

Public Health Assessment

Final Release

**FORMER COLLINS & AIKMAN PLANT SITE
FARMINGTON, NEW HAMPSHIRE**

**DES SITE #198705014
EPA FACILITY ID: NHN000105928**

**Prepared by
New Hampshire Department of Environmental Services**

NOVEMBER 10, 2016

**Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333**

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR'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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Summary	
Introduction	<p>The Former Collins & Aikman (C&A) Plant Site (C&A Site) located in Farmington, Strafford County, New Hampshire (NH) has been the focus of numerous investigations since employees complained to management in 1981 about taste and odor issues with the drinking water (1) (Fig. 1). Beginning in 1966, C&A manufactured injection-molded plastic automobile parts. The C&A Site water source, a Farmington public well located 0.7 mile northeast and hydrogeologically in the direction that groundwater flows from the C&A Site, was found to be contaminated in 1983 with chlorinated volatile organic compounds (cVOCs) (2). Groundwater in the aquifer beneath the C&A Site and downgradient has been regularly sampled since 1984 through the use of monitoring wells (MWs). Contaminated groundwater has extended offsite toward the northeast beneath a tract of land containing wetlands, the Pokamoonshine Brook (PMSB) and the Cochecho River (Fig. 2). The Plant ceased operations in 2006 after bankruptcy, aside from 10 subdivided acres, the C&A Site is currently not in use (2).</p> <p>In January 2013, the Governor of NH requested that the U.S. Environmental Protection Agency (EPA) add the C&A Site to the National Priorities List (NPL) of Superfund Sites (3). Included with the letter request was a Resolution by the Town of Farmington making the same request. On December 11, 2013, EPA officially added the C&A Site to the NPL (4). As mandated by Congress, the Agency for Toxic Substances and Disease Registry (ATSDR) conducts public health assessment activities for all hazardous waste sites proposed for or added to the NPL. The New Hampshire Department of Environmental Services, Environmental Health Program (EHP) has a cooperative agreement with ATSDR to conduct PHAs for sites in New Hampshire.</p> <p>The NH Department of Environmental Services (DES) Environmental Health Program (EHP) evaluated past, current, and potential future exposure to cVOCs in multiple media originating from the C&A site. We reviewed sampling data and past environmental investigation reports to assist us in forming our conclusions. During the public comment period (July 5 – August 5, 2016) for this PHA, no public comments were received.</p>
Conclusions	We reached six important conclusions in this health assessment:
Conclusion 1	EHP concludes that there was no harm to past C&A workers' health from drinking the contaminated public water supply. No current or future harm to Farmington public water users' health from this source is expected.
Basis for Conclusion	The past workers cancer risk from drinking the water is less than 1 in 10 million and no non-cancer health effects are expected. The contaminated Farmington public well serving the Plant was shut down in 1984. The Town has installed several new wells in locations safe from the contaminated groundwater and the direction of its flow. The C&A Site is currently vacant, with no active water supply wells. Future users of the C&A Site would either have water supply wells installed in a location not likely to draw from the contaminant plume, a water treatment system could be installed to

	remove contaminants, or the Town public water supply could be extended to the C&A Site, if necessary.
Conclusion 2	We conclude that past residents' health was not harmed by using their contaminated private wells. Currently, no private wells are located in the area of known groundwater contamination and, in the future, new private wells will not be installed in the area with contaminated groundwater due to the combination of deed restrictions and continuing ownership of this property by the Town.
Basis for Conclusion	High detection limits for one contaminant do not allow us to evaluate cancer risk for a past resident. However, assuming the contaminant is present at the detection limit, the past residents' cancer risk could be no greater than 7 in one million and non-cancer health effects are unlikely. Through investigations to determine where contaminated groundwater is located with test (monitor) wells, visits to the C&A Site area, and examination of Town records, no property owners in the area of <i>known</i> contaminated groundwater are using private wells. Contaminants were not found in the few active private wells tested in 2012 that are located closest to the C&A Site. Based on years of groundwater testing results, investigations of groundwater movement direction, and knowledge of the soil and bedrock in the C&A Site area, the edge of contaminated groundwater is located more than 800 feet to the western side of the nearest private well. In the future, new private wells are not likely to be installed in the area with contaminated groundwater because that area has deed restrictions that do not allow groundwater use or the property is owned by the Town.
Conclusion 3	In the future, if workers on properties in the path of groundwater flow from the C&A Site drink contaminated groundwater from new private wells, they will increase the chance of harm to their health.
Basis for Conclusion	Use of the groundwater in the currently contaminated areas in the groundwater flow path is prohibited by deed restriction until June 30, 2020. The deed restriction on an additional parcel of land that includes former contaminated Town well GP-2 expired in 2015. The area with the expired deed restriction is owned by the Town. They have subdivided it and are offering one parcel for sale. Business owners of these properties could install private wells instead of connecting to the Town public water supply if the deed restrictions on groundwater use are not renewed after 2020. Although the maximum detected contaminant levels found in the groundwater are much higher than what hypothetical future workers would actually consume over a long time period, the most recent historical contaminant levels are substantially above drinking water health screening values.
Next Steps	To ensure that groundwater exposure as drinking water does not occur in the future, EHP recommends that the Town adopt or renew Institutional Controls (ICs) on the parcels of land in the area of contaminated groundwater to prevent installation of wells. Deed restrictions on one parcel owned by the Town have expired. Deed restrictions on a second area beneath which several contaminants in groundwater have been repeatedly detected above standards, remain in effect until 2020.
Conclusion 4	EHP concludes that C&A Site trespassers currently coming in contact with soil are not likely to harm their health. But we cannot determine if future trespasser soil contact will be harmful to their health.

Basis for Conclusion	Soil sampling has found only low amounts of contaminants in surface soil and most of the contaminated soil is covered by asphalt and the former building foundation. If the C&A site sits vacant for a substantial period and the existing asphalt and concrete foundation fall apart, coming in contact with soil is more likely as the asphalt areas continue to crack and deteriorate. However, we cannot determine if this will increase the chance of harm because there are only a few surface soil samples beneath asphalt or the building foundation. Sampling of some additional surface soil areas under the asphalt could provide added confidence that soil contact is not a concern.
Next Steps	Until the site is restored and re-used, EHP recommends surface soil sampling to determine if there is a health concern for direct contact exposure. We recommend fencing to limit trespasser exposure for any areas that sampling demonstrates to be of concern.
Conclusion 5	We cannot conclude whether workers breathing in chemicals in the air inside the C&A plant in the past could have harmed their health or whether future workers could harm their health by breathing the indoor air of a new building on the C&A Site. There are currently no standing buildings on the C&A Site.
Basis for Conclusion	In the past, there were high amounts of chemicals in groundwater beneath the C&A plant, some of which may have turned into a gas and moved through cracks and utility openings into the building. However, there were no indoor air samples taken during the time that C&A was manufacturing automobile parts. Indoor air samples taken in 2008 when tenants occupied the building detected some contaminants, but they were not a health concern at the levels the workers breathed. We do not believe the contaminant levels in the 2008 air sample results can be applied to the levels breathed in by workers many years ago because maximum detected contaminant concentrations in groundwater from several wells within the former building footprint have gone down by 74 to 97%, depending on the chemical. Although contaminant concentrations in groundwater have gone down, the amounts of chemicals remaining in groundwater at the C&A Site are still a potential health concern because they exceed State of New Hampshire health screening values for groundwater contaminants turning into a vapor and moving from groundwater into building air. Should a business put up a building, we are concerned about future workers breathing in vaporized contaminants that have moved from groundwater. EHP has similar concerns for vapor intrusion should a commercial building be constructed in the future over the contaminated groundwater plume located downgradient of the site.
Next Steps	EHP will recommend to the C&A Site regulators that groundwater sampling be included in any C&A Site reuse plan that includes an office or industrial building. If the contaminant concentrations are above screening values established for protecting against harm from chemicals in groundwater moving into indoor air (known as DES Groundwater-2 Screening Values), then restrictions would be put into place limiting reuse and/or requiring vapor mitigation systems in new buildings. This determination would be made before any plans are finalized for reuse and new building construction.
Conclusion 6	EHP cannot conclude whether people wading or swimming in the PMSB and Cocheco River, enjoying other recreational activities, or eating fish caught in these waterbodies could in the past, currently, or in the future, be harmed by chemicals in the water, sediment, or fish.

<p>Basis for Conclusion</p>	<p>We cannot be certain of the contaminant levels in these water bodies because limited surface water and fish samples were last taken more than 25 years ago; sediment samples were never taken. Environmental models predict that some polluted groundwater from the C&A Site ends up in the PMSB and Cocheco River. There are large amounts of water in these water bodies that would dilute the groundwater contaminants, and the contaminants in moving water will tend to evaporate into the air. So, it would take very high contaminant concentrations in the groundwater for them to build up in surface water and sediment at levels that would cause harm. Most of the contaminants found in the groundwater are not the kind that is likely to build up in fish. However, because only a few fish samples from the Cocheco River were collected before 1990 for the investigation of a different site, we cannot be certain whether contaminants could get into fish at levels that would cause harm to the health of recreational fisherman and their families that consume them.</p>
<p>Next Steps</p>	<p>EHP will recommend that some surface water and sediment samples be collected in future investigations to determine if harmful chemical levels are present. We will recommend that the results of surface water and sediment samples be used to determine whether harmful levels of chemicals might have built up in fish. If necessary, fish can be tested as part of a future investigation.</p>

Purpose and Health Issues

The former Collins & Aikman Plant Site was added to the National Priorities List (NPL) on December 11, 2013. As mandated by Congress, the Agency for Toxic Substances and Disease Registry (ATSDR) performs Public Health Assessments (PHAs) for all hazardous waste sites proposed for or added to the NPL. The New Hampshire Department of Environmental Services, Environmental Health Program (EHP) has a cooperative agreement with ATSDR to conduct PHAs for sites in New Hampshire. EHP completed this PHA under the cooperative agreement. EHP is a non-regulatory program within NH DES. It serves to assess the human health implications of hazardous chemical releases, and to make recommendations to protect public health.

The purpose of this PHA is to: 1) determine if exposure to site-related contaminants could have occurred in the past, are occurring now, or will likely occur in the future and if any of these exposures posed or will pose a health hazard; 2) make recommendations for additional sampling to determine if potential exposure pathways are complete; and 3) make recommendations to reduce or eliminate any exposures which might result in harmful health effects to the public.

Background

Site Description

The Former Collins & Aikman (C&A) Plant Site (C&A Site) is approximately 123 acres of which about 33 acres was used for commercial activities with the remainder as undeveloped woodland (2). The C&A Site is located at 56 Davidson Drive, off of Rt. 11 in Farmington, NH. Manufacturing of injection-molded plastic automobile parts began in 1966 under the name of the Davidson Rubber Co. (2). The business changed owners several times, with C&A as the last owners until they ceased operations in 2006 after declaring bankruptcy in 2005 (2). The vacant property is currently owned by the New Hampshire Custodial Trust. The manufacturing building (Plant), which varied in size from 115,000 up to 232,000 square feet as it expanded over the years, was demolished in 2010 (2). West of the Plant, a 60,000 sq. ft. warehouse and 10 acres of land surrounding it was subdivided from the Site and sold in 2013 to a metal recycling company (5).

Properties located in the direction of groundwater flow (downgradient properties) to the north across Rt. 11, commonly referred to in historical reports and maps as the Sara Greenfield Property, include undeveloped land owned by the Town, a commercial composting facility, wetlands, Pokamoonshine Brook (PMSB), and a former Farmington public well installed into the overburden aquifer designated as Gravel Pack 2 (GP-2) (2). Crossing the downgradient properties about 0.15 mile north of the Site boundary, PMSB flows northeast, emptying into the east-to-south flowing Cocheco River about 0.75 mile from the C&A Site (2). A stream on the Site flows northward through a culvert under Rt. 11 and empties into a wetland and the PMSB (6). Figure 2 displays most of these features.

GP-2 is located approximately 0.7 miles northeast of the C&A Site (2). GP-2 was used by the Town to supplement their water supply during times of high demand (7). The Town decided to stop using it for that purpose in August 1983 after low levels of contaminants were detected (8). GP-2 was also the water supply for the C&A Site and continued to be used until June 1984, when three wells installed south of the Plant building, opposite the direction of groundwater flow from the C&A Site, became operational (9).

Demographics and Land Use

The Farmington population in the 2008 to 2012 time period was estimated at 6,768, comprised of 3,424 males and 3,344 females (10). The median resident age was 41.5 years (10). About 10.4% of residents also work in Farmington (10). Estimates of Farmington sensitive populations include 172 children under age five, 894 residents age 65 and older, and 1,620 females between the ages of 20 and 54 (10). There are 2,831 housing units in Farmington, of which 1,684 are single-family (10). With the Collins & Aikman Plant going out of business in 2005, the eight largest Town businesses employ a range of between 44 and 15 workers each (10).

The Town of Farmington is 37 square miles of land area and 0.4 square miles of inland water (10). The Town owns and operates its public water system, which draws water from three overburden wells serving approximately 3,300 people (11). With well GP-2 closed in 1983, the closest operating Town wells to the C&A Site are GP-4 and GP-5 located approximately 0.7 miles northwest (12). The closest private bedrock well is about 0.4 mile east of the location of bedrock monitoring well SH-8R, which has the highest maximum detected total cVOC contaminant concentration of all C&A Site bedrock wells (12) (see Table 6). The Farmington wastewater treatment facility releases an average of 221,000 gallons per day of treated effluent to the ground into rapid percolation basins where it will migrate into groundwater that eventually recharges the Cocheco (11).

The Pokamoonshine Brook flows east of the C&A Site northeast under Rt. 11 into the downgradient property then under Rt. 153, where it merges into the Cocheco River, about 0.75 miles from the C&A Site (12). The Cocheco River flows southeast into Farmington and then through Rochester and Dover where it becomes tidal in Dover (13). The Cocheco is classified as a Class B surface water body, which indicates that it is suitable for fishing, swimming, other recreational purposes, and as a water supply after treatment (13). There is a public canoe launch for the Cocheco in Farmington (13). There are several warm water fish species in the Cocheco including American eel, Eastern chain pickerel, yellow perch, brook trout, small-mouth bass, and shiner (13).

Site and Area Groundwater Information

The C&A Site is located on the southwestern portion of the Cocheco River Valley. Groundwater beneath the C&A Site flows to the north-northeast into the center of the Cocheco River Valley (14). Beneath the downgradient properties is a sand and gravel aquifer, from which Well GP-2 drew its water when in use (14). In a 2006 report, the consultant concluded that because no apparent barriers existed in the subsurface to limit movement of groundwater from overburden deposits into the bedrock, groundwater in the overburden and bedrock in the vicinity of the C&A Site is likely interconnected (15). In a 2009 report, based on water level measurements collected from multiple wells during overburden pumping associated with groundwater treatment, a consultant concluded that some degree of hydraulic interconnection exists between overburden groundwater and both shallow and deep bedrock groundwater (14). The detection of C&A Site-related contaminants in wells installed in both the overburden and bedrock aquifers on the C&A Site as well as the properties in the direction of groundwater flow from the C&A Site provides additional confirmation of the interconnection between overburden and shallow and deep aquifers.

Although the most probable source of contaminants in GP-2 is the C&A Site, pump testing of GP-2 was not able to completely rule out other sources as possible contributors (16). In particular, the Cardinal Landfill and the Farmington Municipal Landfill are also properties located very close to GP-2 which were known to contain cVOCs. Both former landfills are located to the east of GP-2 on the opposite side of the Cocheco River. A DES report stated that additional pump testing and sampling is necessary before it can

be concluded that the Cocheco River acts as a barrier to groundwater contamination migrating from both the Cardinal and Farmington Landfills to the aquifer beneath the downgradient properties (17).

Contaminant Release History

- Organic solvents including tetrachloroethylene (PCE), methyl ethyl ketone (MEK), methylene chloride, and xylene have been used for manufacturing operations. They were kept in aboveground storage tanks (ASTs) south of the Plant between 1977 and 1985 (2) (Fig. 2). Chemicals in the ASTs were brought into the Plant via underground lines. In 1985, the ASTs were removed (18).
- In an interview with DES conducted in 2012, a former employee reported that in 1977, several hundred gallons of PCE were released when a tank-truck driver filled a decommissioned AST (19). According to the former employee, none of the PCE was recovered, so it is likely that it would have soaked into the ground or flowed into a stream or culvert behind the Plant (19). The interviewee also stated that the underground line bringing PCE into the Plant developed a leak. The leak was noticed in 1978 and repaired. In 1978, subsequent to the line repair, the Plant stopped using PCE, reportedly replacing it with methylene chloride (19).
- In 1981, Plant employees complained to management about the taste and odor of the drinking water, which triggered the first of several investigations (1). In August 1983, water samples collected from GP-2 by the State detected cVOCs, some of which had also been detected in surface water samples collected on the Site (8). In October 1983, the State issued the owners a Violation Notice for discharging contaminants found to have migrated beyond the property border (20).
- Other source areas besides the ASTs with a high potential for chemicals used during manufacture to be released into the environment include the Plant septic/leach-field system located NW of the Plant, a system of percolating lagoons located NE of the Plant, and "dipping pits" located within the Plant (2). The septic tank and leach field were for cafeteria and sanitary wastewater disposal. However, some Plant floor drains were found to be directly connected to the septic system (2). The floor drains were cemented over in 1983 (2). Reportedly, floor washings and chemical spills may have been washed into the drains connected to the septic system (2).
- The lagoon system was built in 1975 in order to handle the industrial wastewater stream from the Plant (2). State documentation from an inspection records the lagoons as unlined (21). A leak in the line from the Plant to the lagoons, detected in November 1985, was repaired in May 1986 (22). Use of the lagoons ended sometime in 1985 (23).
- Two pits with concrete walls were located within the Plant. In order to clean the fabricated parts, the parts were reportedly dipped in the PCE-filled pits (2). Environmental investigations report that the concrete pit walls had some slight cracks (2).
- From 1984 to the present, high concentrations of PCE and its environmental breakdown products trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE) and vinyl chloride have been detected in some overburden and bedrock monitoring wells (MWs) located on and downgradient of the Site (Fig. 3). Some PCE detections in samples collected in the 1980s exceeded 1% of PCE's solubility in water, indicating that some of it may exist in groundwater as a dense, non-aqueous phase liquid (DNAPL) (24). Of more recent concern are the 2009 and 2010 detections of PCE in bedrock wells (SH-7, SH-8 multi-level) at concentrations indicating the potential for the

presence of DNAPL (25), although to date, no DNAPL has been recovered from these wells. Based on multi-level screened SH-8 well results, contaminant concentrations increased from shallow bedrock samples to those collected at greater depth (See Table 6). DNAPL can act as a long-term contributor to dissolved phase groundwater contamination (24).

- Soil samples in general have indicated only a few high contaminant concentrations, mainly at subsurface depths. Site surface water (stream, culverts) was sampled only in 1983 (26). Indoor air in the Plant was sampled in 2008 while occupied by a non-manufacturing tenant (27, 28). There is no record of surface water or sediment sampling for the C&A Site occurring in downgradient properties. However, surface water, sediment, and fish samples were collected from the Cocheco River in the 1980s and 1990s for investigations of the Cardinal Landfill (29).

Site Remediation Actions Taken

In December 1990, Farmington adopted Institutional Controls (IC) on approximately 163 acres of land across Route 11 downgradient of the C&A Site (30). The largest area (Area A) of about 150 acres under IC includes land immediately downgradient of the C&A Site, where monitoring wells detected contaminated groundwater. A smaller area (Area B) of about 13 acres is located further downgradient and north of Area A (Fig. 4). Groundwater beneath Area A and any surface water is restricted from being used until June 30, 2020 or until sampling establishes that groundwater meets drinking water standards (30). The same restriction applied to Area B until June 30, 2015 (30). Area B has been subdivided and the Town is offering one parcel (R32-022-3) for sale. The Town is currently mining gravel from Area A (31). Additional controls on property use in Area A include: 1) a prohibition from excavating soil within five feet of the groundwater table and under surface water and 2) soil excavation on Area A will not be allowed should soil testing detect contaminants exceeding State standards (30).

A NH DES Groundwater Management Zone (GMZ) was established in 1995 when C&A Site remediation began. The goal of the GMZ was to reduce C&A Site contaminant levels so that, by 2005, groundwater contaminants would no longer be migrating off-site at concentrations above drinking water standards (2).

In August 1995, a groundwater containment system referred to as a "management of migration" (MOM3a) system became operational in the northwest septic system area (2). MOM3a removed VOCs from the water and returned treated water to the ground. Goals of the remediation effort were to minimize contaminants in groundwater migrating offsite from the northwest septic system leachfields. Although the MOM3a system did reduce groundwater contaminant concentrations in the leachfield area as evidenced by contaminant reductions in well sample results, it has failed to prevent continued contaminant migration offsite to the downgradient property (14). Operation of the groundwater containment system was discontinued as of June 2, 2014 due to its limited effectiveness.

In July 1995, a source area remediation system referred to as SC1A began to dewater the former AST/piping area so that an air sparge and soil vapor extraction system (AS/SVE) could be installed in that source area to clean up the contaminated soils. The AS/SVE system, which became operational in September 1999, operated intermittently because of electrical problems, a high water table in the SVE wells, and low groundwater in the AS wells (2). Results of the AS/SVE system were disappointing and it was shut down permanently in March 2002.

Discussion

The ATSDR Evaluation Process

Please refer to Appendix B for details about the process used by ATSDR to evaluate the public health implications of environmental contamination in general and specifically the screening methods used to determine which chemicals, if any, detected in environmental media may potentially result in adverse health effects to the public.

Environmental Sampling Results

Drinking Water

Public Water Supply:

Extensive sampling of Farmington public well GP-2 occurred after contamination below drinking water standards was detected in August 1983, resulting in the Town decision to no longer use well GP-2 to supplement the water supply in times of high demand (8). GP-2 sample results after 1983 are presented in Table 1. The first GP-2 sample with a contaminant detection exceeding a drinking water standard (PCE) was collected on February 6, 1984 (32). The Plant reportedly continued to use GP-2 as its potable water supply until June 1984 when three supply wells installed on a portion of the Site upgradient of the groundwater contamination became operational (9).

Private Wells:

Because contamination continued to be detected in GP-2 during 1984 sampling, four downgradient residential wells very close to the wellhead and somewhat to the side of the groundwater flow direction were sampled two to five times between 1984 and 1990 (33, 34). Table 2 presents these results. No contaminants were detected in one well, and PCE below its drinking water standard was found in two wells. PCE in Resident 1's well was detected at a maximum concentration of 9.2 µg/L, above its current drinking water standard in four of four samples collected in 1984 and 1985, but below its Carcinogenic Comparison Value (CV), a Cancer Risk Evaluation Guide (CREG) of 17 µg/L, which is set at an excess lifetime cancer risk (ELCR) of 1E-6 (one in one million) (33). TCE was detected at a "trace" concentration, which is below 5 µg/L – the lowest concentration that could be quantified. The actual concentration of TCE in Resident 1's well was likely considerably less than 5 µg/L because the maximum detected concentration of TCE detected in well GP-2, before it was connected to the Town water supply in 1985, was 1 µg/L. Toluene detected in Resident 1's well is below its CV and so is not considered a contaminant of concern (COC). Resident 1's property was connected to the Town water supply in 1985 (33, 34).

In response to very high contaminant concentrations, first detected in January 2009 in bedrock monitoring well SH-8R in the NE portion of the C&A Site in front of the Plant, five bedrock potable supply wells near the intersection of Rt. 11 and Rt. 153 were identified by DES within 3,000 feet of SH-8R. Two of the wells were not in use and access was not granted for a third. The remaining two residential wells were sampled in September 2012. VOCs associated with the site were not detected in the wells located nearest the C&A Site on Rt. 11 (36, 37). Although it is not likely that the remaining three untested bedrock wells or two additional overburden wells near the intersection are contaminated, investigators hope to test the five wells to confirm that contaminated groundwater has not migrated side-gradient into that area (9, 38).

Groundwater Sampled from Monitoring Wells

Sampling of monitoring wells (MWs) installed into the overburden and bedrock aquifers of the C&A Site and downgradient of the site has taken place from 1984 up to the present. MW concentrations, presented in Tables 3 through 10, have been stratified by location (C&A Site or downgradient), aquifer sampled, (overburden or bedrock) and time period of sampling (1984 to 2003 or 2004 to 2013).

1,1-DCE concentrations detected in all MWs for all time frames were below its CV and therefore can be eliminated as a COC. Chloroethane was detected in only one MW downgradient of the C&A Site at 18 µg/L and in eight MWs on the C&A Site with a maximum detected concentration of 22 µg/L. There are no ATSDR CVs for chloroethane. However, there is an EPA Reference Concentration (RfC) of 10 milligrams per cubic meter (mg/m³) (39). Using route-to-route extrapolation and standard exposure factors, the RfC can be converted to a Reference Dose (RfD) of 2.9 milligrams per kilogram per day (mg/kg/day). The RfD can then be converted to a drinking water equivalent CV of 100,000 µg/l. There is considerable uncertainty introduced by using route-to-route extrapolation because of potential differences in route absorption efficiency and the first-pass effect from oral absorption. However, a comparison of the maximum detected concentration of chloroethane in groundwater of 22 µg/l to the calculated CV indicates that it is highly unlikely that there would be an ingestion hazard from chloroethane in groundwater. Therefore, it will not be considered as a groundwater COC. Toluene, 1,1-DCE, and chloroethane are not considered groundwater COCs and will not be evaluated any further.

For sampling conducted during the 1984 to 2003 time period, the maximum detected concentration of a contaminant is presented in Tables 3, 5, 7, and 9 for each monitoring well (MW) because of a combination of elevated detection limits or detection limits not given in historical documents. For the 2004 to 2013 time period, the maximum detected concentration for each MW is presented in Tables 4, 6, 8, and 10 if there were less than 10 samples or if there were less than four samples above the detection limit. For MWs with at least 10 samples and with at least four of them above the detection limit, the most appropriate 95th percentile upper confidence limit of the mean is presented in the Tables using EPA statistical software program ProUCL 5.0.00 to calculate them (40). MW contaminant concentrations chosen as exposure point concentrations (EPCs) are presented in Table 17b.

Historically, there were very high contaminant concentrations detected in some C&A Site overburden MWs with the highest EPCs between 1984 to 2003 of 13,000; 2,200; 6,800; and 8,820 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride, respectively. Maximum detected concentrations in the C&A Site overburden wells for the 2004 to 2013 time period are lower than the earlier period but remain above CVs at 1,096; 168; 560; and 194 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride maximum detected concentrations, respectively.

In the C&A Site bedrock MWs sampled during the 1984 to 2003 time period, the concentrations for PCE, TCE, cis-1,2-DCE, and vinyl chloride exceeded their CVs at concentrations of 2,000; 1,300; 1,400; and 430 µg/L, respectively. Several additional bedrock MWs have since been installed on the C&A Site. High contaminant concentrations have been detected in bedrock during the more recent time period including maximum detected concentrations of 17,000; 2,600; 1,200; and 140 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride, respectively. PCE maximum concentrations in five bedrock MW samples exceed 2,000 µg/L, PCE's 1% effective solubility value in water, indicating its possible presence in bedrock groundwater as DNAPL. A DNAPL source in groundwater can take from between several decades to hundreds of years to completely dissolve as a result of natural groundwater flow (24).

C&A Site-related contamination migrated into the downgradient overburden aquifer during the 1984 to 2003 time period exceeding CVs with maximum concentrations of 450; 180; 270; and 73 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride, respectively. Contaminant concentrations in downgradient overburden groundwater have remained elevated into the 2004-2013 time period with maximum detected concentrations of 316; 55; 89; and 9 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride, respectively.

Some contaminant concentrations detected in the downgradient bedrock aquifer exceeded CVs in the 1984 to 2003 time period with maximum EPCs of 600; 210; and 190 µg/L for PCE, TCE, and cis-1,2-DCE, respectively. Contaminant concentrations in the downgradient bedrock aquifer continue to exceed CVs in the later time period with maximum concentrations of 750; 890; 440; and 20 µg/L for PCE, TCE, cis-1,2-DCE, and vinyl chloride, respectively. COCs exceeding their screening CVs will be evaluated quantitatively to assess their potential to cause adverse health effects from drinking water related exposure.

Soil

In March, 1990, 62 samples from surficial soil and subsurface soil were collected from six potential contaminant source areas (18). They were screened with a photoionization detector (PID) and a gas chromatograph. Thirteen samples with the highest VOC levels and at least one from each of the suspected sources were fully analyzed. The results are presented in Table 12. PCE, TCE, and cis-1,2-DCE from a subsurface sample (3 to 5 ft. depth) collected within one foot of the underground pipelines that carried the chemicals from the former ASTs into the Plant exceeded their respective soil CVs (18). CVs were not exceeded in the one surface soil sample analyzed.

In August 2008, to investigate soils for contaminant sources beneath and exterior to the Plant building, several surface and subsurface soil samples were collected (14). Based on PID readings and to cover all investigated areas, ten samples were selected to be analyzed for VOCs. Results are presented in Table 13. PCE, TCE, and cis-1,2-DCE were detected in some of the samples including one near the surface between 0.7 and 2.7 feet deep that was analyzed; none of them exceeded CVs. Based on the sample results, the consultants concluded that active contaminant sources were no longer present in the areas under investigation (14).

Surface Water

During a C&A Site visit on September 26, 1983, State personnel collected samples from a C&A Site brook and culverts that ultimately flow across Rt. 11 into the wetlands and PMSB (22). PCE and methylene chloride, chemicals that were used at the Plant, and environmental breakdown products of PCE, 1,1-DCA, trans-1,2-DCE, and TCE, were detected in some of the samples. Results are presented in Table 14. Between 1984 and 1990, surface water from the Cocheco River was sampled several times as part of investigations of the Cardinal Landfill. Maximum concentrations of PCE, TCE, 1,2-DCE (total), and vinyl chloride detected were 120, 25, 20.8, and 6.1 µg/L, respectively (29). It cannot be determined if the source of the Cocheco River contamination is the C&A Site, the Cardinal Landfill, or a combination of the two. The surface water data was collected at least 25 years ago and there were no sediment or fish samples taken for this investigation. Therefore, surface water, sediment, and fish exposure pathways cannot be evaluated unless samples are taken.

Indoor Air

On June 12, and October 30, 2008, indoor air samples were collected from several locations in the former Plant (27, 28). The tenants at that time did not use the COCs in their businesses. Samples were collected for 24 hours with summa canisters and analyzed with EPA Method TO-15 SIM. Results are presented in Table 15. Site-related contaminants did not exceed NH DES Commercial Indoor Air Screening Levels (41). TCE slightly exceeded its CV in three locations during the first sample event, but not the second. HVAC adjustments were made to provide more fresh air to the building before the second sample event. The ATSDR air CV exceeded, a CREG, is based on a residential exposure scenario. However, the TCE concentrations were below the NH DES indoor air screening level derived to be protective for an occupational exposure frequency. The building was last occupied in October 2008, so indoor air sampling was not conducted after that date. EHP does not believe that the VI exposures to these tenants indicate what the VI exposures to the C&A workers might have been because the overburden groundwater maximum contaminant concentrations from MWs in the former building footprint are much lower in the 2004-2013 time frame compared to the 1984-2003 time frame. For example, the sum of the maximum detected concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride in five MWs (MW401 through MW405, located within the former building footprint) in the 1984-2003 time frame were 1,994; 1,122; 7,823; and 5,399 µg/L, respectively. The sum of the maximum detected concentrations for PCE, TCE, cis-1,2-DCE, and vinyl chloride in the same five MWs in the 2004-2013 time frame were 515; 95; 1,085; and 139 µg/L, respectively.

NH DES has established screening values for contaminants in groundwater above which migration of vapors into buildings may present a health concern (42). The DES Groundwater-2 (GW-2) values for the contaminants of concern are presented in Table 16. For non-petroleum contaminants, groundwater located within 100 feet vertically or horizontally of a structure may be a potential source of vapor contamination (42). Several of the overburden wells, located in the former Plant footprint or in the vicinity of the former Plant building, have contaminant EPCs that exceed their GW-2 values. For example, the highest concentrations for samples collected between 2004 to 2013 from overburden wells either beneath the footprint of the former Plant or within 100 feet horizontally of it are 997 ppb, 168 ppb, and 47 ppb, for PCE, TCE, and vinyl chloride, respectively. Corresponding GW-2 values are 240, 20, and 4 ppb, respectively. Although indoor air concentrations measured in 2008 indoor air sampling were below CVs for worker exposure, the potential for VI at concentrations of health concern cannot be discounted because of the high contaminant concentrations detected in groundwater.

Exposure Pathways

To determine whether exposure to C&A Site-related contaminants has occurred or could occur, the five elements that comprise an exposure pathway were considered: a contaminant source, transport through an environmental medium, an exposure point, exposure route(s), and an exposed population. Exposure pathways are complete if the five elements exist to indicate that an exposure has occurred in the past, is occurring in the present, or will occur in the future. If an element of an exposure pathway is absent for past or current exposure, but may occur in the future, or data are not available to determine if the pathway is complete, then it is a potential exposure pathway. Exposure pathways can be eliminated as a source of exposure if at least one of the five elements is missing and will never be present. Table 17A summarizes the exposure pathways at the C&A Site where at least one of the five elements is present to identify pathways that are considered either complete or potential and those that can be eliminated from further consideration.

Farmington Public Water Users

Farmington Residents:

This is a completed past exposure pathway. Some Farmington residents were exposed to contaminated drinking water from well GP-2. It is not known when GP-2 was first contaminated, since there were no well samples collected prior to August, 1983 (9). Because GP-2 was blended in the Town water supply only in times of high water demand, contaminant exposure would have been sporadic in nature and diluted by uncontaminated water (7). Exposure ceased in August 1983, when the Town stopped supplementing the Town water supply with water from GP-2 (8). There are no current exposures. Future exposure from a contaminated public well is unlikely because the Town has installed several new wells at locations distant from the current contaminant plume and any likely future migration of contaminated groundwater.

Former C&A Site Workers:

This is a completed past exposure pathway. Well GP-2 was the C&A Site's water supply since 1966, when the Plant began operations. According to a 1988 Report, C&A Site groundwater migrates off-site at a rate of 1.31 feet/day (16). With GP-2 approximately 3,696 feet (0.7 mile) from the C&A Site, it would take about 7.7 years for groundwater from the C&A Site to reach the well. There is no water analysis data for GP-2 prior to August, 1983. GP-2 served as the Plant water source until three C&A Site wells installed in a location upgradient to groundwater contaminant migration began operating in June 1984 (9). A former Plant employee and a former contractor have reported that approximately 1,200 to 1,400 employees worked at the Plant in 1983 (43). Contamination has never been detected in the C&A Site wells installed in 1984. The C&A Site is currently vacant; future exposure from drinking water is not anticipated if the property is re-occupied because of the existence of the site water supply wells located at the southern edge of the C&A Site, in the opposite direction of the flow of contaminated groundwater.

Farmington Private Well Water Users

Samples from four residential wells downgradient of the C&A Site and very close to Well GP-2 were collected between 1984 and 1990. Private well results are presented in Table 2.

This exposure pathway was completed in the past. No contamination was detected in one well. Levels of contaminants below CVs were detected in two of the wells. PCE in the Resident #1 well exceeded its current drinking water standard in all four samples with a maximum detected concentration of 9.2 µg/L, but is below its CREG and EMEG. PCE toxicity was reassessed by EPA in 2012. The recent evaluation reduced PCE's cancer potency and the dose at which non-cancer health effects would be of concern increased. TCE was detected at a trace concentration, meaning it is present below its detection limit of 5 µg/L, but cannot be quantified. The TCE in the water is below its EMEG, but we are unable to determine whether TCE exceeded its CREG of 0.76 µg/L. Resident #1 and one other property was connected to the public water system. EHP was unable to locate records indicating whether the other two well owners were offered connection to public water.

In response to very high contaminant concentrations (PCE ranging up to 17,000 µg/L) detected in bedrock monitoring well SH-8 in the NE portion of the site, two bedrock residential wells within 2,500 feet of SH-8 were sampled in September 2012. VOCs associated with the C&A Site were not detected in the wells located on Rt. 11 near the intersection with Rt. 153 (36, 37). Based on years of groundwater monitoring well results and hydrogeological knowledge gained from previous investigations, the current Conceptual Site Model depicts the limits of groundwater contamination (zero contaminant concentrations) at greater than 800 feet side-gradient from the nearest existing private well. Therefore, DES does not expect existing private wells are currently contaminated or at risk of becoming contaminated (9, 31). However, should future groundwater investigations indicate otherwise, the private wells (five bedrock, two overburden) at the intersections of Rts. 11 and 153 will be sampled (31).

Future additional residential property in the area of contaminated groundwater is not likely because of the Town's plans for commercial development along Rt. 11 and the designation of a portion of it as an Economic Revitalization Zone (ERZ) (44, 45). Institutional controls are in place until 2020 in the downgradient 150-acre Parcel A to prevent installation of new wells serving a business, where there is a known contaminated groundwater plume (30). However, worker exposure to a private well via contaminated groundwater is a potential future exposure pathway should groundwater use restrictions not be renewed.

Surface Soil

Former Workers:

During the time the Plant was operating, almost all the soil on the contaminated portion of the C&A Site was covered by the building or asphalt; therefore, past worker exposure to contaminated surface soil is eliminated as an exposure pathway.

Site Trespassers:

The C&A Site is currently vacant. But the business in the subdivided warehouse portion of the former C&A Site has an easement to cross the site property from a front entrance and the site is not fenced (9). The concrete floor of the former building is intact, but the asphalt pavement of the roads and walkways on the site has been cracking over time (9). Some limited trespasser soil exposure is currently possible and the potential for soil exposure by trespassers will increase in the future as pavement deterioration continues until the C&A Site is reused. This is a potential future exposure pathway.

Indoor Air

Former C&A Workers:

No indoor air samples were collected from the Plant during its operations by C&A or its predecessors. Because maximum EPCs for the 1984 to 2004 time period in C&A Site MWs within 100 ft. horizontally of the former Plant building are 12,000; 1,800; 6,800; and 8,820 µg/L for PCE, TCE, cis-1,2-DCE and vinyl chloride, respectively, vapor migration from groundwater to Plant indoor air would be considered as a potential past exposure pathway.

Indoor air samples collected on two dates in 2008 with post-C&A building tenants had slight exceedances of the TCE CV in the first sample event, but were below the CV in the second event. Results are presented in Table 15. However, because maximum detected concentrations for the 2004 to 2013 time period in C&A Site overburden MWs within 100 ft. horizontally of the former Plant building are 997, 168, 476, and 43 µg/L for PCE, TCE, and vinyl chloride, respectively, vapor migration from groundwater to the indoor air of a building would be considered as a potential future exposure pathway should the C&A Site be re-occupied by a business that constructs a building for human occupancy. This is a potential future exposure pathway. Should a commercial building be constructed over the contaminant plume downgradient of the site, vapor migration into the building could also be a potential future exposure pathway since maximum overburden groundwater concentrations for PCE, TCE, and vinyl chloride are 316, 55, and 9 µg/L for PCE, TCE, and vinyl chloride, respectively.

Surface Water

Recreational Users:

The Cocheco in Farmington has a public launch area for non-motorized watercraft. It is also considered a good fishing spot because several native fish species favored by anglers are plentiful and it has been stocked with brook trout in Farmington annually for the past several years (46). Groundwater modeling conducted by the United States Geological Survey (USGS) predicted that overburden groundwater in the aquifer beneath and downgradient of the C&A Site could discharge to the PMSB and Cocheco River (47). Recreators in the wetlands, PMSB, and Cocheco River could have potentially been exposed to contaminated surface water in the past, could be currently exposed, and may be exposed in the future. C&A Site-related contaminants were detected in the Cocheco River surface water between 1984 and 1990. The source(s) cannot be determined because other cVOC contaminated sites abut the Cocheco.

The four groundwater COCs have moderate to high volatility in water, estimated half-lives in moving water of 2 to 4 hours, and their adsorption to sediments is classified as weak to moderate (48). Table 19 summarizes contaminant chemical and physical properties that influence bioaccumulation in media and therefore, exposure potential for surface water, sediment, and fish recreators could have potentially been exposed to contaminated surface water in the past, may be exposed in the present, and into the future

Sediment

Recreational Users:

Recreators in the wetlands, PMSB, and Cocheco River could have potentially been exposed to contaminated sediment in the past, could be currently exposed, and may be exposed in the future. No sediment has ever been collected for analysis.

Fish

Anglers and Family:

Anglers and their family consuming fish from the PMSB and Cocheco River could have potentially been exposed to contaminated fish in the past, could be currently exposed, and may be exposed in the future.

Based on both measured and estimated bioconcentration factors (BCFs) for cis-1,2-DCE, TCE, and vinyl chloride in fish, the potential for bioconcentration is considered to be generally low to moderate, with only the maximum end of one BCF range for PCE reaching a high potential (49, 50).

EPA has developed National Ambient Water Quality Criteria (AWQC) for health protection applicable to surface water used for both drinking water and consumption of organisms or consumption of organisms only (51). The last update was May 17, 2002. Calculating AWQCs for consumption of organisms only, using EPA methodology and the most recent toxicity values from its Integrated Risk Information System (IRIS), results in AWQCs for PCE, TCE, and vinyl chloride of 62, 8.2, and 4.7 µg/L, which will be protective for those who consume fish (39). EHP used the Cancer Slope Factor (CSF) for adult exposure to vinyl chloride to calculate its AWQC rather than the CSF for exposure from birth because adults would more likely be regular consumers of recreationally-caught fish than children. The updated AWQCs EHP has calculated can be used as Comparison Values for surface water sampling results. Because of likely groundwater contamination discharging into the PMSB, which flows into the Cocheco, consumption of contaminated fish is a potential past, present, and future exposure pathway.

Public Health Implications of Exposure

Maximum detected concentrations for PCE, TCE, cis-1,2-DCE, and vinyl chloride in several groundwater MWs exceed their CVs. However, exceedance of CVs does not mean that adverse health effects will occur or are even likely to occur. See Appendix B for additional information about CVs. Contaminants that exceed CVs are evaluated in greater detail. The potential for those who are exposed to experience adverse health effects depends upon several factors, including:

- Amount of each chemical to which a person is exposed;
- Length of the exposure;
- Route of exposure;
- Health and nutritional status of an exposed person;
- Susceptibility due to inherited factors (genetics);
- Exposure to substances unrelated to the site.

Please refer to Appendix D for health effects information about the contaminants of concern.

Calculations of Excess Lifetime Cancer Risk and Noncancer Hazard for Drinking Water Ingestion Exposures

Past Exposure to C&A Employees

To calculate employee risk for exposure in the past when GP-2 was the water supply, EHP is assuming an exposure duration of 10 years and the maximum detected concentration of each contaminant detected in GP-2 until mid-1984 as the EPCs. Additional exposure factors used to calculate carcinogenic and noncancer risk are an ingestion rate of 0.614 liter/day (L/day) of water for a typical exposed worker (central tendency exposure or CTE) and 1.546 L/day for a highly exposed worker (reasonable maximum exposure or RME), each for 250 days per year. Drinking water exposure from dermal and inhalation exposure routes are not considered significant for workers since they did not shower with the water.

Contaminant drinking water doses are presented in Table 18A while ELCRs and HQs for CTE and RME workers are in Table 18B. The ELCR for the RME worker was $3.6E-8$ (3.6 in 100 million), a risk so minimal that we consider C&A employees to have no expected increased risk of cancer from their past drinking water exposure. HQs for an RME worker were 0.02 and 0.03 for PCE and TCE, respectively, below an HQ of concern of above 1.0. Therefore, non-cancer adverse health effects would not be anticipated for past C&A worker exposure. Appendix E contains assumptions and equations used to calculate risks as well as example calculations.

Past Exposure from a Private Well - Resident #1

The most highly contaminated private well (Resident #1) was located very close to GP-2. Exposure is assumed to have begun no earlier than 1974 and ceased in July 1985 when the home was connected to public water. The results for Resident #1's well are presented in Table 2. The maximum detected concentration of PCE is below the CREG of $17 \mu\text{g/L}$, which is derived based on a $1E-6$ (1 in one million) ELCR and also below its child EMEG of $80 \mu\text{g/L}$ for non-cancer health effects. TCE was detected in the drinking water at less than its detection limit of $5 \mu\text{g/L}$, equal to its child EMEG of $5 \mu\text{g/L}$. Although we cannot determine if TCE's CREG of $0.76 \mu\text{g/L}$ was exceeded, the maximum detected concentration of TCE in public well GP-2 was $1 \mu\text{g/L}$ during the time period before Resident #1 was connected to public water. See Table 1 for GP-2 results. Resident #1's well is located at about the same distance as GP-2 from the C&A Site but more side-gradient to the groundwater migration path of the contaminant plume. It is likely that the actual TCE concentration in Resident #1's well would be similar to that of GP-2. With PCE below its EMEG and TCE possibly equal to its EMEG, non-cancer adverse health effects are not anticipated. A total ELCR for Resident #1 cannot be precisely determined because the actual TCE concentration is not known. Based on a comparison of TCE's maximum possible concentration to its CREG, the total ELCR for PCE and TCE would be no higher than about $7E-6$ (seven in one million), a low risk.

Future Exposure to Workers at a Business Located on the Downgradient Property

Commercial or recreational development only is planned by the Town for the property downgradient of the C&A Site after remediation occurs and a substantial portion of the property has been designated as an Economic Revitalization Zone (ERZ), so potential future residential exposure to contaminated groundwater is considered highly unlikely (44,45). In the event current deed restrictions on groundwater use are not renewed, we have evaluated potential worker exposure to contaminated drinking water should a business install a well for potable use by comparing maximum detected contaminant concentrations in the downgradient bedrock aquifer during the 2004 to 21013 time frame (Table 10) to drinking water CVs

(Table 11). Maximum detected concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride of 750, 890, 440, and 20 $\mu\text{g/L}$, respectively each exceed their CVs. Although used as exposure point concentrations (EPCs), maximum detected groundwater concentrations will not represent actual drinking water intakes over time and the CVs used for comparison are derived based on residential, not worker exposure assumptions. Therefore, the differences seen in the comparison between EPCs and CVs is overstated. However, contaminant concentrations in drinking water from the potential future aquifer are likely to exceed CVs. Hypothetical future worker exposure to drinking water could result in elevated cancer risks and the potential for non-cancer adverse health effects. Therefore, EHP recommends that the untreated water from the aquifer underneath this downgradient property not be considered for a potable water supply should deed restrictions not be renewed when they expire in the year 2020.

Water ingestion exposure doses, cancer risk, and noncancer hazard calculated for the past C&A employees are presented in Table 18A and 18B. For former C&A workers (who drank from well GP-2 for up to 10 years until June 1984), the sum of ECLRs for PCE and TCE ranges from $1.4\text{E-}8$ (1.4 in 100 million) for a typically exposed worker to $3.6\text{E-}8$ (3.6 in 100 million) for a highly exposed worker, which are very low risks. The highest PCE dose to these workers was $1.19\text{E-}4$ mg/kg/day. The highest TCE dose was $1.3\text{E-}5$ mg/kg/day. These RME doses are less than the MRLS of $8\text{E-}3$ and $5\text{E-}4$ mg/kg/day for PCE and TCE, respectively. HQs are also well below the HQ level of concern of 1.0 for both typical and high-end exposed workers.

Child Health Considerations

In communities with environmental contamination issues, the differences between children and adults can result in differences in exposure. Children are at greater risk from certain types of exposures. Because children are shorter than adults, they breathe soil, dust, and vapors closer to the ground. Their lower body weight and higher intake rate for air and water results in a greater contaminant dose per unit of body weight. Children may be at greater risk for certain adverse health effects because of their growing and developing bodies. Finally, children depend upon adults to get their needs met, which include protection from excessive environmental exposures.

Of the C&A Site contaminants, TCE exposure to a fetus and children is of greatest concern (50). The developing fetus is a sensitive subpopulation. The fetus as a sensitive population to TCE exposure has been shown in both animal and human (epidemiology) studies. In particular, if high enough exposure to TCE occurs during the first trimester of pregnancy, during which time the heart develops, the fetus may be at greater risk for heart defects. Additionally, because kidney cancer caused by TCE exposure and all cancers caused by vinyl chloride exposure occur via a mutagenic mode of action, children have an increased cancer risk compared to adults when exposed to TCE and vinyl chloride (52, 53).

Conclusions

EHP evaluated past, current, and potential future exposure to cVOCs in multiple media originating from the C&A site. We reviewed sampling data and past environmental investigation reports to assist us in forming our conclusions. Groundwater data reveals that contaminants have moved off of the C&A Site property. Sampling data for surface soil, off-site surface water, sediment, and fish are very old or lacking so that current and potential future exposure to those media are difficult to assess. We reached the following conclusions for each exposure medium:

1. EHP concludes that there was no harm to past C&A workers' health from drinking the contaminated public water supply. No current or future harm to Farmington public water users' health from this source is expected. The past workers cancer risk from drinking the water is less than 1 in 10 million and no non-cancer health effects are expected. The contaminated Farmington public well serving the Plant was shut down in 1984. The Town has installed several new wells in locations safe from the contaminated groundwater and the direction of its flow. The C&A Site is currently vacant, with no active water supply wells. Future users of the C&A Site would either have water supply wells installed in a location not likely to draw from the contaminant plume, a water treatment system could be installed to remove contaminants, or the Town public water supply could be extended to the C&A Site, if necessary.
2. We conclude that past residents' health was not harmed by using their contaminated private wells. Currently, no private wells are located in the area of known groundwater contamination and, in the future, new private wells will not be installed in the area with contaminated groundwater due to the combination of deed restrictions and continuing ownership of this property by the Town. High detection limits for one contaminant do not allow us to evaluate cancer risk for a past resident. However, assuming the contaminant is present at the detection limit, the past residents' cancer risk could be no greater than 7 in one million and non-cancer health effects are unlikely. Through investigations to determine where contaminated groundwater is located with test (monitor) wells, visits to the C&A Site area, and examination of Town records, no property owners in the area of *known* contaminated groundwater are using private wells. Contaminants were not found in the few active private wells tested in 2012 that are located closest to the C&A Site. Based on years of groundwater testing results, investigations of groundwater movement direction, and knowledge of the soil and bedrock in the C&A Site area, the edge of contaminated groundwater is located more than 800 feet to the western side of the nearest private well. In the future, new private wells are not likely to be installed in the area with contaminated groundwater because that area has deed restrictions that do not allow groundwater use or the property is owned by the Town.
3. In the future, if workers on properties in the path of groundwater flow from the C&A Site that drink contaminated groundwater from new private wells they will increase the chance of harm to their health. Use of the groundwater in the currently contaminated areas in the groundwater flow path is prohibited by deed restriction until 2020. The deed restriction on an additional area of land that includes former contaminated Town well GP-2 expired in 2015. The area with the expired deed restriction is owned by the Town. They have subdivided it and are offering one parcel for sale. Business owners of these properties could install private wells instead of connecting to the Town public water supply if the deed restrictions on groundwater use are not renewed after 2020. Although the maximum detected contaminant levels found in the groundwater are much higher

than what hypothetical future workers would actually consume over a long time period, the most recent historical contaminant levels are substantially above drinking water health screening values.

4. EHP concludes that C&A Site trespassers currently coming in contact with soil are not likely to harm their health. But we cannot determine if future trespasser soil contact will be harmful to their health. Soil sampling has found only low amounts of contaminants in surface soil and most of the contaminated soil is covered by asphalt and the former building foundation. If the C&A site sits vacant for a substantial period and the existing asphalt and concrete foundation falls apart, coming in contact with soil is more likely as the asphalt areas continue to crack and deteriorate. However, we cannot determine if this will increase the chance of harm because there are only a few surface soil samples beneath asphalt or the building foundation. Sampling of some additional surface soil areas under the asphalt could provide added confidence that soil contact is not a concern.
5. We cannot conclude whether workers breathing in chemicals in the air inside the C&A plant in the past could have harmed their health or whether future workers could harm their health by breathing the indoor air of a new building on the C&A Site. There are currently no standing buildings on the C&A Site. In the past, there were high amounts of chemicals in groundwater beneath the C&A plant, some of which may have turned into a gas and moved through cracks and utility openings into the building. However, there were no indoor air samples taken during the time that C&A was manufacturing automobile parts. Indoor air samples taken in 2008 when tenants occupied the building detected some contaminants, but they were not a health concern at the levels the workers breathed. We don't believe the contaminant levels in the 2008 air sample results can be applied to the levels breathed in by workers many years ago because maximum detected contaminant concentrations in groundwater from several wells within the former building footprint have gone down by 74 to 97% depending on the chemical. Although contaminant concentrations in groundwater have gone down, the amounts of chemicals remaining in groundwater at the C&A Site are still a potential health concern because they exceed State of New Hampshire health screening values for groundwater contaminants turning into a vapor and moving from groundwater into building air. Should a business put up a building, we are concerned about future workers breathing in vaporized contaminants that have moved from groundwater. EHP has similar concerns for vapor intrusion should a commercial building be constructed in the future over the contaminated groundwater plume located downgradient of the site.
6. EHP cannot conclude whether people wading or swimming in the PMSB and Cocheco River, enjoying other recreational activities, or eating fish caught in these waterbodies could in the past, currently, or in the future, be harmed by chemicals in the surface water, sediment, or fish. We cannot be certain of the contaminant levels in these water bodies because limited surface water and fish samples were last taken more than 25 years ago and sediment samples were never taken. Environmental models predict that some polluted groundwater from the C&A Site ends up in the PMSB and Cocheco River. There are large amounts of water in these water bodies that would dilute the groundwater contaminants and the contaminants in moving water will tend to evaporate into the air. So, it would take very high contaminant concentrations in the groundwater for them to build up in surface water and sediment at levels that would cause harm. Most of the contaminants found in the groundwater are not the kind that is likely to build up in fish. However, because only a few fish samples from the Cocheco River were collected before 1990 for the investigation of a different site, we cannot be certain whether contaminants could get into fish at levels that would cause harm to the health of recreational fisherman and their families that consume them.

Recommendations

Through this PHA and other evaluations as needed, public meetings, and fact sheets, EHP will make the public aware of the existence of the C&A Site and actual and potential exposure risks from C&A Site-related contaminants. EHP will address any health-related questions and concerns related to this site.

We make the following recommendations at this time:

1. To ensure that groundwater exposure as drinking water does not occur in the future, EHP recommends that the Town adopt or renew Institutional Controls (ICs) on parcels of land in the area of contaminated groundwater to prevent installation of wells. Deed restrictions on one area owned by the Town have expired. Deed restrictions on a second area, beneath which several contaminants in groundwater have been repeatedly detected above standards, remain in effect until 2020.
2. Until the site is restored and re-used, EHP recommends surface soil sampling to determine if there is a health concern for direct contact exposure. We recommend fencing to limit trespasser exposure for any areas that sampling demonstrates to be of concern.
3. EHP will recommend to the C&A Site regulators that groundwater sampling be included in any C&A site reuse plan or on new businesses in downgradient properties that include an office or industrial building. If the contaminant concentrations are above screening values established for protecting against harm from chemicals in groundwater moving into indoor air (known as DES Groundwater-2 Screening Values), then restrictions would be put into place limiting reuse and/or requiring vapor mitigation systems in new buildings. This determination would be made before any plans are finalized for reuse and new building construction.
4. EHP will recommend that surface water and sediment samples be collected in future investigations to determine if harmful chemical levels are present.
5. EHP will recommend that the results of surface water and sediment samples be used to determine whether fish might have built up harmful levels of chemicals and so should also be tested. If necessary, fish can be tested as part of a future investigation.

Public Health Action Plan

The Public Health Action Plan (PHAP) for this Public Health Assessment describes the actions taken or planned for the C&A Site. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but provides a plan of action designed to prevent or mitigate adverse human health effects that could result from future exposure to contaminants. EHP is committed to following-up on this plan and to assist in its implementation. As needed, EHP will revise this PHAP by identifying completed actions and those in progress. Public health actions already taken or to be implemented are as follows:

Actions Completed:

A contaminated Farmington public well was shut down.

Some contaminated residential wells were connected to the Town public water system.

Use of the groundwater in the currently contaminated areas in the groundwater flow path is prohibited by deed restriction until 2020. The deed restriction on an additional area of land that includes former contaminated Town well GP-2 expired in 2015.

Residential bedrock wells were sampled that are closest to the location on the C&A Site where the highest contaminant concentrations were detected in bedrock groundwater monitoring wells. No contaminants were detected in the two wells sampled.

For several years, groundwater beneath the C&A Site was treated and returned to the aquifer in an effort to minimize migration of contaminated groundwater beyond C&A Site boundaries.

EHP submitted the PHA for public comment. During the public comment period (July 5 – August 5, 2016) for this PHA, no public comments were received.

Actions Planned:

EHP will publicize and disseminate this PHA to make the community aware of how they might have been exposed, may be currently exposed, or could potentially be exposed in the future to C&A Site-related contaminants.

EHP will hold a Public Availability Session to hear and respond to community health concerns.

EHP will coordinate its actions with the DES Hazardous Waste Remediation Bureau and EPA, who became the lead Agency for conducting environmental investigations once the C&A Site was added to the NPL.

EHP will review sampling data gathered from future environmental investigations as it becomes available to evaluate whether there are potential exposure hazards to the community.

EHP will reevaluate and expand the PHAP as needed. New environmental data or the results of implementing the PHAP may warrant actions in addition to those currently anticipated.

Preparers of Report

Report Authors:

David S. Gordon, M.S., Environmental Health Risk Assessor
Dennis Pinski, M.P.H., Supervisor, Environmental Health Program
Environmental Health Program
New Hampshire Department of Environmental Services
P.O. Box 95, 29 Hazen Drive
Concord, New Hampshire 03302
David.Gordon@des.nh.gov
Dennis.Pinski@des.nh.gov

ATSDR Technical Project Officer

Laura H. Frazier, M.S.
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
4770 Buford Highway, NE
Mailstop F-59
Atlanta, Georgia 30341-3717

ATSDR Regional Representative

Tarah S. Somers, RN, MSN/MPH
Regional Director
Agency for Toxic Substances and Disease Registry – Region 1
U.S. Department of Health and Human Services
5 Post Office Square, Suite 1010
Mail Code: ATSDR 10-1
Boston, Massachusetts 02109

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Appendix A - Figures

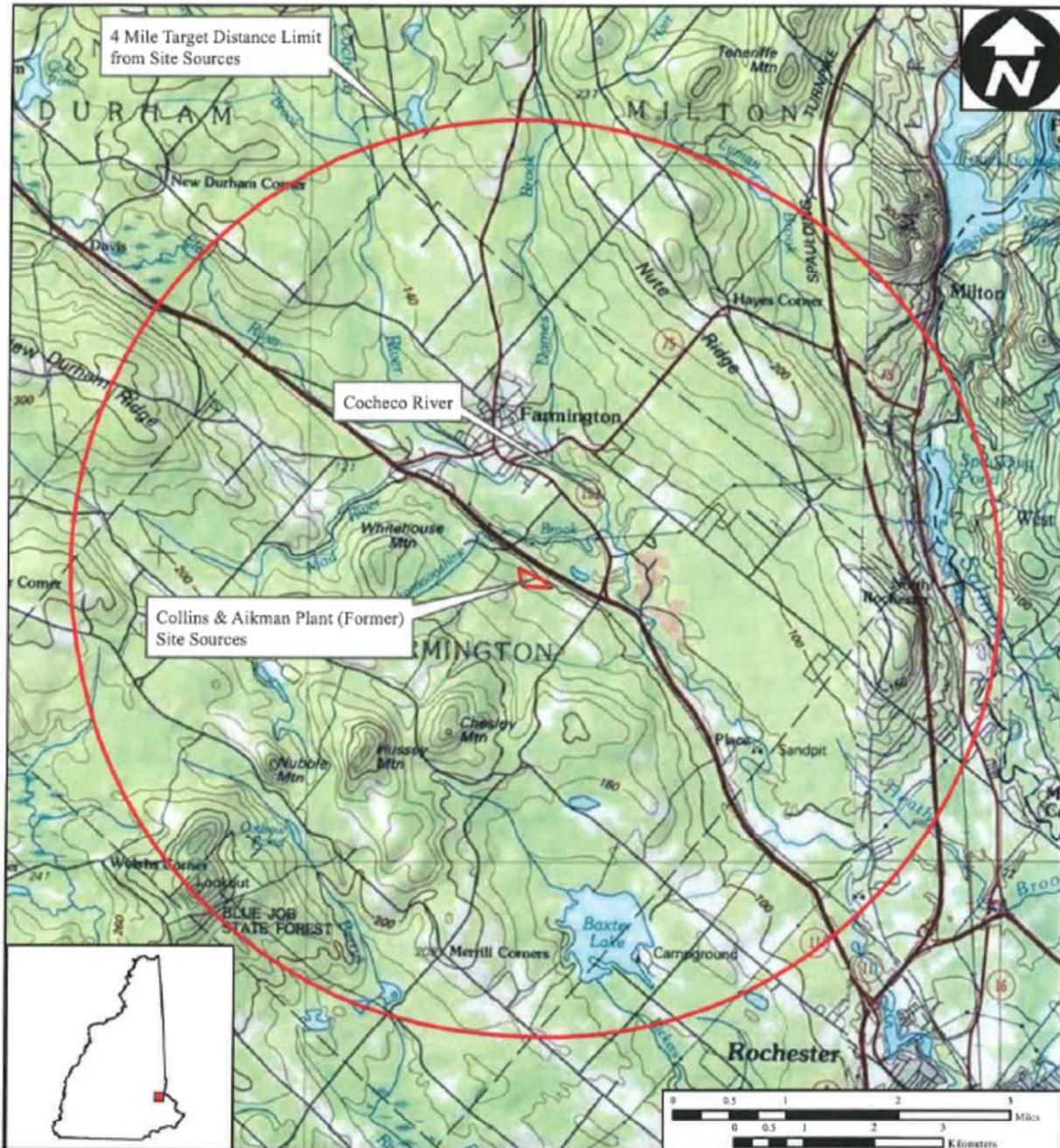
Fig. 1. 4 Mile Target Distance Limit (HRS Figure 5)

Fig. 2. Approximate Monitoring Well and Public Supply Well Location Map (HRS Figure 4)

Fig. 3. Site Features and Exploration Location Plan (SHA Figure 1)

Fig. 4. Location of Areas with Current and Former Institutional Controls to Restrict Groundwater Use

FIG. 1



HRS Figure 5
4 Mile Target Distance Limit
 Collins & Aikman Plant (Former)
 Off Route 11 between Paulson Road
 to the NW and Meetinghouse Hill
 Road to the SE
 Farmington, New Hampshire

EPA Region I
 Superfund Technical Assessment and
 Response Team (START) III
 Contract No. EP-W-05-042
TDD Number: 12-04-0009
Created by: G. Hornok
Created on: 13 February 2013
Modified by: C. Imbres
Modified on: 25 March 2013

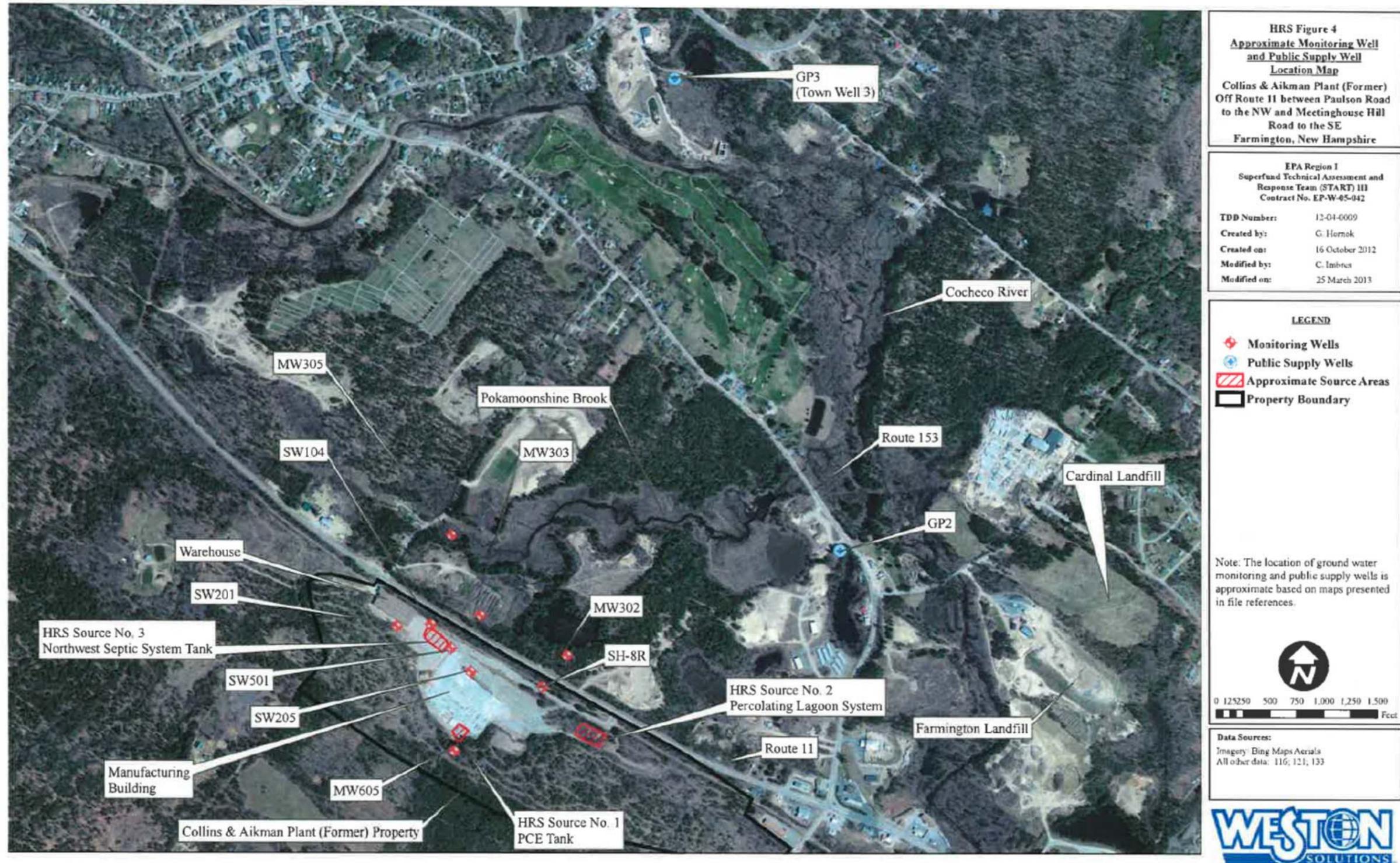
Data Sources:
 Topos: 2011 National Geographic Society
 All other data: 11; 121, p. 41; 210



Collins & Aikman Plant (Former)
 NHN000105928

HRS Documentation Record
 May 2013

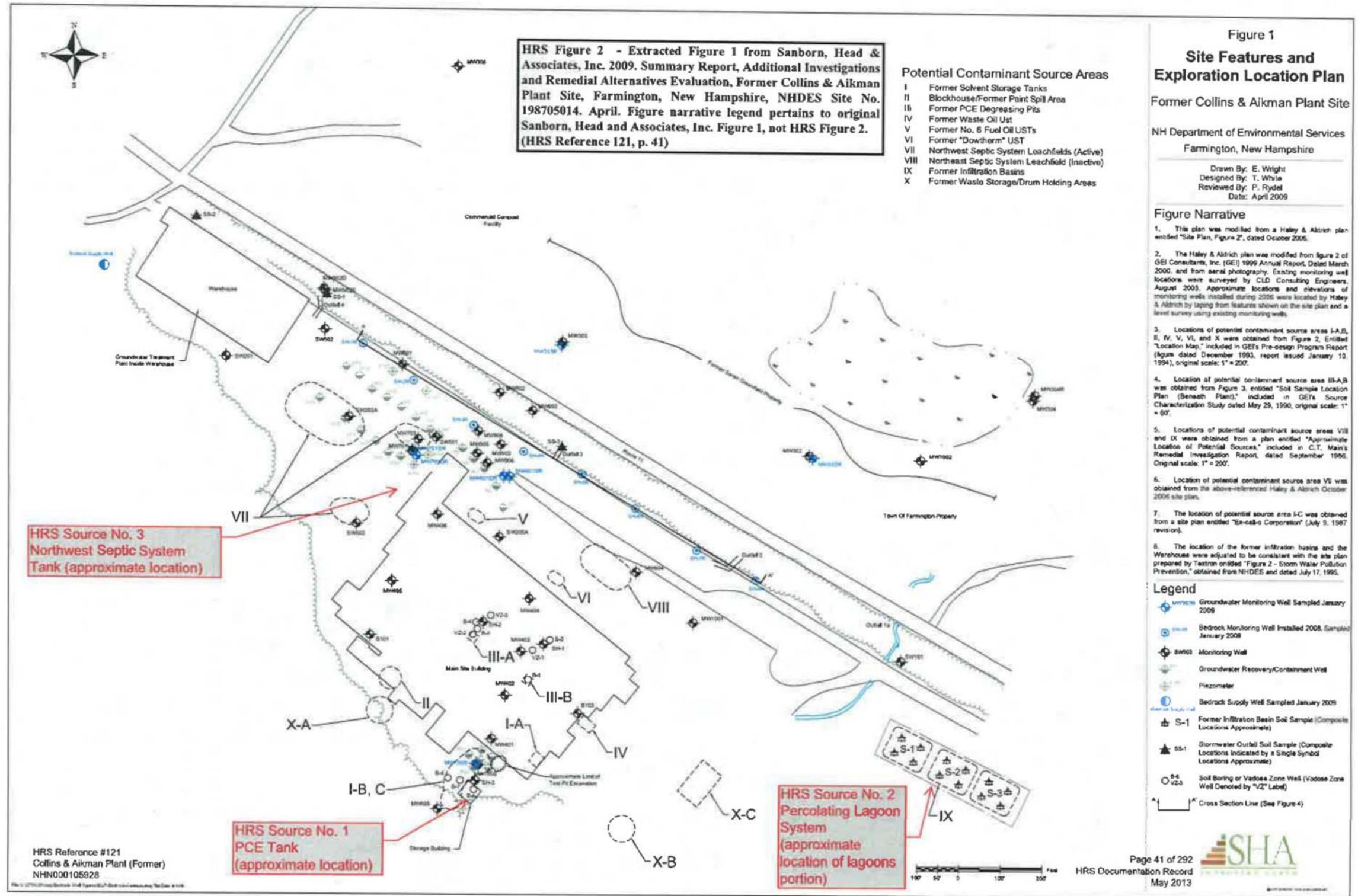
FIG. 2



Collins & Aikman Plant (Former)
NHN000105928

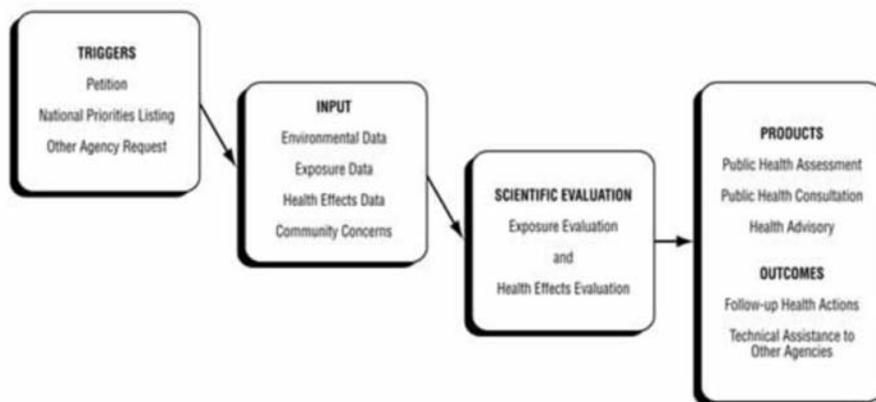
HRS Documentation Record
May 2013

FIG. 3



Appendix B - ATSDR Screening Process

ATSDR has developed a method to evaluate the public health implications of exposures to environmental contamination. This method is called the *public health assessment* process. The public health assessment process serves as a mechanism for identifying appropriate public health actions for particular communities. The process may be triggered by a site's listing on the National Priorities List or a specific request (or petition) from a community member or another government agency. The purpose of the process is to find out whether people have been, are being, or may be exposed to hazardous substances and, if so, whether that exposure is harmful, or potentially harmful, and should therefore be stopped or reduced. The process also serves as a mechanism through which the agency responds to specific community health concerns related to hazardous waste sites. The following diagram summarized the ATSDR screening process (54):



The public health assessment process involves two primary scientific evaluations—the exposure evaluation and the health effects evaluation (ATSDR, 2005).

- **Exposure Evaluation:** ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by federal and state government agencies and/or their contractors, potentially responsible parties, and the public. When adequate environmental or exposure information is not available to evaluate exposure, ATSDR will indicate what further environmental sampling may be needed and may collect environmental and biologic samples when appropriate.
- **Health Effects Evaluation:** If the exposure evaluation shows that people have or could come into contact with hazardous substances, ATSDR evaluates whether this contact may result in harmful effects. ATSDR uses existing scientific information, which can include the results of medical, toxicological, and epidemiologic studies and data collected in disease registries, to determine what health effects may result from exposures.

The public health assessment process enables ATSDR to prioritize and identify additional steps needed to answer public health questions. Public health assessments are conducted by agency health assessors, often supported by a multi-disciplinary team of scientists, health communication specialists, health educators, and/or medical professionals. ATSDR solicits and evaluates information from local, state, tribal, and other federal agencies; parties responsible for operating or cleaning up a particular site; and the community. All of these stakeholders play an integral role in the public health assessment process. For completed or potential exposure pathways identified in the exposure pathway evaluation, the screening analysis may involve (ATSDR, 2005):

- Comparing media concentrations at points of exposure to health-based "screening" values (based on protective default exposure assumptions). These Comparison Values (CVs) are chemical and media-specific concentrations in air, soil, and drinking water that are used to identify environmental contaminants at hazardous waste sites that require further evaluation.
- Estimating exposure doses based on site-specific exposure conditions to compare against health-based guidelines.
- For those pathways and substances identified in the screening analysis as requiring more careful consideration, a host of factors assist in determining whether site-specific exposures are likely to result in illness and whether a public health response is needed. Exposures are studied in conjunction with substance-specific toxicological, medical, and epidemiologic data.
- Based on available exposure, toxicological, epidemiologic, medical, and site-specific health outcome data, are adverse health effects likely in the community? In this step potential health impacts on the general community and impacts of site-specific exposures to any uniquely vulnerable populations (e.g., children, the elderly, women of child-bearing age, fetuses, and lactating mothers) are also reviewed.

Additional information about using Comparison Values (CVs)

When a contaminant is detected at a concentration less than its respective CV, exposure is not expected to result in health effects and it is not considered further as part of the public health assessment process. **It should be noted that contaminants detected at concentrations that exceed their respective CVs, do not necessarily represent a health threat.** Instead, the results of the CV screening identify those contaminants that warrant a more detailed, site-specific evaluation to determine whether health effects may occur.

CVs can be based on either carcinogenic or non-carcinogenic effects. CVs based on cancerous effects account for a lifetime exposure (70 years) with a calculated excess lifetime cancer risk of 1 extra case per 1 million exposed people. When a cancer and non-cancer CV exists for the same chemical, the lower of these values is used in the data comparison for public health protectiveness.

Appendix C - Tables

- Table 1: **Volatile Organic Compounds (VOCs) Detected in Former Farmington Public Well Gravel Pack 2 (GP-2)**
- Table 2: **Volatile Organic Compounds (VOCs) Detected in the Resident 1 Private Well Adjacent to Former Town Well GP-2**
- Table 3: **Maximum Contaminant Concentrations in Overburden Groundwater Wells on Plant Property-1984-2003 Samples**
- Table 4: **Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in Overburden Groundwater Wells on Plant Property-2004-2013 Samples**
- Table 5: **Maximum Contaminant Concentrations in Bedrock Groundwater Wells on Plant Property-1984-2003 Samples**
- Table 6: **Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in Bedrock Groundwater Wells on Plant Property-2004-2013 Samples**
- Table 7: **Maximum Contaminant Concentrations in Overburden Groundwater Wells on the Downgradient Properties-1984-2003 Samples**
- Table 8: **Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in Overburden Groundwater Wells on the Downgradient Properties-2004-2013 Samples**
- Table 9: **Maximum Contaminant Concentrations in Bedrock Groundwater Wells on the Downgradient Properties-1984-2003 Samples**
- Table 10: **Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in Bedrock Groundwater Wells on the Downgradient Properties-2004-2013 Samples**
- Table 11: **ATSDR Drinking Water Comparison Values for Contaminants of Potential Concern**
- Table 12: **Volatile Organic Compounds (VOCs) detected in Soil Samples - Collected March 13-25, 1990**
- Table 13: **Volatile Organic Compounds (VOCs) detected in Soil Samples - Collected August 4 to August 28, 2008**
- Table 14: **Surface Water Samples Collected on the Collins & Aikman Plant Property and Analyzed for Volatile Organic Compounds (VOCs) September 26, 1983**
- Table 15: **Indoor Air Sample Results Collected on June 12 and October 30, 2008 from Former Collin & Aikman Plant Building**

- Table 16: **New Hampshire Department of Environmental Services Method 1 Groundwater Standards - Groundwater 2 Standards for Migration of Vapors to Indoor Air Pathway**
- Table 17A: **Exposure Pathways**
- Table 17B: **Groundwater or Drinking Water Exposure Point Concentrations (EPCs)**
- Table 18A: **Exposure Doses from Drinking Water Ingestion for Past Collins & Aikman Employees**
- Table 18B: **Cancer Risk and Noncancer Hazard from Drinking Water Ingestion for Past Collins & Aikman Employees**
- Table 19: **Contaminant Chemical and Physical Properties Influencing Environmental Migration, Persistence, and Potential for Exposures to Surface Water, Sediment, and Fish**

Table 1
Volatile Organic Compounds (VOCs) Detected in Former Farmington Public Well Gravel Pack 2
(GP-2)
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter ($\mu\text{g/L}$)

Sample Date	PCE	TCE	Trans-1,2-DCE
12/14/83	ND	ND	ND
2/6/84	9	1	3
6/12/84	ND	ND	ND
7/10/84	4	ND	1
1/31/85	TR	TR	ND
7/9/85	8.6	ND	NA
7/9/85	6	ND	3
10/30/85	2	2	TR
11/1/85	4	2	TR
11/4/85	2.3	ND	ND
11/7/85	2	ND	TR
11/8/85	ND	2.5	2
11/11/85	2	ND	2
11/12/85	ND	ND	2
11/13/85	5	ND	3.9
11/14/85	5.2	TR	3.3
2/17/86	TR	ND	TR
4/29/86	ND	ND	ND
4/30/86	ND	ND	TR
6/24/86	ND	ND	TR

Exceeds current Federal Maximum Contaminant Level (MCL). No MCL for PCE existed in 1984 or 1985, but the concentrations exceeded an excess lifetime cancer risk (ELCR) of $1\text{E-}6$, the maximum allowable cancer risk for a substance in New Hampshire groundwater during that time period.

PCE = tetrachloroethylene; TCE = trichloroethylene; trans-1,2-DCE = trans-1,2-dichloroethylene; ND = Not detected; TR = trace = present below the detection limit, but not able to quantify; NA = not analyzed
 Drinking water comparison values for contaminants of potential concern are presented in Table 11.

Table 2
Volatile Organic Compounds (VOCs) Detected in the Resident 1 Private Well Adjacent to Former
Town Well GP-2*
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter ($\mu\text{g/L}$)

Chemical	Date Sampled and Concentrations			
	10/16/84	1/31/85	7/9/85 (DES)	7/9/85 (GEI)
Tetrachloroethylene (PCE)	9.2	6	7.7	5.4
Trichloroethylene (TCE)	ND	TR	ND	ND
Toluene	ND	TR	ND	ND

ND = Not detected; TR = Trace (detected below detection limit of $5\ \mu\text{g/L}$, but unable to quantify)
 DES = NH Dept. Of Environmental Services; GEI = GEI Consultants, Inc.

PCE exceeded a 1980s State Drinking Water Guideline in all samples, which was based on an excess lifetime cancer risk (ELCR) of 1E-6. Resident 1 was connected to Town water on 7/18/85.

*Three other residential wells were sampled between 2 and 5 times between 1984 and 1990 to determine if they were impacted by the Site. Resident 2's well results were ND in the only 2 samples collected. Resident 3's well results were ND in 4 samples except for a TR detection of PCE in 7/85. Resident 4's well results were ND in 5 samples except for TR detections of PCE and toluene in 1/85. Three sample events subsequent to the detections were ND.

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

Table 3
Maximum Contaminant Concentrations in Overburden Groundwater Wells on Plant Property-
1984-2003 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
B101	13,000	15/30	2,200	14/30	840	5/30	4	0/30	ND	NA	59	1/30
B103	780	39/39	99	25/39	27	0/39	ND	0/39	ND	NA	940	39/39
MW105S	12,000	34/41	1,500	35/41	6,800	25/41	11	0/41	ND	NA	1,100	24/41
MW401	1,200	27/31	280	28/31	2,400	11/31	11	0/31	1.0	NA	3,389	31/31
MW402	270	13/35	560	16/35	3,000	22/35	55	0/35	17	NA	900	35/35
MW403	4	0/23	14	7/23	423	12/23	5.2	0/23	13	NA	170	19/23
MW404	130	12/32	98	27/32	800	32/32	29	0/32	12	NA	200	29/32
MW405	390	19/32	170	25/32	1,200	32/32	25	0/32	ND	NA	740	32/32
MW602	160	24/27	31	22/27	28	0/27	6	0/32	ND	NA	ND	0/32
MW603	240	25/27	70	26/27	400	22/27	5	0/27	ND	NA	19	10/27
MW604	2	0/24	9	22/24	150	11/24	2	0/24	3.6	NA	194	24/24
MW701	4,700	9/9	150	9/9	640	9/9	2	0/9	ND	NA	3	1/9
MW801	10	0/1	ND	0/1	ND	0/1	ND	0/1	ND	NA	ND	0/1
SW102	30	6/18	18	9/18	1,300	18/18	6	0/29	8	NA	320	18/18
SW202A	350	13/28	440	15/28	690	9/28	1	0/28	ND	NA	150	7/28
SW203	10	0/14	ND	0/14	30	0/14	TR	0/14	ND	NA	ND	0/14
SW204	ND	0/10	17	1/10	8	0/10	ND	0/10	ND	NA	ND	0/10
SW205/A	6,200	57/57	1,800	57/57	1,300	57/57	5.6	0/57	5	NA	8,820	57/57
SW501	8,700	42/42	350	39/42	630	39/42	6.9	0/42	ND	NA	34	5/42
SW503	1,100	34/41	1,300	38/41	1,300	37/41	19	0/41	ND	NA	3,359	41/41
W20	740	2/5	15	3/5	33	0/5	ND	0/5	ND	NA	ND	0/5
W24	280	4/4	12	¾	ND	0/4	ND	0/4	ND	NA	ND	0/4
MW605	ND	0/16	ND	0/16	ND	0/16	ND	0/16	ND	NA	ND	0/16

CV = Comparison Value; TR = trace; not quantifiable below detection limit; ND = below detection limit; NA = no CV available for chemical; MW605 is a background well.

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride

>CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed. ND values were considered to be detected at one-half of the detection limit.

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 4
Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in
Overburden Groundwater Wells on Plant Property-2004-2013 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
B101	ND	0/4	ND	0/4	ND	0/4	ND	0/4	ND	NA	ND	0/4
B103	168	10/10	4	6/10	3	0/10	0/10	0/10	ND	NA	ND	0/10
MW105S	220	8/10	90	9/10	77	1/10	11	0/10	ND	NA	ND	0/10
MW401	319	10/10	37	10/10	101	3/10	11	0/10	ND	NA	ND	0/10
MW402	155	10/10	35	10/10	321	10/10	55	0/10	ND	NA	43	10/10
MW403	4	0/10	5	4/10	255	10/10	5.2	0/10	ND	NA	19	10/10
MW404	3	0/10	3	4/10	237	10/10	29	0/10	ND	NA	47	6/10
MW405	34	8/10	15	10/10	171	10/10	25	0/10	ND	NA	30	10/10
MW406	24	1/1	ND	0/1	ND	0/1	ND	0/1	NS	NA	ND	0/1
MW602	43	9/9	9	5/9	150	2/9	ND	0/9	ND	NA	14	1/9
MW603	69	10/10	14	10/10	93	6/10	5	0/10	ND	NA	ND	0/10
MW604	2	1/9	9	9/9	124	7/9	2	0/9	ND	NA	194	9/9
MW701	1,096	10/10	56	10/10	364	10/10	2	0/10	ND	NA	ND	0/10
MW703	94	9/9	19	9/9	140	8/9	ND	0/9	ND	NA	ND	0/9
MW801	35	3/7	ND	0/7	ND	0/7	ND	0/7	ND	NA	ND	0/7
MW902S	ND	0/8	ND	0/8	ND	0/8	ND	0/8	ND	NA	ND	0/8
MW903	4	0/10	5	3/10	90	4/10	ND	0/10	ND	NA	26	6/10
MW904	3	0/5	4	2/5	250	2/5	ND	0/5	ND	NA	6	3/5
MW905	5	0/9	6	2/9	180	2/9	ND	0/9	ND	NA	10	3/9
MW906	3	0/8	7	2/8	300	2/8	ND	0/8	ND	NA	17	3/8
MW1001	13	0/4	6	4/4	59	0/4	2	0/4	ND	NA	16	4/4
SW101	ND	0/3	ND	0/3	ND	0/3	ND	0/3	ND	NA	ND	0/3
SW202A	12	0/9	6	1/9	28	0/9	ND	0/9	ND	NA	ND	0/9
SW205/A	121	10/10	168	10/10	401	10/10	5.6	0/10	ND	NA	41	10/10
SW501	997	10/10	58	10/10	315	8/10	6.9	0/10	ND	NA	ND	0/10
SW503	50	6/10	99	8/10	476	10/10	19	0/10	ND	NA	18	9/10
SH-1	ND	0/1	ND	0/1	230	1/1	2	0/1	NS	NA	60	1/1
SH-2	11	0/1	25	1/1	560	1/1	ND	0/1	NS	NA	ND	0/1
SH-3	7	0/1	4	1/1	57	0/1	ND	0/1	NS	NA	10	1/1
W20	30	1/9	ND	0/9	12	0/9	ND	0/9	ND	NA	ND	0/9
W24	44	7/9	7	5/9	29	0/9	ND	0/9	ND	NA	ND	0/9
MW605	ND	0/3	ND	0/3	ND	0/3	ND	0/3	ND	NA	ND	0/3

MW605 is a background well; TR = trace, not quantifiable below detection limit

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride

>CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of

the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 5
Maximum Contaminant Concentrations in Bedrock Groundwater Wells on Plant Property-1984-2003 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW105R	62	2/17	5	1/17	ND	0/17	ND	0/17	ND	NA	ND	0/17
MW703	94	7/7	19	6/7	140	3/7	ND	0/7	ND	NA	3.5	1/9
SW101	ND	0/29	2	1/29	ND	0/29	ND	0/29	ND	NA	ND	0/29
SW104	2,000	19/19	490	19/19	1,400	19/19	ND	0/19	22	NA	430	19/19
SW106	2,000	17/17	1,300	19/19	910	19/19	ND	0/19	ND	NA	15	1/19
SW201	ND	0/10	ND	0/10	ND	0/10	ND	0/10	ND	NA	ND	0/10

SW201 is a background well. PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride
 >CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 6
Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in Bedrock Groundwater Wells on Plant Property-2004-2013 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW105R	ND	0/2	ND	0/2	ND	0/2	ND	0/2	ND	NA	ND	0/2
MW601SR	2,600	6/6	1,200	6/6	620	6/6	ND	0/6	ND	NA	50	4/6
MW601DR	4,400	7/7	1,600	7/7	1,100	7/7	ND	0/6	ND	NA	140	5/7
MW701SR	79	2/5	26	5/5	9	0/5	ND	0/5	ND	NA	ND	0/5
MW701DR	72	5/5	16	5/5	24	0/5	ND	0/5	ND	NA	ND	0/5
MW902D	ND	0/8	ND	0/8	ND	0/8	ND	0/8	ND	NA	ND	0/8
SH-SR	1,400	1/1	450	1/1	350	1/1	ND	0/1	NS	NA	ND	1/1
SH-1R	10	1/1	ND	1/1	3	1/1	ND	0/1	NS	NA	ND	1/1
SH-2R	ND	1/1	ND	1/1	ND	1/1	ND	0/1	ND	NA	ND	1/1
SH-4R	3,400	1/1	1,100	1/1	680	1/1	ND	0/1	NS	NA	ND	1/1
SH-6R	5	1/1	11	1/1	79	1/1	ND	0/1	NS	NA	7	1/1
SH-7R	280	2/2	190	2/2	340	2/2	3	0/2	ND	NA	87	2/2
SH-8R	17,000	2/2	2,600	2/2	1,200	2/2	ND	0/2	ND	NA	ND	0/2
SH-8RU	1,000	1/1	110	1/1	40	1/1	ND	0/1	ND	NA	ND	1/1
SH-8RM	13,000	1/1	1,900	1/1	900	1/1	ND	0/1	ND	NA	ND	1/1

SH-8RL	12,000	1/1	2,100	1/1	1,100	1/1	ND	0/1	ND	NA	ND	1/1
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SR and DR wells = Well with same number is screened at lower depth in bedrock (DR) compared to more shallow screened well (SR)

SH-8R = Well is screened into extensive portion of bedrock (35-110 ft. below ground surface)

SH-8RU = Well screened in upper bedrock (36-46 ft. below ground surface)

SH-8RM = Well screened in middle bedrock (88-93 ft. below ground surface)

SH-8RL = Well screened in lower bedrock (100-105 ft. below ground surface)

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride

>CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 7
Maximum Contaminant Concentrations in Overburden Groundwater Wells on the Downgradient
Properties-1984-2003 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW301	2	0/31	2	3/31	6	0/31	ND	0/31	ND	NA	ND	0/31
MW302	450	41/44	140	43/44	270	14/44	3.6	0/44	18	NA	73	28/44
MW303	300	44/44	180	42/44	250	20/44	1	0/44	ND	NA	ND	0/44
MW304	3	0/32	ND	0/32	ND	0/32	ND	0/32	ND	NA	ND	0/32
MW305	ND	0/31	ND	0/31	ND	0/31	ND	0/31	ND	NA	ND	0/31
MW306	4	0/34	ND	0/34	42	0/34	ND	0/34	ND	NA	ND	0/34

MW305 is a background well.

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride

>CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of

the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 8
Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in
Overburden Groundwater Wells on the Downgradient Properties-2004-2013 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW301	ND	0/9	2	5/9	5	0/9	ND	0/9	ND	NA	ND	0/9
MW302	316	11/11	55	11/11	89	6/11	3	0/11	ND	NA	9	6/11
MW303	115	14/14	7	14/14	29	0/14	ND	0/14	ND	NA	ND	0/14
MW304	ND	0/6	ND	0/6	ND	0/6	ND	0/6	ND	NA	ND	0/6
MW306	ND	0/2	ND	0/2	6	0/2	ND	0/2	ND	NA	ND	0/2
MW1002	ND	0/3	ND	0/3	ND	0/3	ND	0/3	ND	NA	ND	0/3
MW305	ND	0/3	ND	0/3	ND	0/3	ND	0/3	ND	NA	ND	0/3

MW305 is a background well.

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride
 >CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 9
Maximum Contaminant Concentrations in Bedrock Groundwater Wells on the Downgradient
Properties-1984-2003 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW303R	600	17/17	210	17/17	190	16/17	ND	0/17	ND	NA	ND	0/17
MW304R	ND	0/17	ND	0/17	TR	0/17	ND	0/17	ND	NA	ND	0/17

MW305 is a background well; TR = trace, not quantifiable below detection limit

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride
 >CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 10
Maximum Contaminant or 95th Percentile Upper Confidence Limit of the Mean Concentrations in
Bedrock Groundwater Wells on the Downgradient Properties-2004-2013 Samples
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Concentrations are in micrograms per liter (µg/L)

Well ID	PCE	>CV/ Tot.	TCE	>CV/ Tot.	Cis-1,2- DCE	>CV/ Tot.	1,1- DCE	>CV/ Tot.	Chloro- ethane	>CV/ Tot.	VC	>CV/ Tot.
MW302R	230	6/6	180	6/6	440	6/6	2	0/6	ND	0/4	20	5/6
MW303R	750	8/8	890	8/8	320	4/8	ND	0/8	ND	NA	ND	0/8
MW304R	ND	0/4	ND	0/4	ND	0/4	ND	0/4	ND	NA	ND	0/4

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; VC = vinyl chloride

>CV/Tot. = For each chemical, the number of samples with detects greater than its comparison value to total samples analyzed

Drinking water comparison values for contaminants of potential concern are presented in Table 11.

The maximum detected concentration is presented for each contaminant for well data collected in the 1984 to 2003 time period. For the 2004 to 2013 time period, the maximum detected concentration is presented for wells with less than 10 samples or if less than 4 samples were detections. For wells and chemicals with at least 10 samples and 4 of them detections, the 95th percentile upper confidence limit of the mean concentration was determined using ProUCL 5.0.00 and is presented instead of the maximum detected concentration.

Table 11
ATSDR Drinking Water Comparison Values for Contaminants of Potential Concern
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter (µg/L)

Chemical	Chronic EMEG/RMEG	CREG
Tetrachloroethylene (PCE)	80-Child; 280-Adult	17
Trichloroethylene (TCE)	5-Child; 18-Adult	0.76
Cis-1,2-Dichloroethylene (cis-1,2-DCE)	70 ^a	None
Trans-1,2-Dichloroethylene (trans-1,2-DCE)	700 ^a	None
1,1-Dichloroethene (1,1-DCE)	320	None
Chloroethane	None	None
Toluene	200-Child; 700 ^a -Adult	None
Vinyl chloride	110	0.025

Source: ATSDR. 2015. Comparison Values Tables. Division of Health Assessment and Consultation, Agency for Toxic Substances and Disease Registry. Updated March 2015.

EMEG =Environmental Media Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide; CREG = Cancer Risk Evaluation Guide; a = chronic value not available so intermediate RMEG was used; child and adult EMEGs/RMEGs are presented for the three contaminants detected in the private well; adult CVs were used to evaluate worker exposure in this Assessment.

Table 12
Volatile Organic Compounds (VOCs) detected in Soil Samples - Collected March 13-25, 1990
Former Collins & Aikman Plant Site
Farmington, New Hampshire

VOCs	Sample ID and Depth (Concentrations in mg/kg)													
	ATSDR Chronic CV (mg/kg)	MW105 S S2 6-8'	MW 105S S2 20-21'	B1 S2B 7-8'	B2 S1 3- 5'	B3 S1A 3-4'	B4 S1 3-5'	B4 S3 7-9'	B5 S1 1'	B6 S3 7- 9'	B8 S2 7- 9'	B10 S1 3'	B102 S3 6-8'	B103 S5A 9-10'
PCE	330	ND	ND	ND	2.9	0.5	11,000	310	0.5	N D	N D	ND	0.8	ND
TCE	15	ND	ND	ND	0.7	ND	440	1.2	ND	N D	N D	ND	ND	ND
cis- 1,2- DCE	100	3.0	ND	1.5	3.7	ND	500	2.2	ND	N D	N D	ND	ND	ND
1,1- DCE	450	ND	ND	ND	ND	ND	1.7	ND	ND	N D	N D	ND	ND	ND
1,1- DCA	NA	ND	ND	ND	ND	ND	1.8	ND	ND	N D	N D	ND	ND	ND
MC	350	ND	ND	ND	ND	ND	3.9	ND	ND	N D	N D	ND	ND	ND

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; 1,1-DCE = 1,1-dichloroethylene; 1,1-DCA = 1,1-dichloroethane; MC = methylene chloride

Comparison Values (CVs) for PCE, TCE, and MC are Cancer Risk Evaluation Guides (CREGs); the CV for 1,1-DCE is an Environmental Media Evaluation Guide (EMEG); the CV for cis-1,2-DCE is a Reference Dose Media Evaluation Guide (RMEG).

The two samples (B4-S1, B4-S3) with CV exceedances were both collected within 1 foot of the underground pipelines running from the former Aboveground Storage Tanks (ASTs) into the Plant. Only analytes with at least one detection are listed.

Table 13
Volatile Organic Compounds (VOCs) detected in Soil Samples - Collected
August 4 to August 28, 2008
Former Collins & Aikman Plant Site
Farmington, New Hampshire

VOCs	Sample ID and Depth (Concentrations in milligrams per kilogram (mg/kg))												
	ATSDR Chronic CV (mg/kg)	B1 S3 10- 12'	B2 S2 2.5- 3.4'	VZ2 S4 7-8'	VZ2 S6 12- 12.5'	B5 S2 2- 4'	B5 S3B 5-6'	B7 S3A 5.5- 5.7'	B7 S3B 5.8- 7.5'	SH1 S3 4.7- 5'	SH3 S1 0.7- 2.7'	TP1 S1 E. Wall Composite	TP1 S2 E. Wall Grab
PCE	330	ND	ND	ND	ND	26	0.81	ND	ND	ND	30	0.06	0.32
TCE	15	ND	ND	ND	ND	0.7	0.33	ND	ND	ND	ND	ND	ND
cis- 1,2- DCE	100	ND	ND	ND	ND	0.3	0.35	ND	ND	ND	ND	ND	ND

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene
Comparison Values (CVs) for PCE and TCE are Cancer Risk Evaluation Guides (CREGs); the CV for cis-1,2-DCE is a Reference Dose Media Evaluation Guide (RMEG).

Only analytes with at least one detection are listed.

Table 14
Surface Water Samples Collected on the Collins & Aikman Plant Property and Analyzed for
Volatile Organic Compounds (VOCs)
September 26, 1983
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Chemicals	Sample Locations (concentrations in micrograms per liter ($\mu\text{g/L}$))				
	Upgradient Brook Behind Plant	Culvert-Rt. 11 Opposite Plant	Culvert-Inlet Under Plant	Culvert Outlet - SE End of Parking Lot	Culvert to Pokamoonshine Brook
Methylene Chloride	ND	56	ND	817	ND
1,1-DCA	ND	ND	ND	18	ND
Trans-1,2-DCE	ND	10	ND	90	ND
PCE	ND	22	ND	244	ND
TCE	ND	ND	ND	35	ND

1,1,-DCA = 1,1-dichloroethane; trans-1,2-DCE = trans, 1,2-dichloroethylene; PCE = tetrachloroethylene; TCE = trichloroethylene

Only analytes with at least one detection are listed.

Table 15
Indoor Air Sample Results Collected on June 12, and October 30, 2008 from Former Collins & Aikman Plant Building
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Chemical	Building Location (concentration in µg/m ³)									
	Nurse Office	2nd Floor Conference Room	Office Area-L. of Main Entrance	Office Area-R. of Main Entrance – Duplicates		Near Previous Interior Air Sample	Near Previous Interior Soil Vapor Sample - Duplicates		ATSDR Air CVs	NH DES Commercial Indoor Air Screening Levels
Cis-1,2-DCE	ND; ND	0.13; ND	ND; ND	1.3; 0.31	1.3; 0.32	ND; ND	ND; ND	ND; NS	790 ^a	53 ^a
Trans-1,2-DCE	ND; ND	ND; ND	ND; ND	ND; ND	ND; ND	ND; ND	ND; ND	ND; NS	790 ^b	53
PCE	1.3; 0.52	0.53; ND	0.42; ND	2.4; 0.88	2.4; 0.92	2.4; 1.1	2.0; 1.3	2.0; NS	3.8 ^c	35
TCE	ND; ND	ND; ND	0.4; ND	0.39; ND	0.37; ND	ND; ND	ND; ND	ND; NS	0.24 ^c	1.8
Vinyl Chloride	ND; ND	ND; ND	ND; ND	ND; ND	ND; ND	0.073; ND	0.11; ND	0.10; ND	0.11 ^c	2.8

Results in cells are in order of sample date. µg/m³ = micrograms per cubic meter; CVs = Comparison Values; ND = not detected; NS = (duplicate) not sampled; a = trans-1,2-DCE value used as a surrogate; b = Intermediate Environmental Media Evaluation Guide (EMEG)/Reference Dose (RfD); c = Cancer Risk Evaluation Guide (CREG).

At least one concentration exceeds ATSDR CV

cis-1,2-DCE = cis-1,2-dichloroethylene; trans-1,2-DCE = trans-1,2-dichloroethylene; PCE = tetrachloroethylene; TCE = trichloroethylene; benzene was detected, but it is not included because it is not a Site COC and is a common indoor air background contaminant.

New Hampshire Department of Environmental Services (NH DES) Screening Levels from Waste Management Division Table 1 Vapor Intrusion Screening Levels, Revised February 2013. Agency for Toxic Substances and Disease Registry (ATSDR) Air CVs from Comparison Values Tables, updated March, 2015.

Samples collected with Summa Canisters for 24 hours and analyzed using EPA Method TO-15 SIM.

Table 16
New Hampshire Department of Environmental Services Method 1 Groundwater Standards
Groundwater 2 Standards for Migration of Vapors to Indoor Air Pathway
Former Collins & Aikman Plant Site
Farmington, NH

Concentrations are in micrograms per liter ($\mu\text{g/L}$)

Chemical	Method 1 Groundwater Standards NH GW-2
Tetrachloroethylene (PCE)	240
Trichloroethylene (TCE)	20
Cis-1,2-Dichloroethylene (cis-1,2-DCE)	560*
Vinyl chloride	4

*Because there is no GW-2 value for cis-1,2-DCE, the GW-2 value for trans-1,2-DCE is used as a surrogate.

Source of GW-2 Values: NH DES. Risk Characterization and Management Policy (RCMP). Table 2.
 Available at: <http://des.nh.gov/organization/divisions/waste/hwrb/documents/rcmp.pdf>.

Table 17A
Exposure Pathways
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Pathway	Source	Media	Exposure Point	Exposure Route	Exposed Population	Time	Pathway Complete?
Public Water supply	C&A Plant Contaminant Release(s)	Drinking Water	Farmington PWS (GP-2)	Ingestion, Dermal, Inhalation	Farmington Residents, C&A Plant workers	Past	Complete
						Present	Incomplete - Well Shut Down in 1984
						Future	
Private Wells	C&A Plant Contaminant Release(s)	Drinking Water	Farmington homes/businesses	Ingestion, Dermal, Inhalation	Farmington Residents and Workers	Past	Complete
						Present	Incomplete- Any At-Risk Wells Tested = ND
						Future	Potential-If Institutional Controls in Place to Prevent Well Installation Are Not Renewed When They Expire
Soil	C&A Plant Contaminant Release(s)	Surface Soil	Site Surface Soil	Ingestion, Dermal, Inhalation	Former Workers, Site Trespassers	Past	Incomplete- Contaminated Portion Was Paved or Covered by Building
						Present	Potential- Pavement Deteriorating,
						Future	

							Site Not Fenced
Indoor Air	C&A Plant Contaminant Release(s)	Indoor Air	C&A Plant	Inhalation	C&A Plant Workers	Past	Potential-No Data, But Shallow Groundwater Concentrations Exceed NH GW-2 Screening Values
						Present	Incomplete-Site Not in Use
						Future	Potential-If Business Re-occupies Unremediated Site
Indoor Air	C&A Plant Contaminant Release(s)	Indoor Air	Future Commercial Building Located Over Downgradient Contaminant Plume	Inhalation	Future Workers	Past	Incomplete-No Commercial Buildings in Past or Present
						Present	
						Future	Potential-If Building is Constructed Over Groundwater Contaminant Plume
Indoor Air	C&A Plant Contaminant Release(s)	Indoor Air	C&A Plant	Inhalation	Worker Tenants after C&A business closed	Past	Complete
						Present	Incomplete-Site Not in Use
						Future	Potential-If Business Re-occupies Unremediated Site
Surface Water	C&A Plant Contaminant Release(s)	Wetlands, Streams, Rivers	Downgradient Wetlands, Pokamoonshine Brook (PMSB), Cocheco River	Ingestion, Dermal, Inhalation	Recreational Users	Past	Potential-But Data Limited to a Few 1983 Site samples
						Present	
						Future	
Sediment	C&A Plant Contaminant Release(s)	Sediment in Wetlands, Streams, Rivers	Sediments associated with downgradient wetlands, PMSB, Cocheco River	Ingestion, Dermal	Recreational Users	Past	Potential-But Data Limited to a Few 1983 Surface Water Site samples
						Present	
						Future	
Fish	C&A Plant Contaminant Release(s)	Fish	Caught from PMSB, Cocheco River	Ingestion	Anglers and Family	Past	Potential- Of 4 COCs, 3 Have Low BCFs in Fish, but PCE BCF is Moderate

PWS = public water system; GP-2 = public well gravel pack-2; NH GW-2 Screening Values = New Hampshire Groundwater-2 Screening Values are contaminant concentrations in groundwater protective against adverse health effects from vapor migration into buildings; COCs = contaminants of concern; BCF=bioconcentration factors (see Table 19); PCE = tetrachloroethylene

Table 17B
Groundwater or Drinking Water Exposure Point Concentrations (EPCs)
Former Collins & Aikman Plant Site
Farmington, New Hampshire
Concentrations are in micrograms per liter ($\mu\text{g/L}$)

Chemicals	Receptors		
	C&A Employees – Past Exposure*		Worker on Downgradient Property – Future Exposure***
Cis-1,2-DCE	ND		440
Trans-1,2-DCE***	3		ND
PCE	9		750
TCE	1		890
Toluene**	ND		ND
Vinyl Chloride	ND		20

cis-1,2-DCE = cis-1,2-dichloroethylene; trans-1,2-DCE = trans-1,2-dichloroethylene; PCE = tetrachloroethylene; TCE = trichloroethylene

* C&A Plant used well GP-2 as water source until June, 1984.

** Cis-1,2-DCE and toluene EPCs are less than CVs, therefore they were not quantitatively evaluated.

*** These are maximum detected concentrations in the bedrock aquifer monitoring wells between 2004 to 2013. They are not representative of contaminant concentrations that would be ingested on a daily basis by a hypothetical future worker.

Table 18A
Exposure Doses from Drinking Water Ingestion for Past Collins & Aikman Employees
Worker, 10 Year Exposure Duration
Former Collins & Aikman Plant Site
Farmington, New Hampshire

	Cancer (mg/kg/day)		Non-Cancer (mg/kg/day)	
	CTE	RME	CTE	RME
Tetrachloroethylene (PCE)	6.06E-6	1.53E-5	4.7E-5	1.19E-4
Trichloroethylene (TCE)	6.74E-7	1.70E-6	5E-6	1.3E-5

mg/kg/day = milligrams per kilogram per day; CTE – central tendency exposure; RME = reasonable maximum exposure

Table 18B
Cancer Risk and Noncancer Hazard from Drinking Water Ingestion for Past Collins & Aikman Employees
Worker, 10 Year Exposure Duration
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Chemical	CSF (mg/kg/day) ⁻¹	ELCR – CTE	ELCR – RME	RfD (mg/kg/day)	HQ – CTE	HQ – RME
PCE	2.1E-3	1.3E-8	3.2E-8	0.006	0.008	0.02

TCE	4.6E-2	1.4E-9	3.6E-9	0.0005	0.01	0.03
Total ELCR		1.4E-8	3.6E-8			

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene; ED = Exposure Dose; CSF = EPA oral Cancer Slope Factor; ELCR = excess lifetime cancer risk; CTE = central tendency exposure; RME = reasonable maximum exposure; RfD = EPA oral Reference Dose; HQ = Hazard Quotient

Table 19
Contaminant Chemical and Physical Properties Influencing Environmental Migration, Persistence, and Potential for Exposures to Surface Water, Sediment, and Fish
Former Collins & Aikman Plant Site
Farmington, New Hampshire

Chemical	Henry's Law Constant (H) (atm-m ³ /mol) Volatility Descriptor	Estimated 1/2 Life in Model River (hours)	Soil Adsorption Coefficient (Koc) (unitless) Adsorption Descriptor	Fish Bioconcentration Factor(s) (BCF) (unitless)	BCF Assessment Category*
PCE	1.77E-2; High	4	200-237; Moderate	39, 49, 26-77, 36-115	mainly Moderate; upper range of 1 BCF = High
TCE	9.85E-3; Moderate	3	101; Weak-Moderate	17, 39, 4.3-17, 4-16	mainly Low; 1 BCF = Moderate
Cis-1,2-DCE	4.08E-3; Moderate	3	49; Weak	8	Low
Vinyl Chloride	2.78E-2; High	2	57; Weak	< 10	Low

PCE = tetrachloroethylene; TCE = trichloroethylene; cis-1,2-DCE = cis-1,2-dichloroethylene

Chemical/Physical Property Values, except for BCF Categories, taken from: Hazardous Substance Data Bank (HSDB) At: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>

Qualitative H and Koc Descriptors taken from: North Belmont PCE Site Remedial Investigation. USEPA, Reg. 4, Science and Ecosystems Support Division. SESD Project No. 96S-058. June, 1997.

<u>BCF Numerical Category*</u>	<u>BCF Descriptor *</u>
<30	Low
30 – 100	Moderate
100 – 1,000	High
>1,000	Very High

*BCF assessment and categorization developed and described in: Franke, C et al 1994. The Assessment of Bioaccumulation. Chemosphere. Vol. 29, No. 7, pgs. 1501 – 1514.

Appendix D - Potential Health Effects of Contaminants of Concern

Potential health effects for the contaminants of concern (COCs) at the C&A Site are presented. Not all the adverse effects listed would be expected to occur based on the concentrations found as a result of the C&A Site and duration of exposures. However, they are included for the benefit of the Reader. Each of the four COCs are chlorinated volatile organic compounds (cVOCs).

Tetrachloroethylene (PCE)

PCE was used to clean the parts manufactured by the Plant until its use reportedly ended in 1978. PCE exposure can result in effects to the central nervous system including color vision changes, slowing of reaction times, and reductions in cognition (55, 56). PCE exposure can also have effects to the kidney, liver, immune system, and blood. PCE is classified by EPA as “likely to be carcinogenic to humans” by all exposure routes. Cancer of the liver, bladder, and multiple myeloma, which is a cancer of the bone marrow, are types that have been associated with PCE exposure (55, 56).

Trichloroethylene (TCE)

There are no records indicating TCE was used at the Plant, but TCE is often a breakdown product of PCE as it decomposes in the environment. Non-cancer effects from TCE exposure include effects to the central nervous system, liver, kidney, immune system, male reproductive system, and developmental effects to a fetus (57, 58). Results of animal studies have indicated TCE exposure may increase certain types of fetal malformations, including heart malformations. TCE exposure during weeks 6 to 9 of pregnancy, the period during which the human heart forms and develops, is the more specific window of vulnerability (50). An epidemiologic (human) study of TCE-exposed pregnant women also found an increase in fetal heart malformations (50). TCE is classified by EPA as “carcinogenic in humans by all routes of exposure”. There is very strong evidence for TCE increasing cancers of the kidney, liver, and non-Hodgkin Lymphoma and lesser evidence for cancers of the bladder, prostate, breast, cervix, esophagus, and childhood leukemia (57, 58). Kidney cancer from TCE exposure is the one type which has clear evidence that exposure when young confers a greater risk than adult exposure (57, 58).

Cis-1,2-Dichloroethylene (cis-1,2-DCE)

There are no records indicating that cis-1,2-DCE was used at the Plant, but it is often one of the breakdown products of PCE as it decomposes in the environment. Changes in liver and kidney weight are often noted following exposure to cis-1,2-DCE although other toxic changes to these organs were not found (59, 60). EPA has placed cis-1,2-DCE in the category of “inadequate information to assess the carcinogenic potential” because of the small number of available studies (59).

Vinyl Chloride

There are no records indicating that vinyl chloride was used at the Plant, but it is often one of the breakdown products of PCE as it decomposes in the environment. Vinyl chloride can be toxic to the liver, sperm, testes, immune and nervous systems (53, 61). Specific nervous system effects seen in workers are impaired blood flow to the hands resulting in pain when exposed to the cold (53, 61). EPA has classified vinyl chloride as “carcinogenic to humans” by all exposure routes. Long-term exposure increases the risk of a specific form of liver cancer called an angiosarcoma. Vinyl chloride exposure has also increased rates of brain, lung, and blood cancers. Animal studies have indicated that infants and young children are more susceptible than adults to the carcinogenic effects of vinyl chloride (53, 61).

Appendix E - Calculations of Water Ingestion Exposure and Risk with Examples

Water Ingestion Exposure Dose Equation (54):

$$D = (C \times IR \times EF) / BW$$

Where,

D = Exposure Dose (mg/kg/day)

C = Contaminant Concentration (mg/L)

IR = Ingestion Rate (L/day)

EF = Exposure Factor (unitless)

BW = Body Weight (kg)

The EF is calculated as follows:

$$EF = (F \times ED) / AT$$

Where,

EF = Exposure Factor (unitless)

F = Frequency of Exposure (days/year)

ED = Exposure Duration (years)

AT = Averaging Time (ED x 365 days/year)

Cancer Risk can be calculated (54):

$$ELCR = D \times CSF$$

ELCR = Excess Lifetime Cancer Risk (unitless)

D = Exposure Dose (mg/kg/day)

CSF = Cancer Slope Factor (mg/kg/day)⁻¹

Noncancer hazard is calculated as follows (52):

$$HQ = D / RfD$$

Where,

HQ = Hazard Quotient (unitless)

D = Exposure Dose (mg/kg/day)

RfD = EPA Reference Dose (mg/kg/day)

Sample Dose and Risk Calculations for Past C&A Worker Exposure

Water Ingestion Dose Calculations for PCE at 9 ug/L

Carcinogenic – RME

$$EF(\text{unitless}) = (250 \text{ days/yr.} \times 10 \text{ yrs.}) / (78 \text{ yrs.} \times 365 \text{ days/yr.})$$

$$EF = 0.0878$$

$$D(\text{mg/kg/day}) = 0.009 \text{ mg/L} \times 1.546 \text{ L/day} \times 0.0878 / 80 \text{ kg}$$

$$D = 1.53\text{E-}5 \text{ mg/kg/day}$$

Cancer Risk Calculation for PCE RME

$$ELCR(\text{unitless}) = 1.53\text{E-}5 \text{ mg/kg/day} \times 0.0021 \text{ mg/kg/day-}1$$

$$\text{ELCR} = 3.2\text{E-}8 \text{ for 10 yr. exposure (RME) to PCE at 9 ug/L}$$

Water Ingestion Dose Calculations for TCE at 1 ug/L

Non-Cancer - CTE

$EF(\text{unitless}) = (250 \text{ days/yr.} \times 10 \text{ yrs.}) / (10 \text{ yrs.} \times 365 \text{ days/yr.})$

$EF = 0.6849$

$D(\text{mg/kg/day}) = 0.001 \text{ mg/L} \times 0.614 \text{ L/day} \times 0.6849 / 80 \text{ kg}$

$D = 5.26\text{E-}6 \text{ mg/kg/day}$

Hazard Quotient Calculation for TCE CTE

$HQ(\text{unitless}) = 5.26\text{E-}6 \text{ mg/kg/day} / 5\text{E-}4 \text{ mg/kg/day}$

HQ = 0.011 for 10 yr. exposure (CTE) to TCE at 1 ug/L