8.9**	3.4	<0.21
1/20	3†	sub-slab	3.6	<1.1	43	**~260**
2/20	3†	sub-slab	0.75	<1.1	1.5	**~44**
12/17	3	indoor	<0.13	<1.1	<0.25	<0.21
8/19	3	indoor	<0.13	**~1.6**	<0.25	<0.21
1/20	3†	indoor	**~0.28**	<1.1	0.18	**~0.39**
2/20	3†	indoor	**~0.25**	**~0.65**	<0.25	**~2.5**
12/17	4	soil gas	3.8	<1.1	<0.25	<0.21
8/19	4	soil gas	**~7.2**	**~8.9**	29	<0.21
12/17	4	indoor	**~0.57**	**~6.6**	<0.25	**~0.42**
8/19	4	indoor	**~0.98**	**~1.3**	**~3.9**	<0.21

*Indoor air samples adjusted for 5 days/week and 10 hours/day exposure.

† Maximum of 2-3 sample locations.

~ Results are greater than the ATSDR cancer risk evaluation guide (CREG). CREGs (μg/m^3) are 0.13 for benzene, 0.029 for naphthalene, 3.8 for tetrachloroethylene, and 0.21 for trichloroethylene. The sub-slab and soil gas equivalent for these screening levels (μg/m^3) are 4.3 for benzene, 0.97 for naphthalene, 127 for tetrachloroethylene, and 7.0 for trichloroethylene.

Indoor air TCE concentrations were the highest in the office area of Building 2. The property owner followed IDEM recommendations to install a carbon air filter unit in March 2020 to remove VOCs from the air and to install fans at the building's bay doors to increase air exchanges. The owner conducted follow-up sampling to confirm that VOC concentrations had declined [Patriot 2020b]. As noted in Section 2, the building owner planned to install a long-term mitigation system in 2022.

Naphthalene has not been found in groundwater samples and is not considered a site contaminant at HRID. Its concentrations in soil gas samples are only marginally higher than the indoor concentrations in Buildings 3 and 4, indicating that vapor intrusion is not occurring. Possible sources of naphthalene in indoor air include moth and pest repellants, deodorizers (toilet cleaner or air fresheners), cigarette smoke, and vehicle emissions. Benzene was elevated in some soil and sub-slab gas samples; however, the indoor concentrations are likely related to above-ground vehicle and equipment operations, as well as cigarette smoke or industrial adhesives and paints [ATSDR 2007].

4.3 Community Drinking Water

IAW discovered cis- and trans-DCE in untreated water from Webb Wellfield in 1988. However, the water delivered to customers had contaminant levels consistently below EPA's MCLs because IAW blended water from contaminated wells with water from three unaffected well fields in the area: Sugar Creek, Orme/Marlin/White River, and London Road well fields are respectively ¾, 12, and 7 miles away from the Webb Well Field. Webb Wellfield was fully decommissioned by 2013 and the community is supplied with water from the remaining community wells that do not have VOC contamination.

Regular well testing data conducted by IAW showed that cis-DCE was as high as 122 ppb in untreated water from Well 2 in 2001 and 218 ppb in untreated water from Well 3 in 2006. Maximum trans-DCE levels were 9.3 at Well 2 in 2007 and 16 ppb at Well 3 in 2006. The finished drinking water had cis-DCE concentrations as high as 60.5 ppb in 2006, which is just below the EPA MCL (70 ppb) but exceeds ATSDR's reference dose media evaluation guide for children's and adult's chronic exposure, 14 and 52 ppb respectively. Potential noncancer health effects related to cis-DCE exposures are discussed in Section 5.2. Cis-DCE is not considered to be a carcinogen. Trans-DCE concentrations did not exceed the MCL or ATSDR's CVs.

5. ENVIRONMENTAL HEALTH EVALUATION

5.1 Cancer Risk Assessment

As explained in Section 4.1, 1,2-DCA, MC, PCE, and TCE maximum concentrations were measured above ATSDR CVs in some homes within the Amphenol plume area. Non-residential properties in the Hougland plume area, as described in Section 4.2, had indoor concentrations exceeding the CVs for TCE, naphthalene, and benzene.

1,2-DCA studies have shown that rats and mice with oral exposures had an increased incidence of tumors of the spleen, liver, pancreas, and adrenal gland [ATSDR 2001]. MC inhalation by mice and rats has been shown in studies to increase their incidence of liver and lung cancer, and benign mammary gland tumors (fibroadenomas or adenomas) [ATSDR 2000]. PCE exposure has been linked in human studies to a higher risk of developing bladder cancer, multiple myeloma, and non-Hodgkin's lymphoma. Research on animals shows strong evidence that PCE causes cancers of the liver, kidney, and blood system [ATSDR 2014a]. TCE is believed to cause kidney, liver, and esophageal cancers and non-Hodgkin's lymphoma in humans. Based on animal studies, the risk of developing these cancers is increased with early life exposures. Additional evidence from occupational studies points to possible relationships between TCE exposure and increased risk of Hodgkin's disease, cervical cancer, multiple myeloma, bladder cancer, female breast cancer, and prostate cancer. However, many of these studies have strong limitations including unknown exposure level, small sample size, and inability to separate effects of TCE from other solvents present in the workplace [ATSDR 2014b].

To estimate cancer risks associated with air exposures, ATSDR multiplied concentrations measured in indoor air by the IUR for each VOC above CVs. Given limited sampling in indoor air, ATSDR used the maximum concentration reported for each home. The respective IURs for 1,2-DCA, MC, and PCE are 2.6E-05, 1.0E-08, and 2.6E-07 $(\mu g/m^3)^{-1}$. For TCE, cancer risk is based on three separate target tissue sites – kidney, lymphoid tissue, and liver. The IUR for TCE [4.1E-06 $(\mu g/m^3)^{-1}$] is the result of summing risks for each of these cancer types [EPA 2011]. Since TCE and MC have been designated as mutagens, ATSDR incorporated age-dependent adjustment factors (ADAFs) to address early-life susceptibility. This approach is described in more detail in Appendix B.

ATSDR considers residential exposures to occur for 33 years, the 95^{th} percentile residential occupancy default. Specifically, cancer risk was summed from birth to age 21 plus 12 additional years during adulthood for a total of 33 years. To consider exposures to 1,2-DCA, MC, PCE and TCE, the individual cancer risks were added. ATSDR evaluated cancer risk from breathing 1,2-DCA, MC, PCE and TCE at residential properties where one or more chemicals exceeded the CREG. ATSDR substituted the detection limit for samples where one of the compounds was below detection. Results are summarized on Table 7.

The greatest cancer risk attributable to PCE and TCE, contaminants associated with the Amphenol plume, are 4 in 1 million at PR02 and 22 in 1 million at PR22, respectively. Both properties have evidence of vapor intrusion. The total cancer risk at these two homes, summed across all four contaminants, is 20 and 28 in 1 million, respectively. ATSDR does not consider this to be an elevated cancer risk.

Table 7. Maximum indoor air concentrations (micrograms per cubic meter) and cancer risk estimate for 1,2-dichloroethane (1,2-DCA), methylene chloride (MC), tetrachloroethylene (PCE), and trichloroethylene (TCE) at residential properties near Amphenol plume

Site	1,2-DCA max	MC max	PCE max	TCE max	1,2-DCA risk† (per million)	MC risk† (per million)	PCE risk (per million)	TCE risk (per million)	Total risk (per million)
PR01	0.11	5.0	0.13	0.15	1	0.05	0.01	0.4	2
PR02	0.32	549	40	2.8	4	5	4	7	20
PR03	0.25	5.5	0.85	1.0	3	0.05	0.09	2	5
PR05	3.9	11	4.1	0.28	43	0.1	0.5	0.7	44
PR06	1.3	6.7	0.52	0.08	14	0.1	0.06	0.2	15
PR08	0.27	5.4	4.7	0.29	3	0.05	0.5	0.7	4
PR09	0.87	6.4	3.0	0.98	10	0.06	0.3	2	12
PR10	0.16	5.4	0.26	0.89	2	0.05	0.03	2	4
PR11	0.67	5.3	4.7	1.2	7	0.05	0.5	3	11
PR12	6.7	8.9	7.3	1.0	74	0.09	0.8	2	77
PR13	0.15	5.2	0.18	0.08	2	0.05	0.02	0.2	2
PR14	0.45	5.8	8.6	4.1	5	0.06	1	10	15
PR15	0.79	13	3.2	0.37	9	0.1	0.4	0.9	10
PR16	0.089	5.3	2.5	0.35	1	0.05	0.3	0.8	2
PR19	5.6	5.3	0.52	0.57	62	0.05	0.06	1	63
PR20	0.52	8.5	5.0	6.6	6	0.08	0.6	15	22
PR22	0.41	14	15	9.4	5	0.1	2	22	28
PR24	0.16	5.5	2.7	1.2	2	0.05	0.3	3	5
PR25	4.2	7.0	0.44	0.19	46	0.07	0.05	0.4	47
PR26	0.12	5.3	2.6	0.08	1	0.05	0.3	0.2	2
PR28	0.087	2,040	0.50	0.14	1	20	0.06	0.3	21
PR29	1.4	6.7	6.3	2.8	15	0.07	0.7	7	23
PR30	0.15	5.3	1.9	0.46	2	0.05	0.2	1	3
PR31	0.83	86	2.3	0.32	9	0.9	0.3	0.8	11
PR32	13	5.3	0.21	0.11	146	0.05	0.02	0.3	147
PR33	0.55	7.0	0.92	0.42	6	0.07	0.1	1	7
PR34	2.4	7.2	1.4	0.78	26	0.07	0.2	2	28
PR35	0.31	9.9	0.23	0.098	3	0.1	0.03	0.2	4
PR36	2.9	11	0.30	1.1	32	0.1	0.03	3	35
PR38	0.64	5.3	1.3	0.08	7	0.05	0.1	0.2	7
PR39	1.8	5.3	0.32	0.08	20	0.05	0.04	0.2	20
PR40	0.096	5.3	0.21	0.08	1	0.05	0.02	0.2	1
PR41	1.8	7.9	0.77	1.4	20	0.08	0.09	3	23

* “Risk” refers to the number of estimated excess cancer cases per million exposed individuals.

† DCA and MC are not associated with the groundwater plume and are likely present in household products.

There is one home with an estimated lifetime cancer risk at a level that ATSDR considers a concern for increased cancer risk: PR32 had 147 in 1 million cancer risk, which is almost entirely contributed by 1,2-DCA, a contaminant not associated with the Amphenol plume and apparently not the result of vapor intrusion. Older cleaning products and many household items, such as poly-resin molded decorations, contain and could off-gas 1,2-DCA, suggesting an indoor source for this contaminant. A lesser amount of cancer risk was contributed at some homes by MC; risk from MC was as high as 20 in 1 million at PR28. MC is likely to have an indoor source, for example paint strippers, adhesive removers, spray shoe polish, adhesives, paint thinners, or other consumer products [ATSDR 2000]. The Consumer Product Information Database (see: https://www.whatsinproducts.com/), which is supported by the National Institute of Environmental Health Sciences, part of the Department of Health and Human Services, provides information on household products and chemicals. Homeowners can also decrease their exposures by looking up summaries of individual hazardous substances on the ATSDR ToxFAQ page found here: https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsLanding.aspx.

ATSDR applied a similar methodology to characterize cancer risk from inhaling benzene, naphthalene, PCE, and TCE at Buildings 2, 3, and 4 of the HRID property, with adjustments made to account for the fact that worker exposures are different from residential scenarios. Long-term benzene exposure can cause acute myeloid leukemia [ATSDR 2007.] Long-term naphthalene exposure has been associated with nasal tumors in rats and lung tumors in mice [ATSDR 2005.] ATSDR used the adjusted indoor air concentrations developed for risk screening (values multiplied by 5/7 days and 10/24 hours) and factored in the period that a person is likely to work at a site (25/78 years). These adjusted concentrations were multiplied by the IURs for benzene, naphthalene, PCE, and TCE and summed together as described above. ATSDR used the highest reported concentrations for each building in the risk calculations. Results are summarized on Table 8 below.

Table 8. Maximum adjusted indoor air concentrations (micrograms per cubic meter) and cancer risk estimate for benzene (Benz), naphthalene (Naph), tetrachloroethylene (PCE), and trichloroethylene (TCE) at non-residential buildings affected by Hougland plume

Building	Benz max	Naph max	PCE max	TCE max	Benz risk* (per million)	Naph risk (per million)	PCE risk (per million)	TCE risk (per million)	Total risk (per million)
2	0.33	NA†	1.1	9.2	3	NA	0.3	21	24
3	0.090	0.51	0.056	0.80	1	17	0.02	2	20
4	0.31	2.1	1.2	0.13	3	71	0.3	0.3	74

* “Risk” refers to the number of estimated excess cancer cases per million exposed individuals.

† NA = not applicable. Naphthalene was below detection limits in all samples at Building 2.

The highest total cancer risk related to underground contamination was 24 in 1 million at Building 2, where 21 was contributed by TCE and 3 from benzene. ATSDR does not consider this to be a concern for cancer risk. Risks at Buildings 3 and 4 were primarily from naphthalene exposure, which is not related to the Hougland plume, with a total risk of 20 in 1 million and 74 in 1 million, respectively. ATSDR does not consider this to be a concern for cancer risk.

5.2 Noncancer Health Effects

As detailed in Section 4.1, ATSDR’s CVs were exceeded in indoor air and further evaluation is necessary for 1,2-DCA, MC, PCE, and TCE at homes potentially affected by Amphenol. Additionally, Buildings 2 and 4 of the HRID property, near the Hougland plume, had indoor levels of naphthalene and benzene above CVs. Section 4.3 describes historic contamination of the community wellfield affected by Hougland, including cis-DCE concentrations above the CV in finished drinking water.

PCE- ATSDR's noncancer health evaluation of PCE is based on an occupational epidemiology study which found that dry-cleaning workers acquired decrements in color vision with a lowest observed adverse effect level (LOAEL) of 1.7 ppm (11,544 μg/m^3) [ATSDR 2019a]. The highest indoor air PCE concentrations at homes near Amphenol (40 and 15 μg/m^3 at PR02 and PR22, respectively) are about 1,000 times lower than the LOAEL. ATSDR does not expect that noncancer health effects from PCE exposure would occur at these concentrations.

TCE- ATSDR assesses chronic noncancer effects of TCE inhalation based on two critical oral exposure studies which found: 1) increased rates of heart defects in newborn rats resulting from maternal exposure to TCE in drinking water during pregnancy; and 2) adult female mice showed immune system effects (decreased thymus weight) after exposure to TCE in drinking water. EPA applied physiologically based pharmacokinetic models to perform route-to-route extrapolation to obtain human equivalency concentrations (HECs) for these animal studies. The resulting 99th percentile human equivalent concentrations (HEC_{99}) were 0.0037 ppm based on fetal heart malformations and 0.033 ppm based on the thymus weight study. At these respective exposure levels, there is an expected 1% response rate of fetal heart defects and immune system effects in humans. [ATSDR 2019b]. The more sensitive of the two health endpoints, heart defects, may occur at an air concentration of 0.0037 ppm, i.e., 20 μg/m^3. The highest indoor air TCE levels in homes near the Amphenol site (9.4 and 6.6 μg/m^3 at PR22 and PR20, respectively) are approaching the level expected to be associated with potential health effects in people. The adjusted indoor air TCE concentrations at HRID Building 4 (29 μg/m^3) is higher than the level where health effects could potentially occur, if women become pregnant and continue working in the recycling center office while pregnant. The highest concentration in Building 4 (0.42 μg/m^3) is about 50 times less than the level associated with fetal heart defects and is not considered a hazard.

1,2-DCA- Human and animal studies demonstrate that the liver is a target organ for 1,2-DCA. ATSDR evaluated chronic noncancer health effects based on a rat study that found a no observed adverse effects level (NOAEL) of 50 ppm (203,000 μg/m^3) for animals exposed for 7 hours/day, 5 days/week for 2 years [ATSDR 2001]. The highest indoor level of 1,2-DCA near the Amphenol site was 13 μg/m^3 at PR32, which is about 10,000 times lower than the NOAEL. ATSDR does not expect that noncancer health effects from 1,2-DCA exposure would occur at this level.

MC- ATSDR evaluates intermediate and chronic noncancer health effects of MC based on multiple animal studies. Continuous exposure of mice and rats for 100 days to 25 or 100 ppm caused fatty changes in the liver; an intermediate LOAEL was defined for rats exposed at 25 ppm (87,500 μg/m^3). Chronic exposure of rats to 200–500 ppm or greater for 2 years resulted in increased incidence of liver cell damage; 50 ppm was identified as the chronic NOAEL [ATSDR 2000]. The NOAEL was adjusted for continuous exposure (6 hours per day, 5 days per week), resulting in an adjusted NOAEL of 8.9 ppm (31,150 μg/m^3). The highest observed indoor concentration of MC in Franklin was 2,040 μg/m^3 at PR28, which is about 15 times less than the chronic NOAEL. Therefore, ATSDR does not consider liver effects from MC exposure to be likely at this level.

Naphthalene- ATSDR evaluates naphthalene toxicity based on two animal studies. One study evaluated mice and the other studied rats, both of which were exposed to naphthalene in air for several hours a day over the course of about 100 weeks. In both studies, the LOAEL was 10 ppm, at which point animals experienced lesions in nasal and respiratory tissues. The HEC from the rat study, the lower of the two LOAELs, is 0.2 ppm (1,048 $\mu g/m^3$) [ATSDR 2005b]. The $LOAEL_{HEC}$ is more than 150 times higher than the concentration (6.6 $\mu g/m^3$) measured in Building 4 at HRID. ATSDR does not consider respiratory effects from exposure to naphthalene at this level to be likely.

Benzene – Epidemiologic studies show hematological effects in workers chronically exposed to benzene, including significant reductions in white blood cells, red blood cells, and platelet counts. Workers exposed to benzene at shoe manufacturing industries in China were studied over a 16-month period. Decreased B cell count was selected as the critical effect since the group with highest benzene exposures had B cell counts approximately 36% lower than the control group. EPA modeled the benchmark concentration lower bound as 0.1 ppm (320 $\mu g/m^3$) and then adjusted from an 8-hour workday to a continuous exposure level of 0.03 ppm (96 $\mu g/m^3$). The highest benzene concentration at HRID was 1.0 $\mu g/m^3$ at Building 2. This level is nearly 100 times less than the benchmark concentration. ATSDR does not consider hematological effects from benzene exposure to be likely for people at the HRID property.

cis-DCE- Animal studies show that blood cell toxicity is the most significant effect of cis-DCE exposure in drinking water. Female rats exposed for 14 days experienced decreased red blood cell count and hematocrit levels (proportion of total blood that consists of red blood cells). A NOAEL was observed at 97 mg/kg/day and was used by ATSDR to derive an acute-duration oral minimal risk level (MRL). Decreased hematocrit levels were found in male rats exposed for 90 days (intermediate duration) and decreased hemoglobin levels were reported in both sexes with a NOAEL at 32 mg/kg/day [ATSDR 1996]. Cis-DCE was not detected in indoor air sampling in Franklin, however it was reported in community drinking water samples. The highest concentration of cis-DCE in finished drinking water was 60.5 ppb. This concentration corresponds to a reasonable maximum exposure (RME) via ingestion of 0.0086 mg/kg/day for the age group of birth to 1 year and 0.0047 mg/kg/day for age 1-2. We estimated additional dermal exposures via showering and bathing as the central tendency exposure (CTE) 0.00017 mg/kg/day for age 1-2 years, i.e., the highest exposed age group, resulting in a total of 0.0049 mg/kg/day for this age group. The RME for children up to 1 year of age is 3,700 times lower than the NOAEL. ATSDR considers it unlikely that blood effects would occur from cis-DCE exposure.

6. COMMUNITY CONCERNS

6.1 Johnson County Pediatric Cancers

IIWYC has raised concerns about pediatric cancer in the city of Franklin in Johnson County and requested that IDOH and CDC conduct a cancer cluster investigation. In response to community concerns, IDOH evaluated childhood cancer data and issued a report in December 2017 titled "Findings of a Cancer Inquiry Investigation, Johnson County, Indiana 2015-17". IDOH found the number of documented cancer cases among children aged 0-19 years between 1999 and 2013 was within the 95% confidence interval of what was expected in Johnson County. IDOH concluded that the data did not fit the definition of a cancer cluster [ISDH 2017]. The IDOH report is presented in Appendix C.

In July 2018, IDOH requested that CDC/National Center for Environmental Health (NCEH) review the report in relation to the CDC and Council of State and Territorial Epidemiologists' 2013 Guidelines for Investigating Suspected Cancer Clusters and Responding to Community Concerns [CDC 2013]. CDC concluded that "CDC concurs with the methods and conclusions described in the ISDH report, but offers the following comments for your consideration…" CDC provided recommendations on how to further evaluate cancer data if ongoing environmental investigations find evidence of community exposure to chemical contaminants that are potential risk factors for pediatric cancer, including consideration to evaluate pediatric cancer using other geographic boundaries, to review longer-term historical trends, and to continue monitoring pediatric cancer using Indiana cancer registry data [NCEH 2018]. The full letter is available here:
https://www.in.gov/idem/cleanups/files/site_franklin_us_hhs_letter_to_isdh.pdf.

ATSDR reviewed available information about VOCs in drinking water, outdoor air, and indoor air as documented in this health consultation. These data do not suggest environmental exposures to cancer-causing contaminants at levels likely to result in measurably increased rates of cancer in northeast Franklin.

Indiana's 2018-2020 Cancer Control Plan has useful information about cancer and cancer prevention (see: https://ftp.cdc.gov/pub/Publications/Cancer/ccc/indiana_ccc_plan-508.pdf).

6.2 Indoor Air Community Investigations

In 2018 Edison Wetlands Association (EWA) began a series of three indoor air investigations in Franklin in response to concerns raised by IIWYC and in parallel to EPA and IDEM's ongoing efforts around Amphenol and Webb Wellfield.

ATSDR reviewed the EWA workplans and laboratory reports to consider whether the data could be used in this health consultation. We have determined that the studies have methodological and data quality limitations that make them insufficient for our purposes. First, EWA did not follow EPA guidance for vapor intrusion assessments, which states that canisters should be individually certified cleaned by the laboratory to ensure that residual contaminants from previous sample events are not present. EWA's reports indicate that canisters were cleaned but only "batch" certified; this means that one out of every 10 or 20 cans is certified cleaned, and the others may potentially be contaminated, thus biasing the results.

EPA allows batch certification for sub-slab samples, but it is not recommended for indoor vapor intrusion sampling. Second, indoor air samples from the first round could not be attributed to vapor intrusion, because concurrent sub-slab or soil vapor samples were not collected. Without paired sub-slab data, we cannot determine whether indoor VOCs emanated from underground or were the result of common indoor air contaminants. Finally, EWA collected continuous real-time VOC data in their third study to capture potential short-term peaks in indoor VOC concentrations. ATSDR and EPA risk assessment guidance calls for using 24-hour integrated samples as representative of a person's exposure throughout a day. These 24-hour averages are taken as a surrogate for a person's chronic exposure over a period of several weeks or months for health risk assessment. One-hour peak VOC concentrations are not appropriate to use for chronic exposure assessment. Although EWA reported some VOCs at levels above ATSDR's health-based CVs, the data could not be used to assess exposures due to the limitations described above. However, this information could be used in support of environmental health education efforts, in particular making the community aware of VOCs in household products and how they can reduce their exposures.

7. CONCLUSIONS

Following its review of environmental data provided by EPA and IDEM, ATSDR reached three health-based conclusions.

Conclusion 1

ATSDR concludes that people's health could have potentially been harmed in the past by breathing contaminants from the Hougland groundwater plume that migrated into indoor air at one nearby non-residential property.

Basis for Conclusion 1

- ATSDR evaluated indoor air collected at three commercial properties potentially impacted by the Hougland groundwater plume. The property owner conducted three rounds of indoor air sampling in 2016, 2017, and 2019 as required by IDEM due to their proximity to the underground trichloroethylene (TCE) plume.
- One of the structures, Building 2, which houses a recycling center, had TCE levels in indoor air at levels that could be a higher risk for fetal heart defects if a pregnant employee were exposed. High TCE levels in the sub-slab gas indicated that the contamination was due to vapor intrusion from the groundwater plume. Buildings 3 and 4, including the former gymnastics center, did not have indoor air VOCs at levels of potential health concern.
- IDEM recommended that the property owner install a carbon air filtration unit at Building 2 to remove VOCs from the air and to install fans to increase ventilation. The changes were implemented, and follow-up sampling confirmed that TCE levels were reduced. ATSDR does not consider VOCs in indoor air to pose an ongoing health hazard to occupants of this property.
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Conclusion 2

ATSDR concludes that people's health could have potentially been harmed in the past by breathing contaminants from the Amphenol groundwater plume that have migrated into indoor air at two residences via vapor intrusion or through the sewer system.

Basis for Conclusion 2

- ATSDR evaluated indoor air data collected by EPA from 37 homes potentially impacted by the Amphenol groundwater plume. In the case of homes where indoor air contaminants could be attributed to subsurface or sewer contamination, there were two homes with TCE levels in indoor air at levels that could be a higher risk for fetal heart defects if a pregnant resident were exposed. EPA has required and implemented engineering controls at these homes to reduce TCE levels in indoor air. Other VOCs were below levels that are likely to cause cancer and noncancer health effects.
- There was one home near Amphenol where the indoor concentration of a VOC, which was not related to the underground plume, was reported at a level that is a concern for a potential increase in cancer risk. The presence of 1,2-DCA in this home was likely the result of an indoor source, as

this chemical is found in a variety of common consumer products. EPA has advised the resident to safely dispose of older cleaning products that may contain 1,2-DCA.

- To control migration of VOCs from the Amphenol plume to indoor air, EPA has installed SSDS at 7 homes, performed plumbing repairs at 11 homes, and replaced or re-lined 2,600 feet of damaged sewer pipe along Forsythe Street. EPA has conducted follow-up indoor air testing at homes near Amphenol to ensure the effectiveness of these remedies. ATSDR does not consider VOCs in indoor air to pose an ongoing health hazard to occupants of these properties.

Conclusion 3

ATSDR concludes that people's health is not likely to be harmed by ingesting drinking water in Franklin, both currently and in the past.

Basis for Conclusion 3

- VOCs were discovered by IAW in community drinking water wells at Webb Wellfield in 1988. The utility blended water from contaminated wells with water from unaffected wells to ensure that finished drinking water did not exceed EPA standards.
- ATSDR determined that historic maximum concentrations of VOCs in finished drinking water for the City of Franklin were below levels that are expected to be associated with health effects.
- IAW discontinued use of all wells at Webb Wellfield by 2013 and community water is extracted from the three remaining wells not impacted by groundwater contamination. IDEM is currently overseeing investigation and remediation of the source of contamination at the Hougland site.

8. RECOMMENDATIONS

Following its review of available information, ATSDR recommends that:

1) IDEM continue to oversee the investigation and remediation of properties impacted by the migration of VOC contaminants from the Hougland groundwater plume.
2) EPA continue to oversee the on-site and off-site investigation and remediation of properties impacted by the migration of VOC contaminants from the Amphenol groundwater plume. Conduct future resampling at the former Franklin Power Products site, as conditions change over time and sub-surface VOCs may migrate indoors. Implement a formal operations and maintenance plan for homes adjacent to Amphenol where an SSDS was installed once this becomes feasible.
3) The homeowner at PR32 to limit the storage and use of household chemicals that have contributed to VOCs and associated health risks in indoor air. The Consumer Product Information Database (see: https://www.whatsinproducts.com/)provides information on household products and chemicals. Residents can also learn how to decrease their exposures by looking up summaries of individual hazardous substances on the ATSDR ToxFAQ page found here: https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsLanding.aspx.
4) IDOH and JCHD continue to promote cancer awareness and recommendations for cancer prevention in the Franklin community as outlined in IDOH's 2018-2020 Cancer Control Plan.

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Appendix A

Indoor air sampling results, micrograms per cubic meter (µg/m^3)

Site	Round	Type	1,2-dichloro-ethane	Methylene chloride	Tetrachloroethylene	Trichloroethylene
PR01	1	Bath	0.1	< 5.0	< 0.1	< 0.08
PR01	1	Crawl	0.11	< 5.0	0.12	< 0.08
PR01	1	Indoor	0.11	< 5.0	0.13	0.15
PR02	1	Bath	0.24	107	40	2.8
PR02	1	Bath	0.22	549	8.4	1.3
PR02	1	Indoor	0.2	158	17	1.9
PR02	2	Bath	0.2	7.7	9.8	0.16
PR02	2	Bath	0.32	6.8	6.5	0.13
PR02	2	Indoor	0.2	6.7	6.4	0.13
PR03	1	Bath A	0.12	< 5.5	0.85	0.68
PR03	1	Bath B	0.071	< 5.5	0.27	0.11
PR03	1	Crawl	< 0.06	< 5.5	0.43	1.0
PR03	2	Bath A	0.15	< 5.2	0.41	< 0.08
PR03	2	Bath B	0.25	< 5.5	0.39	< 0.08
PR03	2	Crawl	0.079	< 5.2	0.30	< 0.08
PR04	1	Bath	3.9	< 5.3	0.68	0.66
PR04	1	Indoor	3.6	< 5.3	0.30	0.62
PR04	2	Bath	0.59	5.6	< 0.1	< 0.08
PR04	2	Indoor	0.43	< 5.3	< 0.1	< 0.08
PR05	1	Bath A	3.8	< 5.1	3.7	0.28
PR05	1	Bath B	3.9	7.0	2.3	< 0.08
PR05	1	Crawl	2.2	< 5.4	3.4	0.17
PR05	1	Indoor	3.1	11	4.1	0.13
PR05	2	Bath A	0.58	< 5.3	0.24	< 0.08
PR05	2	Bath B	0.93	< 5.5	0.45	< 0.08
PR05	2	Crawl	0.16	< 5.3	0.13	< 0.08
PR05	2	Indoor	0.2	< 5.4	0.14	< 0.08
PR06	1	Bath	1.3	< 5.4	0.36	< 0.08
PR06	1	Indoor	1.1	< 5.3	0.28	< 0.08
PR06	2	Bath	0.78	6.7	0.46	< 0.08
PR06	2	Indoor	0.45	< 5.1	0.52	< 0.08
PR08	1	Bath A	0.27	< 5.8	2.0	< 0.08
PR08	1	Bath B	0.13	< 5.3	2.4	< 0.08
PR08	1	Crawl	0.083	< 5.6	1.2	< 0.08
PR08	2	Bath A	0.19	5.4	3.8	< 0.08
PR08	2	Bath B	0.13	< 5.2	4.7	0.099
PR08	2	Crawl	0.094	< 5.5	2.6	0.29
PR09	1	Bath	0.87	< 5.3	0.35	0.14
PR09	1	Indoor	0.43	6.4	3.0	0.98
PR09	2	Bath	0.17	< 5.3	0.84	0.16
PR09	2	Indoor	0.19	6.3	0.83	0.22

Site	Round	Type	1,2-dichloro-ethane	Methylene chloride	Tetrachloroethylene	Trichloroethylene
PR10	1	Bath	0.16	< 5.4	0.11	0.32
PR10	1	Crawl	0.15	< 5.4	0.15	0.45
PR10	2	Bath	0.14	< 5.3	0.18	0.38
PR10	2	Crawl	0.13	< 5.5	0.26	0.89
PR11	1	Bath A	< 0.06	< 5.3	4.7	0.19
PR11	1	Bath B	0.65	< 5.3	4.4	0.32
PR11	1	Indoor	0.67	< 5.3	4.4	1.2
PR11	2	Bath A	0.13	< 5.3	0.49	0.13
PR11	2	Bath B	0.13	< 5.3	0.46	0.15
PR11	2	Bath C	0.094	< 5.3	0.31	< 0.08
PR11	2	Indoor	0.12	< 5.3	0.68	< 0.08
PR12	1	Bath	6.7	7.9	6.0	0.53
PR12	1	Indoor	6.6	8.9	5.9	0.55
PR12	2	Bath	1.1	< 5.5	6.9	1.0
PR12	2	Indoor	1.3	< 5.0	7.3	0.99
PR13	1	Bath	0.15	< 5.2	0.15	< 0.08
PR13	1	Indoor	0.097	< 5.2	0.18	< 0.08
PR14	1	Bath	0.36	5.8	8.3	3.8
PR14	1	Indoor	0.45	5.8	8.6	4.1
PR14	2	Bath	0.11	< 5.2	0.17	< 0.08
PR14	2	Indoor	0.18	< 5.3	0.19	< 0.08
PR15	1	Bath	0.68	7.3	0.39	0.097
PR15	1	Indoor	0.79	13	3.2	0.37
PR15	2	Bath	0.4	10	0.23	0.25
PR15	2	Indoor	0.43	6.3	0.25	< 0.08
PR16	1	Bath	0.074	< 5.4	0.11	< 0.08
PR16	1	Crawl	0.073	< 5.3	0.15	< 0.08
PR16	2	Crawl	0.089	< 5.3	2.5	0.35
PR19	1	Bath	5.6	< 5.3	0.52	0.57
PR20	1	Bath A	0.43	8.5	5.0	2.5
PR20	1	Bath B	0.52	< 5.3	4.1	3.0
PR20	1	Crawl	0.17	< 5.3	2.1	6.6
PR20	2	Bath A	0.32	< 5.3	4.6	3.0
PR20	2	Bath B	0.33	5.3	4.6	2.9
PR20	2	Crawl	0.2	6.5	3.0	2.7
PR20	2	Indoor	0.26	8.0	4.1	2.7

Site	Round	Type	1,2-dichloro-ethane	Methylene chloride	Tetrachloroethylene	Trichloroethylene
PR22	1	Bath A	0.31	< 5.5	7.1	4.9
PR22	1	Bath B	0.19	< 4.8	8.5	3.8
PR22	1	Bath C	0.35	< 5.5	6.7	4.4
PR22	1	Crawl	0.3	14	2.1	1.9
PR22	1	Indoor	0.41	5.2	15	9.4
PR22	1	Indoor	0.12	< 5.2	0.42	< 0.08
PR22	2	Bath A	0.13	< 7.9	0.48	0.34
PR22	2	Bath B	0.16	< 5.3	3.2	1.0
PR22	2	Bath C	0.15	< 5.3	0.85	< 0.08
PR22	2	Crawl	0.11	< 5.3	0.23	< 0.08
PR24	1	Bath	0.16	< 5.5	2.7	1.2
PR24	1	Crawl	0.13	< 5.1	1.3	0.63
PR24	2	Bath	0.13	< 5.5	1.6	0.75
PR24	2	Crawl	0.11	< 5.4	1.1	0.48
PR25	1	Bath	4.2	5.7	0.44	0.18
PR25	1	Indoor	3.3	7.0	0.40	0.19
PR26	1	Bath	0.12	< 5.6	2.5	< 0.08
PR26	1	Indoor	0.11	< 5.3	2.6	< 0.08
PR28	1	Crawl	0.087	2,040	0.50	0.14
PR29	1	Bath	0.48	6.3	6.3	2.8
PR29	1	Indoor	0.46	< 5.5	6.0	2.7
PR29	2	Bath	1	< 5.5	2.9	0.93
PR29	2	Indoor A	1.4	< 5.5	2.2	0.84
PR29	2	Indoor B	0.89	6.7	3.9	1.7
PR30	1	Crawl	0.068	< 5.1	1.1	0.11
PR30	2	Bath	0.15	< 5.3	1.9	0.46
PR30	2	Crawl	0.094	< 5.3	0.74	0.10
PR32	1	Bath	13	< 5.3	0.18	< 0.08
PR32	1	Indoor	12	< 5.3	0.21	0.11
PR33	1	Bath A	0.25	7.0	0.63	0.37
PR33	1	Bath B	0.27	5.7	0.66	0.37
PR33	1	Bath C	0.55	< 5.1	0.92	0.35
PR33	1	Crawl	0.22	< 5.2	0.70	0.42
PR33	1	Indoor	0.23	< 5.3	0.68	0.32
PR34	1	Bath	2.1	6.5	1.4	0.78
PR34	1	Crawl	2.4	7.2	1.0	0.28
PR35	1	Bath	0.31	7.9	0.22	0.089
PR35	1	Indoor	0.29	9.9	0.23	0.098

Site	Round	Type	1,2-dichloro-ethane	Methylene chloride	Tetrachloroethylene	Trichloroethylene
PR36	1	Bath	2.9	6.5	0.26	1.0
PR36	1	Indoor	1.6	7.1	0.30	1.1
PR36	2	Bath	0.25	7.1	0.16	0.10
PR36	2	Indoor	0.23	11	0.19	0.27
PR38	1	Bath	0.64	< 5.4	0.12	< 0.08
PR38	1	Crawl	0.11	< 5.3	0.22	< 0.08
PR38	1	Indoor	0.11	< 5.3	1.3	< 0.08
PR38	2	Bath	0.33	< 5.4	0.12	< 0.08
PR39	1	Bath	1.8	< 5.4	0.13	< 0.08
PR39	1	Indoor	0.87	< 5.4	0.32	< 0.08
PR40	1	Bath	0.093	< 5.4	0.13	< 0.08
PR40	1	Indoor	0.096	< 6.3	0.21	< 0.08
PR41	1	Bath	1.8	7.9	0.16	0.82
PR41	1	Crawl	1.2	< 5.5	0.14	0.89
PR41	1	Indoor	1.4	5.7	0.77	1.4

Appendix B

Health Evaluation Methods

Drinking Water: Exposure dose is calculated using the formula shown below. ATSDR calculated exposure doses for both CTE, which refers to persons who have an average or typical contaminated water intake rate, and RME, which refers to persons who are at the upper end of the exposure distribution (approximately the 95th percentile). The RME scenario assesses exposures that are higher than average but still within a realistic exposure range.

Exposure Dose Equation

$$D = \frac{C * IR * EF}{BW}$$

where

D = exposure dose (mg/kg-day)
C = contaminant concentration (mg/L)
IR = ingestion rate of contaminated water (L/day)
$EF_{chronic}$ = exposure factor (unitless) = (F x ED)/AT

- F = exposure frequency (d/wk x wk/yr)
- ED = exposure duration (yr)
- AT = averaging time
  - noncancer = ED (yr) x F (d/wk x wk/yr)
  - cancer: 78 yr x F (7 d/wk x 52.14 wk/yr)

BW = body weight (kg)

Source: The Public Health Assessment Guidance Manual, Appendix G, Exhibit 3 (ATSDR 2005).

The below table shows the age group specific water ingestion rates used by ATSDR. For a residential exposure scenario, ATSDR assumes 33 years: 21 years of childhood exposures plus 12 years as an adult.

ATSDR Recommended Age-specific Water Ingestion Rates*

Age range	Mean (mL/day)	95^{th} Percentile (mL/day)	Body Weight (kg)
Birth to <1 year	504†	1,113	7.8
1 to <2 year	308	893	11.4
2 to <6 year	376	977	17.4
6 to <11 year	511	1,404	31.8
11 to <16 year	637	1,976	56.8
16 to <21 year	770	2,444	71.6
Adults, ≥21 year	1,227	3,092	80

*Ingestion rates for combined direct and indirect water from community water supply (EPA 2011)
†Time-weighted average = [(470*1+552*2+556*3+467*6)/12] = 504 mL/day

ATSDR also calculates showering and bathing exposures to contaminants in drinking water using the below formula for dermal exposures [ASTDR 2020].

$$DAD = \frac{DA_{event} \times SA \times EV \times EF}{BW}$$

where,

DAD = dermal absorbed dose (µg/kg/day),
DA_{event} = absorbed dose per event (µg/cm^2/event),
SA = surface area available for contact with water (cm^2),
BW = body weight (kg),
EV = event frequency (events/day), and
EF = exposure factor.

(EPA 2004, ATSDR 2018)

The formula used for cancer calculations for drinking water ingestion is described below.

Age-Specific Cancer Risk = D × CSF × (ED / 78)

where,

D	=	age-specific exposure dose in milligrams per kilogram per day (mg/kg/day)
CFS	=	cancer slope factor in (mg/kg/day)$^{-1}$
ED	=	age-specific exposure duration in years

For TCE, cancer risk is based on three separate target tissue sites – kidney, lymphoid tissue, and liver. The CSFs for the three individual cancer types (respectively, 9.33E-03, 2.16E-02, and 1.55E-02 µg/kg/day) are summed, resulting in a total CSF of 4.6E-02 mg/kg/day. ATSDR applies ADAFs to TCE exposures to reflect a greater risk of kidney cancer with early life exposures. The kidney cancer component of the above formula is multiplied by a factor of 10 for ages birth to two years and a factor of 3 for ages 2 to 16.

Inhalation – ATSDR quantifies cancer risk from carcinogens in air by using EPA's IUR. The IUR is an estimate of increased cancer risk from inhalation exposure to a concentration of 1 µg/m^3 for a lifetime. The IUR is multiplied by an estimate of lifetime exposure to estimate the lifetime cancer risk.

The formula used for cancer calculations for inhalation is described below.

$$\text{Age-Specific Cancer Risk} = D \times IUR \times (ED / 78)$$

where,

D = air concentration ($\mu g/m^3$)
IUR = inhalation unit risk [$(\mu g/m^3)^{-1}$]
ED = age-specific exposure duration in years

Similar to drinking water exposures, ATSDR assumes that residential inhalation exposures occur over a 33-year period. Worker exposures occur during a 25-year period. Further, TCE exposures in air are also adjusted with ADAFs to quantify additional kidney cancer risks with early-life exposures in the residential scenario.

Appendix C

Indiana State Department of Health Cancer Inquiry Investigation

Findings of a Cancer Inquiry Investigation
Johnson County, Indiana
2015-2017

Released December, 2017

The Indiana State Department of Health (ISDH) has made a reasonable effort to ensure that the accompanying information is current, accurate, complete and comprehensive at the time of disclosure. These records reflect data as reported to this agency by the geographic region for the reporting period indicated. These records are a true and accurate representation of the data on file at the ISDH. Availability of this data and information does not constitute scientific publication. Authenticated information is accurate only as of the time of validation and verification. The ISDH is not responsible for data that is misinterpreted or altered in any way. Derived conclusions and analyses generated from this data are not to be considered attributable to the ISDH. The ISDH investigates all suspected cancer clusters. This does NOT mean the ISDH believes it to be more likely than not that there is a cancer cluster.

Questions or comments regarding this investigation may be directed to Keylee Wright, M.A., Director, Cancer Control Section, for the ISDH at 317-234-2945 or kwright@isdh.in.gov.

Executive Summary

On November 17, 2015, the Indiana State Department of Health (ISDH) opened an investigation into childhood cancers in Johnson County at the request of the Johnson County Health Officer. Local health officials received reports from citizens and the media that, since 2010, their community experienced a higher than normal number of cancers among children and expressed concerns regarding water contamination from the Webb Wellfield, a pumping station that served the city of Franklin municipal water supply.

The Centers for Disease Control and Prevention (CDC), the National Cancer Institute, and other public health institutions define a cancer cluster as a "greater than expected number of cancer cases that occurs within a group of people in a geographic area over a defined period of time." Using recommended CDC investigative protocol, the ISDH analyzed cancer cases occurring among children aged 0-19 years in Johnson County between 1999 and 2013. Cancers were analyzed in two groups, including all cancer types combined, and a smaller subset of the most commonly diagnosed childhood cancers, including leukemia, brain and other central nervous system tumors, neuroblastoma, Wilms tumor, lymphoma (Hodgkin and non-Hodgkin), rhabdomyosarcoma, retinoblastoma and bone cancer (including osteosarcoma and Ewing sarcoma).

Investigators calculated standardized incidence ratios (SIRs) to evaluate whether a greater than expected number of childhood cancers occurred in Johnson County. To calculate the SIRs, investigators divided the actual number of cancer cases diagnosed among children aged 0-19 years in Johnson County from 1999 to 2013 by the expected number of cases, which was based on the incidence of cancer among children aged 0-19 years throughout Indiana during the same time period. For all cancer types combined, the number of cases was similar to what was expected (111 cases observed, 107 cases expected, SIR = 1.04, 95% confidence interval = 0.84-1.23). The results were similar for the subset of the most common childhood cancers (79 cases observed, 77 cases expected, SIR = 1.03, 95% confidence interval = 0.80-1.26). Neither SIR indicated a statistically significant difference between the number of cases observed and the number expected. At the time of the investigation, data were not complete for 2014 and 2015, and did not become publicly available until June 2017. These data are included in the addendum of this report.

After analyzing available data, reviewing information gathered during interviews, and comparing findings to cancer cluster criteria, this investigation indicated that the criteria for defining a cancer cluster were not met. At this time, unless the ISDH receives new information that warrants additional review, the investigation is closed.

Introduction

On November 17, 2015, the Indiana State Department of Health (ISDH) opened an investigation into childhood cancer in Johnson County at the request of the Johnson County Health Officer. Local health officials received reports from citizens and the media that, since 2010, their community experienced a higher than normal number of cancers among children and expressed concerns regarding water contamination from the Webb Wellfield, a pumping station that served the city of Franklin municipal water supply.

The types of cancers that occur most often in children are different from those seen in adults. According to the American Cancer Society (ACS), the most frequently diagnosed cancer types among children are leukemia, brain and central nervous system tumors, neuroblastoma, Wilms tumor, lymphoma (including both Hodgkin and non-Hodgkin), rhabdomyosarcoma, retinoblastoma and bone cancer (including osteosarcoma and Ewing sarcoma). Breast, prostate, lung, and colon cancers are most common among adults.

Little is known about the causes and risk factors for most childhood cancers. According to the National Cancer Institute (NCI), a small percent (approximately 5%) of cancers in children arise from inherited mutations (genetic mutations that can be passed from parents to their children). Identifying potential environmental causes of childhood cancer has been difficult for numerous reasons. Cancer in children is rare, which makes it difficult to study. It is also difficult to determine what exposures children might have had early in their development, as well as the frequency and duration of exposure. Exposure to ionizing radiation is associated with increased risk for childhood brain and central nervous system tumors. Although chronic exposure to benzene is associated with acute leukemia in adults, evidence linking benzene exposure with leukemia in children is lacking. Viruses thought to increase risk for certain childhood cancers include the human lymphotropic viruses I and II and the Epstein-Barr virus.

Methods of Investigation

Definition of a Cancer Cluster

The official definition of a cancer cluster used by the Centers for Disease Control and Prevention (CDC), the NCI, and other public health institutions is as follows:
A cancer cluster is defined as a greater than expected number of cancer cases that occurs within a group of people in a geographic area over a defined period of time.

According to the CDC, to be classified as a cancer cluster, a group of cancer cases must meet all of the following criteria:1

- **A greater than expected number:** A greater than expected number is when the observed number of cases is higher than what would typically be seen in a similar setting (i.e. in a group with similar population, age, race, or sex). This may involve comparing rates for groups of people over a much larger area, such as an entire state or a county.
- **Of cancer cases:** All of the cases must involve the same type of cancer, or types of cancer scientifically proven to have the same cause.
- **That occurs within a group of people:** The population in which the cancers are occurring is carefully defined by factors such as race/ethnicity, age or gender for purposes of calculating cancer rates.
- **In a geographic area:** Both the number of cancer cases included in the cluster and calculation of the expected number of cases can depend on the geographic area where the cluster occurred is defined. The boundaries must be defined carefully. It is possible to "create" or "obscure" a cluster by selection of a specific area.
- **Over a defined period of time:** The number of cases included in the cluster – and calculation of the expected number of cases – will depend on how the time period over which the cases occurred is defined.

As part of the investigation, the traits of the suspected cancer cluster in Johnson County were compared to the criteria listed above.

Results

Study Population

Based on the above criteria, it was necessary to identify the number of cancer cases of interest, the relevant geographic area, and a defined period of time. The addresses of those children mentioned in media reports were plotted on a map and used initially to establish the geographic area for this investigation. The next step was to identify the number of children aged 0-19 years diagnosed with cancer in the reported geographic area during a specific, relevant period. At the time of this investigation, cancer diagnosis data collected by the Indiana State Cancer Registry were verified and considered complete through December 2013. Newly diagnosed cases from 2014 and 2015 had either not yet been reported to the registry or had not yet been verified, so these two years were excluded from the initial analysis. The final study population for this investigation included 111 children aged 0-19 years diagnosed with cancer in Johnson County between 1999 and 2013. A 15-year cohort timeframe is a standard lookback period for cancer incidence. Standard practice for determining cancer incidence is typically done over multiple years, due to random fluctuation of cancer cases from year to year.

To determine whether Johnson County was experiencing a greater than expected number of childhood cancer diagnoses, investigators calculated a standardized incidence ratio (SIR). The SIR compares the actual number of cancers diagnosed in the study population to the number of cases that would have been expected to occur if the incidence for the study population was equal to the incidence for a similar comparison population. For this investigation, the study population was Johnson County and the comparison population was the state of Indiana.

A SIR higher than 1 indicates a greater than expected number of cases, a SIR close to 1 indicates that the number of cases is similar to what would be expected, and a SIR lower than 1 indicates that the number of cases diagnosed was less than expected. Because there is always random error associated with statistical estimation, it is standard practice to calculate a 95% confidence interval around the SIR. A confidence interval describes the interval within which the true value may fall. In other words, the SIR may be as low as the lower confidence limit, or as high as the upper limit.

Description of Cases

The majority of children diagnosed with cancer in Johnson County between 1999 and 2013 were white and non-Hispanic. Table 1 shows a breakdown by gender for all cancer types as well as for the subset of the most common childhood cancers.

Table 1. Distribution of cancers (number and percent of total) by gender, children aged 0-19 years, Johnson County compared to Indiana, 1999 to 2013

Type of cancer	Gender	Johnson County	Indiana
All cancer types	Males	59 (53%)	2,620 (52%)
	Females	52 (47%)	2,444 (48%)
	Total	111	5,065
Common childhood cancers*	Males	45 (57%)	1,952 (54%)
	Females	34 (43%)	1,658 (46%)
	Total	79	3,610

*Common childhood cancers include leukemia, brain and other central nervous system tumors, neuroblastoma, Wilms tumor, lymphoma (Hodgkin and non-Hodgkin), rhabdomyosarcoma, retinoblastoma and bone cancer (including osteosarcoma and Ewing sarcoma).

Rates of Childhood Cancer and SIRs

The incidence rate for all cancers among children aged 0-19 years in Johnson County was 5.4 cases per 100,000 children (Table 2). The incidence rate for Indiana during the same time period was similar: 5.6 cases per 100,000 children. Restricting the analysis to the subset of the most commonly diagnosed childhood cancers, the incidence rate for Johnson County was 4.0 cases per 100,000 children while the incidence rate for Indiana was 3.9 cases per 100,000 children.

For all cancer types, the actual number of cases diagnosed between 1999 and 2013 was similar to what was expected (111 cases observed, 107 cases expected, SIR = 1.04, 95% confidence interval = 0.84-1.23). The results were similar for the subset of the most common childhood cancers (79 cases observed, 77 cases expected, SIR = 1.03, 95% confidence interval = 0.80-1.26). Neither SIR indicated a statistically significant difference between the number of cases observed and the number expected. Statistical significance refers to the likelihood that an event has not occurred solely by random chance, and refers only to the process and results of the statistical calculations. It in no way implies any judgment about the importance or significance of cancer (see Technical Notes for more information).

Webb Wellfield

Chemical contamination of the Webb Wellfield was first reported to the Indiana Department of Environmental Management (IDEM) in 1988 during routine compliance sampling for IDEM's Public Water Supply Program of the Office of Water Quality. Cis-1,2-dichloroethene (cis-1,2-DCE) and trans-1,2-dichloroethene (trans-1,2-DCE), both industrial solvents, were detected in two of three supply wells comprising the Webb Wellfield. These compounds are often associated with natural breakdown of more commonly used industrial solvents tetrachloroethene (PCE) or trichloroethene (TCE). Although these contaminants were found in the raw water of the Webb Wellfield, after processing, the city's drinking water remained safe to drink based on required testing conducted by the Indiana American Water Company in compliance with the Safe Drinking Water Act (§42 U.S.C. 300f et seq.). At no time did the public water supply for the City of Franklin exceed safe drinking water levels established by the United States Environmental Protection Agency (US EPA).

In 2009, the US EPA investigated the Webb Wellfield under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (§42 USC 9601 et seq.) to determine whether conditions qualified it for placement on the National Priorities List (NPL). As part of the evaluation of the site, a CERCLA Preliminary Assessment was conducted in 2010 followed by a CERCLA Site Investigation in 2011, and a CERCLA Expanded Site Inspection in 2012. The culmination of these investigations identified a source of contamination directly east of the former Houghland Tomato Factory, which lies approximately one-half mile southwest of the wellfield. The site was given an Other Cleanup Activity (OCA) designation by the US EPA in 2014, turning authority for the cleanup of the site over to IDEM. The US EPA monitors progress of OCA sites until no further action is required at the state or federal level.

The Houghland Tomato Factory site was assigned to the IDEM State Cleanup Program in March, 2013 and investigations have been on-going since then. The process to determine the depth of ground water contamination (vertical delineation) should be completed early in 2018. To date, the precise source of contamination at the Houghland Tomato Factory has not been identified. Evidence suggests that the source of this contamination reached the Webb Wellfield.

Currently, based on the US EPA's most recent assessment2, there is "inadequate information to assess the carcinogenic potential" of trans-1,2-DCE and cis-1,2-DCE. This designation is based on a lack of both epidemiologic studies in humans and animal studies to evaluate the carcinogenic potential of these chemicals.

Municipal water suppliers are required to follow federal guidelines to test and treat water to meet established standards set by the Safe Drinking Water Act. For those using well water, current recommendations advise routine private well water testing to detect chemical or biological exposures that could potentially cause adverse health effects. Private well water safety cannot be ensured without appropriate testing. Many factors play a role in the composition (make-up) of the well water, creating variability among users. Even if well water testing indicates a contaminant, its presence does not prove that it caused cancer.

Conclusion

The ISDH determined that the criteria for a cancer cluster remained unmet after analyzing available data, reviewing information gathered during interviews, and comparing findings to the established definition of a cancer cluster. The difference between the observed number of childhood cancers (either for all cancer types or for the subset of most common childhood cancers) diagnosed in Johnson County and the number expected during the time period of interest was not statistically significant. At this time, unless the ISDH receives new information that warrants additional review, the investigation is closed.

Recommendations

- Concerned citizens could advocate for and support greater scientific research to help identify causes and risk factors for childhood cancers.
- The local health department could conduct local educational campaigns to promote private well testing to identify exposures to chemicals or bacteria that might contribute to other illnesses.
- The ISDH will update this analysis upon request.

Additional Information and Resources

For additional information about cancer clusters, visit the CDC "About Cancer Clusters" web page at www.cdc.gov/nceh/clusters/about.htm and/or the NCI "Cancer Clusters" web page at www.cancer.gov/cancertopics/factsheet/Risk/clusters.

For additional information on childhood cancer, visit the ACS "Cancer in Children" web page at www.cancer.org/acs/groups/cid/documents/webcontent/002287-pdf.pdf.

Additional online resources:

ISDH

- *Guidelines for the Management of Inquiries Related to Cancer Concerns or Suspected Cancer Clusters in Indiana*
- Questions and Answers about Suspected Cancer Clusters
- Childhood Cancer Fact Sheet

Indiana Cancer Consortium

- *Indiana Cancer Facts and Figures 2015*
- Childhood Cancer Toolkit

Indiana Department of Environmental Management

- Webb Wellfield Fact Sheet

Agency for Toxic Substances and Disease Registry

- 1,2-Dichloroethene Fact Sheet

National Water Quality Monitoring Council

Safe Drinking Water Act

Questions or comments regarding this investigation may be directed to Keylee Wright, M.A., Director, Cancer Control Section, for the ISDH at 317-234-2945 or kwright@isdh.in.gov.

References

1. The Centers for Disease Control and Prevention and the National Public Health Information Coalition. Cancer Clusters: A Toolkit for Communicators. The National Public Health Information Coalition; 2013, Website Accessed March 20, 2017.

2. United States Environmental Protection Agency. *cis-1,2-Dichloroethylene*. Environmental Protection Agency, 2017, https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=418. Accessed on March 20, 2017.

Addendum

With initial concerns raised about the number of childhood cancer cases diagnosed in Johnson County in 2014 and 2015, the ISDH revised this analysis in June 2017 to evaluate a new 15-year cohort ending in 2015 (2001-2015). Currently, the Indiana State Cancer Registry is complete through 2015, meaning that all cases reported as of December 31, 2015, have been verified and have undergone quality control processes to meet registry standards. Table 3 presents the updated age-adjusted cancer incidence rates, observed versus expected numbers of cases, SIRs and 95% confidence intervals for cancers diagnosed among children aged 0-19 years between 2001 and 2015. The incidence rate for all cancer types in Johnson County was 6.1 cases per 100,000 children compared to the incidence rate for Indiana: 5.6 cases per 100,000 children. When restricting to the subset of common childhood cancers, the incidence rate for Johnson County was 4.3 cases per 100,000 children and the rate for Indiana was 3.9 cases per 100,000 children.

Table 3. SIRs for all cancer types and common childhood cancers, children aged 0-19 years, Johnson Count compared to Indiana, 2001 to 2015.

Type of cancer	Age-adjusted incidence rate, Johnson County*	Age-adjusted incidence rate, Indiana*	Observed/ Expected Cases† (#)	SIR	95% confidence interval, lower limit	95% confidence interval, upper limit	p-value
All cancer types	6.1	5.6	123/113	1.09	0.90	1.28	0.37
Common childhood cancers‡	4.3	3.9	88/80	1.10	0.87	1.33	0.38

*Age-adjusted incidence rates are number of cases per 100,000 children and age-adjusted to the 2000 U.S. Standard Population. This is done to account for differences in the age distribution of the populations of Johnson County and Indiana, which is necessary to make these two rates directly comparable. These rates are not directly comparable to the observed or expected counts.

† Expected cases equals the number of cancers that would have been expected to occur if age-specific cancer incidence in Johnson County was equal to age-specific cancer incidence throughout the state of Indiana.

‡ Common childhood cancers include leukemia, brain and other central nervous system tumors, neuroblastoma, Wilms tumor, lymphoma (Hodgkin and non-Hodgkin), rhabdomyosarcoma, retinoblastoma and bone cancer (including osteosarcoma and Ewing sarcoma).

For all cancer types, the actual number of cases diagnosed between 2001 and 2015 was similar to what was expected (123 cases observed, 113 cases expected, SIR = 1.09, 95% confidence interval = 0.90-1.28). The results were similar for the subset of the most common childhood cancers (88 cases observed, 80 cases expected, SIR = 1.10, 95% confidence interval = 0.87-1.33). While the number of cases observed and expected are higher for 2001 to 2015 than 1999 to 2013, neither SIR indicated a statistically significant difference between the number of cases observed and the number expected.

Statistical significance refers to the likelihood that an event has not occurred solely by random chance, and refers only to the process and results of the statistical calculations. It in no way implies any judgment about the importance or significance of cancer (see Technical Notes for more information). The inclusion of the additional data does not change the findings of the initial investigation.

The ISDH also assessed the impact of Trevor's Law on its processes for responding to inquiries related to suspected cancer clusters. On June 22, 2016, 42 U.S.C. §280g-17, also known as Trevor's Law, was enacted. This federal law requires the Secretary of the United States Department of Health and Human Services (HHS) to develop criteria for the designation of cancer clusters, as well as develop, publish, and periodically update guidelines for the investigation of potential cancer clusters. In addition, the law requires that HHS provide assistance to state and local health departments. The ISDH's current *guidelines* for responding to inquiries related to suspected cancer clusters align with the 2013 *guidelines* from the CDC and the Council of State and Territorial Epidemiologists. These guidelines have not changed since the passage of Trevor's Law. The ISDH will continue to monitor for new guidance or changes in resources provided by federal partners.

Technical Notes

Age-adjusted rates

The rates of almost all causes of disease, injury, and death vary by age. Age adjustment is a technique to reduce the effects of age on crude or raw cancer rates. This allows comparisons across groups of people of different ages. For example, comparing the crude rate of heart disease in Florida with that of California is misleading, because the older population in Florida leads to a higher crude death rate. For such a comparison, age-adjusted rates are better. All mortality and incidence rates in this publication were age-adjusted using the direct method. This method weights the age-specific rates (i.e., rates calculated for each age group) for a given sex, race, or geographic area by the age distribution of the standard population. The 2000 United States standard million population and five-year age group population numbers were used to calculate all of the age-adjusted rates in this report.

Confidence interval

A confidence interval is a measure of how precise a number is in a statistical study. Statistics help people estimate actual numbers. In a statistical study, confidence intervals are usually set at 95%. For example, suppose investigators find an age-adjusted breast cancer rate in a town of 10 cases per 1,000 women, with a confidence interval of plus or minus five. This means that the number of cases could range from 5 (i.e., 10 minus 5) to 15 (i.e., 10 plus 5). That indicates a 95% chance that the rate is between 5 and 15 and a 5% chance that the rate is below 5 or above 15. The confidence interval is a reminder that there is always a possibility that findings are due to chance. However, a larger sample size produces more accurate and reliable findings.

SIR

SIR stands for *standardized incidence ratio*. The SIR is the number of observed cases divided by the number of expected cases of a given disease. The expected number is the number of cases that would occur in a community if the disease rate in a larger reference population (like a county, state, or country) occurred in that community. A SIR over 1 indicates a higher than expected number of cases, a SIR of 1 indicates the number of cases is what would be expected, and a SIR below 1 indicates the number of cases is less than expected. If the SIR falls within the confidence interval, it is not significant. For instance, a SIR of 1.2 would indicate 20% more reported cases within the study population than expected. In order to figure out significance, 95% confidence intervals are calculated to provide the upper and lower boundaries within which the true observed ratio might fall. A SIR falling within the confidence interval would not be statistically significant and considered to be the same as what would be expected.

Statistically significant

Another step in evaluating whether the number of observed cases is higher than what would be expected is to evaluate whether the difference between these two numbers is statistically significantly different. If the difference between the actual and expected number of cancer cases is statistically significant, the finding is less likely to be the result of chance alone. If the difference is not statistically significant, then the observed number of cases could have occurred simply by chance alone. The term "statistical significance" refers only to the process and results of the statistical calculations and in no way implies any judgment about the importance or significance of cancer. For more information, visit the NCI's page on this topic at www.cancer.gov/cancertopics/factsheet/Risk/clusters.