Public Health Assessment

Technitronics Site

Casselberry, Seminole County, Florida

FDEP FACILITY ID: COM_275450
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October 21, 2014

Prepared by:
Florida Department of Health
Division of Disease Control and Health Protection
Under Cooperative Agreement with
U. S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry,
Centers for Disease Control and Prevention

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Acronyms and Abbreviations

ATSDR	Agency for Toxic Substance and Disease Registry
AT	Averaging Time
ADAF	Age Dependent Adjustment Factor
bls	below land surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
BW	Body Weight
C	Contaminant Concentration
CF	Conversion Factor
COC	Contaminant of Concern
cis-1,2-DCE	*cis*-1,2-dichloroethene
CNS	Central Nervous System
CREG	Cancer Risk Evaluation Guideline
CVOC	Chlorinated Volatile Organic Compound
CYP2E1	Cytochrome P450 2E1; enzyme involved in the metabolism of foreign substances
DCA	1,2-dichloroethane
DHEP	di(2-ethylhexyl phthalate)
D	Dose
ED	Exposure Duration
EDB	Ethylene Dibromide
EF	Exposure Factor
EMEG	Environmental Media Evaluation Guide
EPA	Environmental Protection Agency
F	Frequency of Exposure
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
HLA-B8	Human Lymphocyte Antigen gene associated with autoimmune diseases
HLA-DR5	Human Lymphocyte Antigen gene associated with autoimmune diseases
HLA-DR3	Human Lymphocyte Antigen gene associated with several diseases and diabetes
IR	Intake Rate
LOAEL	Lowest Observable Adverse Effect Level
MCL	Maximum Concentration Level
MRL	Minimum Risk Level
MTBE	Methyl Tertiary Butyl Ether
NQ01	Enzyme involved in metabolism, quinine oxidoreductase
PCE	Perchloroethylene or Tetrachloroethene
POE	Point Of Entry
R	Risk (Cancer)
RfD	Reference Dose (EPA)
RMEG	Reference Media Evaluation Guide
SCTL	Soil Target Cleanup Level
SF	Slope Factor
TCE	Trichloroethene
VOC	Volatile Organic Compound

Foreword

The Florida Department of Health (FDOH) evaluates the public health threat of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This is a state report, meaning FDOH health professionals reviewed it. FDOH prepared this report using the same guidelines and equations we use for US Environmental Protection Agency (EPA) sites that ATSDR reviews by mandate. This public health assessment is part of an ongoing effort to evaluate health effects associated with groundwater, air, and soil from the Technitronics hazardous waste site. The FDOH evaluates site-related public health issues using the following processes:

Evaluating exposure: FDOH scientists review available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is on the site, and how human exposures might occur. The Florida Department of Environmental Protection (FDEP) provided the data for this assessment.

Evaluating health effects: If we find evidence that exposures to hazardous substances are occurring or might occur, FDOH scientists next determine whether that exposure could be harmful to human health. We focus on potential health effects for the community as a whole. We base our conclusions and recommendations on current scientific information.

Developing recommendations: FDOH lists its conclusions regarding any potential health threat posed by groundwater, air, and soil. FDOH then offers recommendations for reducing or eliminating human exposure. The role of the FDOH in dealing with hazardous waste sites is primarily advisory. Our public health assessments will typically recommend actions for other agencies, including the EPA and the FDEP. If a health threat is actual or imminent, FDOH will issue a public health advisory warning people of the danger and will work to resolve the problem.

Soliciting community input: The evaluation process is interactive. FDOH starts by soliciting and evaluating information from various government agencies, individuals, or organizations responsible for cleaning up the site, and those living in communities near the site. We share any conclusions about the site with the groups and organizations providing the information, and we ask for feedback from the public.

If you have questions or comments about this report, please write to us at:

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Summary

INTRODUCTION

At the Technitronics hazardous waste site, the Florida Department of Health (FDOH) and the federal Agency for Toxic Substances and Disease Registry's (ATSDR) top priority is that nearby residents have the best information to safeguard their health.

The two-acre Technitronics site is at 1041 and 1043 Seminola Boulevard, in Casselberry, Seminole County, Florida. From 1968 to 1997, several businesses used chlorinated solvents to clean circuit boards and tools, and to make dry cleaning solution.

Recent testing found two types of groundwater contamination under the site but very little surface soil contamination. The chlorinated solvent contamination may have come from the Technitronics site and the former Connery Marine site to the west. The gasoline contamination may have come from the former 7-Eleven (former Cumberland Farms) and/or Connery Marine sites to the west. Contaminated groundwater extends to the northeast from these source areas.

The purpose of this report is to assess the public health threat from contaminated soil, indoor air, and groundwater at and near the site. The Florida Department of Environmental Protection (FDEP) requested this assessment. FDOH considers past, current, and future on- and off-site exposures.

CONCLUSION #1

Shallow groundwater under the site is highly contaminated. Shallow groundwater northeast of the site is also contaminated, but to a lesser degree. FDOH has not identified anyone ***currently*** using this contaminated groundwater. Future use of contaminated groundwater under or near the site is unlikely due to its strong chemical smell and the fact that municipal water is available. FDEP has not found how far groundwater contamination extends.

BASIS FOR DECISION #1

Drinking, showering, or other household uses of groundwater under the Technitronics site with the highest trichloroethene (TCE) levels could cause illness and an extremely high increased cancer risk. Similar use of groundwater northeast of the site with the highest levels of vinyl chloride could cause a moderate increased cancer risk.

NEXT STEP #1

People should not install drinking water wells on or near the Technitronics site. FDEP is working with the current and former site owners to find and remediate site-related contamination. FDEP has also asked the US Environmental Protection Agency for remediation help.

CONCLUSION #2	In 1994, FDOH Seminole County staff found chlorinated solvent contamination in private drinking water wells about one-half mile northeast of the Technitronics site. Although levels of benzene, TCE and vinyl chloride were slightly above drinking water standards, residents were not at significant risk of illness. FDEP connected these houses to city water. FDOH staff in Seminole County has continued to test the nearest private drinking water wells, but so far, none has exceeded drinking water standards for Volatile Organic Compounds (VOCs).
BASIS FOR DECISION #2	FDOH estimated the health risks for long-term use of water with the highest levels measured in 1994. Although solvent levels in these wells were slightly above drinking water standards, FDOH found non-cancer illness was not likely. Increased cancer risks ranged from very low to extremely low.
NEXT STEP #2	The FDOH staff in Seminole County will continue to test private drinking water wells northeast of the site as warranted.
CONCLUSION #3	People using City of Winter Springs municipal well water are not at risk of illness from *cis*-1,2-dichloroethene.
BASIS FOR DECISION #3	Tests have not found any solvents in municipal well water other than *cis*-1,2-dichloroethene. The highest level of *cis*-1,2-dichloroethene tests measured in city water (0.00159 mg/L) was 44 times lower than the drinking water standard of 0.070 mg/L. This *cis*-1,2-dichloroethene level was measured in a 2002 test, levels since that time have been lower.
NEXT STEP #3	The City of Winter Springs will continue to test their water monthly for *cis*-1,2-dichloroethene and other chlorinated solvents from the Technitronics site.

CONCLUSION #4 Workers and others on the site are not at risk from chemicals in surface soil or from vapor intrusion.

BASIS FOR DECISION #4 FDEP did not find elevated solvent levels in on-site surface soil, soil gas, or indoor air. Because solvents at the groundwater surface are limited to areas away from on-site buildings, vapor intrusion is unlikely.

CONCLUSION #5 Solvents in the groundwater are not likely to enter nearby homes via vapor intrusion.

BASIS FOR DECISION #5 Chlorinated solvents sink in groundwater because they are denser than water. Offsite monitoring wells show that the solvents in groundwater are well below the water surface and are therefore unlikely to move up into soil gas or through cracks in the foundation of nearby homes.

COMMUNITY UPDATE On August 22, 2014, we mailed out a community update to approximately 900 nearby residents and other interested parties. This update summarized the draft report, gave the web address, solicited public comments, and announced the date/location of an open house.

FDOH posted this final report at http://www.floridahealth.gov/environmental-health/hazardous-waste-sites/health-assessments.html.

FOR MORE INFORMATION If you have concerns about your health or the health of your children, you should contact your health care provider. You may also call the FDOH toll-free at 877-798-2772 or 850-245-4444 x 2316 and ask for information about the Technitronics hazardous waste site.

Background and Statement of Issues

The purpose of this report is to assess the public health threat from toxic chemicals in groundwater at and near the Technitronics hazardous waste site. This report also considers, but rules out, surface and near-surface soil and vapor intrusion as exposure pathways. Because on-site levels of solvents in groundwater are high, and contamination has spread off the site, the Florida Department of Environmental Protection (FDEP) requested this assessment. Florida Department of Health (FDOH) considers past, current, and future on-and off-site exposures in this report. The Technitronics site is at 1041 and 1043 Seminola Boulevard in Casselberry, Seminole County, Florida 32707 (Figures 1 and 2).

Health scientists look at what chemicals are present and in what amounts. They compare those amounts to health guidelines. These guidelines are set far below known or suspected levels associated with health effects. FDOH uses guidelines developed to protect children. If chemicals are not present at levels high enough to harm children, they are even less likely to harm adults.

This assessment considers health concerns of nearby residents and explores possible associations with site-related contaminants. It requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat.

This assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. Tests found many of the highest levels measured on the site, so the risks we calculated may not apply equally to nearby residents. As a result, the health risks for most nearby residents are less than the health risks estimated in this report. Those residents who have not contacted site-related chemicals via groundwater are not likely at risk from this site.

Site Description

The Technitronics site is in a mixed-use area of Casselberry, with commercial and light industrial businesses along Seminola Boulevard and residential areas to the north and south (Figure 1). Figure 2 shows the two 4,000 square–foot buildings developers built on these parcels in 1963 and 1964 [E&E, 2013]. Each parcel was just under an acre, making the combined site area a little less than 2 acres. Technitronics began manufacturing circuit boards on the eastern property in 1971 and expanded to include the western property in 1980 (Photograph 1). Technitronics changed the facility name to Circuitronics in 1995 and continued to make circuit boards at the site until 1997.

The site is in a relatively flat area of Casselberry; the elevation is about 60 feet above sea level. It decreases about five feet in elevation toward the northeast. The site has quickly draining fine-grained sand and a water table that varies from 5-10 feet below land surface (bls). There is no surface water on the site.

Industrial businesses that operated on the site include the following [FDEP 2013]:

Western property (1041 Seminola)
1968 – Fab Tool
1971 – Schwartz Chemical Co.
1980 to 1995 – Technitronics
1995 to 1997 – Circuitronics

Eastern property (1043 Seminola)
1968 to 1971 – Dynatronics
1971 to 1995 – Technitronics
1995 to 1997 – Circuitronics

Site History

Although FDEP does not have information on the waste-handling practices of the earlier businesses that operated on the site, their consultant did discover an indication that an earlier business on the western parcel may have used solvents. On May 10, 1972, the owner of Schwartz Chemical Co. applied for a patent for an emulsion of "fat solvent" (tetrachloroethene is mentioned) and 1-(3-chloroallyl)-3,5,7-triaza-1-azoniadamantane chloride in a 100:1 ratio, for use in a dry cleaning process with disinfection. This patent application indicates the possible experimentation with, use and/or disposal of chlorinated solvents by Schwartz Chemical Company, Inc., at the property.

Starting during inspections in 1981, FDEP noticed soil staining and improper waste handling practices on the western portion of the site. Figure 3 shows site operation and waste handling areas. In 1997, the site owners ceased operations.

Technitronics workers cut fiberglass boards, silk-screened circuitry patterns on them, and then plated these patterns with copper and other metals using electricity. They soldered board connections and electronic components in place using a tin/lead solder mixture. To finish the circuit boards, they removed the solder flux (a melting compound) with solvents such as tetrachloroethene (PCE) and trichloroethene (TCE).

The wastewater likely contained metals (copper, lead, and nickel), cyanide, nitrate, and a number of chlorinated solvents including PCE, TCE, and 1,1,1-trichloroethane. Chlorinated solvents can remain stable in a pool in the groundwater for years. However, as chlorinated solvents dissolve and travel through saturated subsurface soils and limestone, they break down into *cis*- and *trans*-1,2-dichloroethene and vinyl chloride [Watts 1989].

In early 1994, the FDOH staff in Seminole County followed up on a resident's complaint of petroleum odors in their well water. They sampled 11 private wells on Jackson Circle, Murphy Road, and Tradewinds Road in the Foxmoor East neighborhood one-half mile northeast of Technitronics. They found gasoline components along with chlorinated volatile organic chemicals (CVOCs). Some of these wells had vinyl chloride, benzene, and TCE levels that exceeded drinking water standards [FDOH 2013].

In 1994, FDEP funded the connection of five contaminated private wells in the Foxmoor East neighborhood to municipal water supplies [FDEP 2007]. FDEP is able to do this for wells with concentrations of contaminants above the drinking water standards. A sixth private well owner paid for their own connection because contamination in their well was below the drinking water standards. Contaminant levels in the other wells identified and sampled in 1994 have not exceeded drinking water standards in subsequent tests and are still in use. Currently, the FDOH staff in Seminole County tests these wells as warranted.

In October 1999, the City of Winter Springs first detected *cis*-1,2-dichloroethene in production well #3. State regulations require that operators of water treatment plants test tap-ready water at the point of entry (POE) to the water distribution system. The state requires them to establish a POE running annual average for chemicals detected below the maximum contaminant level (MCL) and report the results to FDEP. The highest level of *cis*-1,2-dichloroethene measured in tap-ready water was 1.59 µg/L on January 30, 2002 [FDEP 2007]. This is 44 times lower than the drinking water standard of 70 µg/L. Tests have not found other VOCs in these wells [McCarthy 2013, Baggs 2013].

The Casselberry North Plant well field northwest of Technitronics has three wells. Tests of the 350- and 388-foot deep wells have detected some CVOCs. The 1,200-foot deep well is not contaminated. FDEP could not associate Technitronics contamination with the Casselberry well field contamination because their monitoring wells did not find contamination between the two areas. Their monitoring wells also found that the groundwater flow direction from Technitronics is northeast, not northwest toward the Casselberry wells. Therefore, we do not discuss the Casselberry municipal well field contamination further in this report.

Demographics

FDOH examines demographic and land use data to identify sensitive populations, such as young children, the elderly, and women of childbearing age. From this, we may evaluate sensitive populations' threat of exposure to potential health risks. Demographics also provide details on population mobility and residential history in a particular area. We may use demographics to evaluate residents' length of exposure to contaminants.

According to the 2010 census, approximately 9,900 people live within a 1-mile radius of the Technitronics site: 84% are white, 7% are black, 3% are Asian and 6% are other categories. Approximately 5% of the residents are younger than 4 years old and 15 % are 65 and older [EPA 2013a].

Land Use

A decorative concrete company, and a hurricane/flood damage recovery company (Photographs 1 and 2) operated on the Technitronics site in 2013 [FDEP 2013]. The western building (1041) was not occupied when FDOH visited the site in July 2014.

Commercial, light industrial, and residential properties surround the Technitronics site. Residential properties on Bluebell Drive border the site on the north. Commercial properties (an animal clinic and an auto repair shop) border the site on the west (Photograph 3). A small storm water retention pond (approximately 40 by 20 by 8 feet deep) is immediately west of the site on the auto repair shop property. West of the animal clinic, at the intersection of North Winter Park Drive and Seminola, are a tire store and a city park. The tire store was formerly Connery Marine and the city park was formerly a 7-Eleven and before that a Cumberland Farms (Figure 2).

The 1-acre parcel immediately east of the site is wooded and undeveloped. East of that is a roofing company with a large warehouse [Seminole County Property Appraiser 2013].

South of the site is Seminola Boulevard, a 4-lane divided highway with a wide grass median. South of Seminola Boulevard are commercial businesses, single-family residences, and five small lakes (Figure 1).

Two City of Winter Springs public water supply wells are approximately 1 mile northeast of the site. Three City of Casselberry public water supply wells are one-half to six-tenths mile northwest of the site. Casselberry Elementary, South Seminole Middle School, and Central Christian Academy are approximately 1 mile south of the site (Figure 1) [FDEP 2007].

Parts of the site and some surrounding properties are wooded. The areas around the small lakes south of the site are also wooded. Secret Lake Conservation Area is six-tenths of a mile west of the site, North Winter Park Drive Conservation Area is two-tenths of a mile northeast of the site, and Lake Kathryn Circle Conservation Area is six-tenths of a mile northeast of the site [FNAI 2013].

Community Health Concerns

The primary community health concern for the Technitronics site is impact to local groundwater. Two municipal supply wells for Winter Springs are 1 mile northeast of the site and private wells are one-half mile and farther northeast of the site. These wells are hydraulically downgradient of the Technitronics site and six have intercepted contaminated groundwater [FDEP 2007].

We evaluate these health concerns in the Community Health Concerns Evaluation section.

Discussion

Environmental Data

FDOH evaluated environmental data from the following three reports.

Casselberry and Winter Springs Municipal Well Field Investigation: FDEP looked at water quality in a 2 by 3 mile area that encompassed the Casselberry and Winter Springs public supply wells. Their analysis of the test results allowed them to separate the study into an eastern area and a western area. Technitronics is in the eastern study area.

FDEP established a connection between contamination in the Winter Spring's municipal supply, private potable wells, and contamination sources in the eastern study area, including Technitronics. They installed 8 surficial aquifer monitor wells, 7 Floridan aquifer (deeper) wells, and 58 screen points in the eastern study area [FDEP 2007]. FDEP was unable to establish a connection between contamination in the Casselberry North Well field and either western or eastern source areas [FDEP 2007].

Technitronics Preliminary Contaminant Assessment Report: FDEP installed 37 screen-point wells and took samples at multiple depths [FDEP 2013]. CVOCs are denser than water and sink once they reach the groundwater surface (water table). FDEP was able to identify the depth of the groundwater contaminants. They tested for gasoline components, CVOCs, 1,2-dibromomethane (EDB), semi-volatile VOCs, metals, and 1,4-dioxane.

FDEP identified two areas of ground water contamination on the Technitronics site. One area contains CVOCs and other chemicals. They found the highest concentrations of one CVOC, trichloroethene (TCE), adjacent to the northeastern corner of the western building. This area of groundwater contamination is under the northern three-quarters of the site and appears to have an additional source off site, possibly the former Connery Marine site (Figure 4). FDEP concluded that Technitronics is the primary source of CVOCs affecting the Winter Springs well field and eastern study area's aquifers.

The second on-site area of groundwater contamination contains gasoline components: benzene, toluene, ethylbenzene, xylenes (BTEX), and the octane-enhancer methyl *tert*-butyl ether (MTBE). Possible sources include the former Connery Marine and the former 7-Eleven/Cumberland farms. Testing found gasoline-related chemicals near the ground surface on these properties. The BTEX groundwater contamination is present on the northern two-thirds of the Technitronics site (Figure 5).

Expanded Site Investigation: Consultants for FDEP identified potential source areas and gathered data to rank the site for possible federal Superfund assistance [E&E 2013]. They sampled soil gas at 47 locations, including between the buildings and near/under the eastern building former waste storage areas. They used the results to target soil sample locations. They collected 4 surface soil and 33 sub-surface soil samples at 23 locations (in addition to background and duplicate samples) and analyzed for VOCs. They tested sub-slab soil gas under the western building floor and tested air inside the eastern building. Their extensive soil testing found only limited contamination. Testing detected acetone, toluene, and xylene in surface soil and methylcyclohexane in subsurface soil. These soil gas and indoor air concentrations were below ATSDR comparison values.

E&E also collected groundwater from 9 permanent monitoring wells and 3 new microwells, each with 3 sample depths. They analyzed for VOCs.

Appendix A lists test results from the above three studies and the testing done by the FDOH staff in Seminole County and the Winter Springs Utilities Department (Appendix A).

- Table 1 lists on-site groundwater VOC concentrations,
- Table 2 lists off-site groundwater VOC concentrations downgradient of Technitronics,
- Table 3 lists past VOC concentrations in private potable wells, and
- Table 4 lists VOC concentrations in Winters Springs municipal supply water.

Testing at this early stage of investigation has not allowed FDEP to delineate the extent of groundwater contamination on or off the site. The eventual plans for cleanup will depend on better understanding of the extent of groundwater contamination.

FDEP has identified other possible sources of VOCs in the City of Winter Springs municipal wells, in addition to the Technitronics site. These other possible sources include leaking gasoline storage tanks west of Technitronics, Southwick Inc. one-half mile east of Technitronics, and other leaking gasoline storage tanks on Seminola Boulevard near Southwick. Groundwater downgradient from sources near Southwick has levels of benzene, 1,2-dichloroethane, *cis*-1,2-dichloroethene, and vinyl chloride similar to the groundwater downgradient of Technitronics. Groundwater downgradient of Technitronics has toluene while the Southwick area does not. The TCE levels downgradient of Technitronics are 4 times higher than the areas downgradient of Southwick. VOCs could also have come from past disposal of chemicals in residential septic tanks or from other unidentified sources. FDEP plans to investigate these other off-site contamination areas separately (Jim McCarthy, FDEP, personal communication, 8/6/2014).

Pathway Analyses

Chemical contamination in the environment can only harm someone's health if he or she contacts those contaminants. If there is no exposure, there can be no associated harm to health. If exposure does occur, how much of the contaminants someone contacts (concentration), how often the contaminants are contacted (frequency), for how long they are contacted (duration), and the danger of the contaminant (toxicity) all contribute to the risk of harm.

To assess any contaminant's public health importance, we estimate the frequency with which people could have contact with that contaminant. The method for assessing whether people face a health risk is to determine whether a completed exposure pathway connects them to a contaminant source, and whether exposures to that contaminant source are high enough to be of health concern.

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at contact with the human body. A completed exposure pathway consists of five elements:

1. Source of contamination, such as a hazardous waste site;
2. An environmental medium such as air, water, or soil that can hold or move the contamination;
3. A point where people come into contact with a contaminated medium, such as water at the tap or soil in the yard;
4. An exposure route, such as ingesting (contaminated soil or water) or breathing (contaminated air); and
5. A population, such as people who live near or work on a contaminated waste site.

Generally, the ATSDR and FDOH consider three exposure categories:

- Completed exposure pathways—all five elements of a pathway are present;
- Potential exposure pathways—one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element; and
- Eliminated exposure pathways—at least one element is not present and will not likely be present.

Exposure pathways evaluate specific ways in which people were, are, or might be exposed to environmental contamination in the past, present, and future.

Completed Exposure Pathways

FDOH evaluated two completed human exposure pathways: off-site private wells and off-site public water supply wells (Table 5).

For these pathways, spilled or leaked solvents and leaking gasoline-storage tanks are the main sources of contamination. Groundwater is the environmental media. Taps and spigots in residences and businesses to the northeast of Technitronics are the points of exposure. Drinking (ingestion), inhalation of vapors from running water, and dermal contact are the routes of exposure.

In the past, users of contaminated private wells in the Foxmoor East neighborhood were an exposed population. DOH became aware of these exposures in 1994 when a homeowner complained of gasoline odors in their well water.

Since 1999, the City of Winter Springs has detected low levels of *cis*-1,2-dichloroethene in their public supply wells.

Potential Exposure Pathways

FDOH evaluated future potential use of potable water from wells that people could install in areas with contaminated water (Table 6). The extent of off-site groundwater contamination is not well defined and there are no restrictions for homeowners installing new private wells.[1]

For future wells, spilled or leaked solvents and leaking gasoline-storage tanks would be the main sources of contamination and groundwater the environmental media. Taps and spigots in residences and businesses would be the points of exposure. Drinking (ingestion), inhalation of vapors from running water and dermal contact would be the routes of exposure. New private well users would be the exposed population.

Eliminated Exposure Pathways

VOC vapor intrusion into on-site or nearby off-site buildings—Soil gas testing did not find solvent vapors in the indoor air or beneath the slab of the two on-site buildings [E&E 2013]. Extensive testing did not find contamination in surface or subsurface soil, nor did it show elevated chemicals in shallow groundwater that could serve as a source for vapor intrusion (Table 7, Figures 4 and 5) [E&E 2013, FDEP 2013].

Although the water table varies from 5-10 feet deep, on-site solvent contamination is primarily at 30 + feet (Figure 4) and gasoline-related contamination is at 20 feet and deeper (Figure 5). The sand-filled sinkhole in the northeastern corner of the Technitronics site acts as a groundwater conduit to deeper groundwater (Figure 6).FDEP installed wells north of the site on Bluebell Court. The water table is at 8 feet there, but they detected VOCs first at 33 feet below land surface (bls).

Surface Soil on and Near the Site—A small worker population exists on the site. Neighborhood children walk across the site to go to a convenience store [E&E 2013]. Because available test data did not find surface soil, soil gas, or indoor air contamination, there are no current exposure pathways for workers or others on the site (Table 7) [E&E 2013, FDEP 2013].

Private Wells—In 1994, FDEP connected four residences with contaminated wells on Jackson Circle and one on Murphy Road in the Foxmoor East neighborhood to city water (Table 7). A sixth residence owner with less than MCL tests results connected to city water themselves.

Public Health Implications

This assessment requires the use of assumptions and judgments, and relies on incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in the assessment of the site's impact on public health err on the side of protecting public health and may overestimate the risk (Appendix E).

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[1] St. Johns River Water Management District water well construction contact, hydrologist Wesley Curtis, confirmed that no regulations restrict homeowners from installing private wells in Seminole County, in non-delineated areas. Kipton Lockcuff of Winter Springs Utilities said that if reclaimed water were available for an area, they would not permit homeowners to drill irrigation wells (phone calls, 12/13/13).

FDOH provides site-specific public health recommendations based on toxicological literature, levels of environmental contaminants, evaluation of potential exposure pathways, duration of exposure, and characteristics of the exposed population. Whether a person will be harmed depends on the type/amount of contaminant, how they are exposed, how long they are exposed, how much contaminant is absorbed, genetics, and individual lifestyles.

After identifying contaminants of concern, FDOH evaluates exposures by estimating daily doses for children and adults. Kamrin [1988] explains the concept of dose as follows:

> …all chemicals, no matter what their characteristics, are toxic in large enough quantities. Thus, the amount of a chemical a person is exposed to is crucial in deciding the extent of toxicity that will occur. In attempting to place an exact number on the amount of a particular compound that is harmful, scientists recognize they must consider the size of an organism. It is unlikely, for example, that the same amount of a particular chemical that will cause toxic effects in a 1-pound rat will also cause toxicity in a 1-ton elephant.
>
> Thus instead of using the amount that is administered or to which an organism is exposed, it is more realistic to use the amount per weight of the organism. Thus, 1 ounce administered to a 1-pound rat is equivalent to 2,000 ounces to a 2,000-pound (1-ton) elephant. In each case, the amount per weight is the same, 1 ounce for each pound of animal.

This amount per weight is the *dose*. Toxicology uses dose to compare toxicity of different chemicals in different animals. They use the units of milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day) to express doses in this assessment[2].

To calculate the daily doses of each contaminant, FDOH uses standard factors needed for dose calculation [ATSDR 2005b; EPA 2011]. We also make the health protective assumption that 100% of the ingested chemical is absorbed into the body. The percent actually absorbed into the body is likely less.

The general formula for estimating a dose is:

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

Where:
D = exposure dose (mg/kg/day)
C = contaminant concentration (various units)
IR = intake rate (amount per day)
EF = exposure factor (unit less)

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[2] A milligram is 1/1,000 of a gram; a kilogram is approximately 2 pounds.

CF = conversion factor (10^{-6} kg/mg)
BW = body weight (kilograms or kg)

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

Where:
EF = exposure factor (unit less)
F = frequency of exposure (days/year)
ED = exposure duration (years)
AT = averaging time (days) (ED × 365 days/year for non-carcinogens; 78 years × 365 days/year for carcinogens)

Exposure Estimates

ATSDR groups health effects by duration (length) of exposure. Acute exposures are those with duration of 14 days or less; intermediate exposures are those with duration of 15 to 364 days; and chronic exposures are those that occur for 365 days or more (or an equivalent period for animal exposures).

For total in-home exposure to groundwater contaminated with VOCs, ATSDR recommends doubling the drinking (ingestion) dose to account for dermal and inhalation exposures through other household uses such as showering [Bogen and McKone 1988, McKone 1989, McKone and Knezovich 1991].

FDOH uses the following standard assumptions to estimate exposure from incidental ingestion of contaminated water:

1. children ages birth to 1 year drink an average of 0.5 liters and an upper percentile of 1 liter of water per day, and weigh 7.8 kg on average,
2. children ages 1 to 2 years drink an average of 0.31 liters and an upper percentile of 0.9 liter of water per day, and weigh 11.4 kg on average,
3. children ages 2 to 6 years drink an average of 0.5 liters and an upper percentile of 1 liter of water per day, and weigh 17.4 kg on average,
4. children ages 6 to 11 years drink an average of 0.5 liters and an upper percentile of 1.25 liters of water per day, and weigh 31.8 kg on average,
5. adolescents ages 11 to 21 years drink an average of 0.75 liters and an upper percentile of 2 liters of water per day, and weigh 64.2 kg on average,
6. adults ages 21 to 65 years drink an average of 1.18 liters and an upper percentile of 2.85 liters of water per day, and weigh 80.0 kg on average,
7. adults ages 65 to 78 years drink an average of 1.24 liters and an upper percentile of 2.6 liters of water per day, and weigh 76.0 kg on average.

FDOH compares estimated exposure doses to ATSDR chemical-specific minimal risk levels (MRLs). MRLs are comparison values that establish exposure levels many times lower than levels where researchers either did or did not observe adverse health effects in animal or human studies. ATSDR designs MRLs to protect the most sensitive, vulnerable individuals in a population. The chronic MRL is an exposure level below which non-cancerous harmful effects are unlikely, even after daily exposure over a lifetime.

Exceeding a comparison value does not imply that adverse health effects are expected. If contaminant concentrations are above comparison values, FDOH health scientists further analyze exposure variables (for example, duration and frequency), toxicology of the contaminants, past epidemiology studies, and the weight of evidence for health effects. We use chronic MRLs where possible because exposures are usually longer than a year. If chronic MRLs are not available, we use intermediate length MRLs [ATSDR 2005b].

For cancer, FDOH quantifies the increased estimated risk by using the general formula:

$$Risk = D \times ED \times SF \times ADAF / LT$$

Risk = Cancer risk
D = Age specific dose (mg/kg/day)
ED = Exposure duration (years)
SF = Slope factor $(mg/kg\text{-}day)^{-1}$
ADAF = Age Dependent Adjustment Factor (adjustment for mutagenic chemicals)
LT = Lifetime (78 years)

This is a high (conservative) estimate of the increased cancer risk. The actual increased cancer risk is likely lower. Because of large uncertainties in the way scientists estimate cancer risks, the actual cancer risk may be as low as zero.

To put the cancer risk into perspective, FDOH uses the following descriptors for the different numeric cancer risks:

1 in 1 (10^{-0})	"extremely high" increased risk
1 in 10 (10^{-1})	"very high" increased risk
1 in 100 (10^{-2})	"high" increased risk
1 in 1,000 (10^{-3})	"moderate" increased risk
1 in 10,000 (10^{-4})	"low" increased risk
1 in 100,000 (10^{-5})	"very low" increased risk
1 in 1,000,000 (10^{-6})	"extremely low" increased risk

We usually estimate the cancer risk from lifetime (78 years) exposure. Studies of animals exposed over their entire lifetime are the basis for calculating cancer slope factors. Usually, researchers know little about the cancer risk in animals from less than lifetime exposures. Therefore, we also use lifetime exposure to estimate the cancer risk in people.

Identifying Contaminants of Concern

FDOH compares the maximum concentrations of contaminants found at a site to ATSDR and other comparison values. Comparison values are specific for the medium contaminated (soil, water, air, etc.). We screen the environmental data using these comparison values:

- ATSDR Cancer Risk Evaluation Guides (CREGs)
- ATSDR Environmental Media Evaluation Guides (EMEGs)
- ATSDR Reference Media Evaluation Guides (RMEGs)
- FDEP Soil Cleanup Target Levels (SCTLs)
- EPA Maximum Contaminant Levels (MCLs)

When determining which comparison value to use, FDOH follows ATSDR's general hierarchy and uses professional judgment.

We select contaminants with maximum concentrations above a comparison value for further evaluation. Comparison values, however, are not thresholds of toxicity. We do not use them to predict health effects or to establish clean-up levels. A concentration above a comparison value does not necessarily mean harm will occur. It does indicate, however, the need for further evaluation. We do not evaluate maximum contaminant concentrations below comparison values further because it is unlikely these lower contaminant concentrations would cause adverse health effects.

FDOH selected 13 chemicals found in on-site groundwater above their comparison values as contaminants of concern (COCs). Of these 1,1,2-trichloroethane, 1,2-dichloroethane, *bis*(2-ethylhexylthalate), *cis*-1,2-dichloroethene, methylene chloride, tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride are likely site related. 1,2-Dibromoethane (EDB), benzene, ethylbenzene, naphthalene, and toluene, are likely related to leaking underground fuel tanks formerly located west of the Technitronics site. We include these chemicals in Tables 8 through 11 because on-site tests measured them above their screening levels.

General Effects of Exposure to VOCs and other COCs

To avoid repetition, we describe the general effects of exposure to VOCs before we describe the effects that differentiate them. VOCs evaporate easily and contain carbon. Most VOCs enter the body through inhalation or through ingesting water containing them. Many VOCs can also be absorbed to some extent through the skin. After they enter the body, the blood carries VOCs to the liver, kidney, brain, heart, spleen, and fat.

Most VOCs initially act to slow down brain activity, which doctors refer to as central nervous system (CNS) depression, except for *bis* (2-ethylhexylthalate) and naphthalene. Because naphthalene inhibits the oxygen carrying capacity of blood, it can also cause CNS depression. Symptoms of CNS depression include dizziness, drowsiness, headache, nausea, and shortness of breath. VOCs may also adversely affect the liver and kidneys. They rarely stay in the body more than 2 days, leaving the body mostly in the breath or urine.

1,1,2-Trichloroethane is a manufactured chemical that is used as a solvent and in making 1,1-dichloroethane. It has health effects typical of VOCs [ATSDR 1989]. Animal studies associate 1,1,2-trichloroethane exposure with liver cancer in mice, EPA classifies it as possible human carcinogen [ATSDR 2010a EPA 2013g].

1,2-Dibromoethane, also known as ethylene dibromide (EDB), is a manufactured chemical that was widely used in the past as a gasoline additive and pesticide. Although it has health effects typical of VOCs, EDB also reacts with the skin, gastrointestinal tract, liver, and kidneys causing blistering. EDB causes birth defects in offspring of exposed animals and people. A worker's inhalation of vapors causes bronchitis, headache, and depression [ATSDR 1992].

Animal studies associate EDB exposure with liver cancer and lung tumors in mice, tumors in the lungs and noses in rats, and cancer in multiple organs at higher exposure levels in rats (forestomach tumors, cancer of the blood vessels (hemangiosarcomas) and thyroid carcinomas) [ATSDR 1992]. EPA classifies 1,2-dibromoethane as a likely human carcinogen [EPA 2013g].

1,2-Dichloroethane (DCA) is a manufactured chemical used as a solvent and in making polyvinyl chloride pipes, construction materials, furniture and automobile upholstery, wall coverings, housewares, and automobile parts.

While DCA has health effects typical of VOCs, most human exposure effects are known at large doses. Doctors report nervous system disorders, liver and kidney disease, and lung effects. Researchers report similar effects in animals, in addition to reduced ability to fight infections (immune effects). Doctors have not reported adverse immune effects in people [ATSDR 2001].

Animal studies associate DCA exposure with cancer of the lining of the blood vessels (hemangiosarcoma) [EPA 2013g]. These tumors can occur throughout the body. Animal studies have also shown that skin exposure to DCA causes lung tumors [ATSDR 2001]. EPA classifies it as a probable human carcinogen [EPA 2013g].

Benzene comes from industrial and natural sources. It is highly flammable and is a component of gasoline and other fuels. While benzene may cause health effects typical of VOCs, high levels of exposure may also cause rapid heart rate, tremors, confusion, and unconsciousness. Skin contact with benzene may cause redness and sores. Eye contact can cause irritation and cornea damage [ATSDR 2007].

Long-term benzene exposure can disrupt normal blood production and harm the immune system. Benzene inhalation exposure has been associated with acute myeloid leukemia in humans [EPA 2013g].

***Bis*(2-Ethylhexylphthalate)** more commonly known as di(2-ethylhexyl phthalate) (DEHP) is a manufactured chemical commonly added to plastics to make them flexible. DEHP may be present in plastic products such as wall coverings, tablecloths, upholstery, shower curtains, garden hoses, swimming pool liners, plastic packaging, cable sheathing, medical tubing, and blood storage bags. Some vinyl products can contain up to 40% DEHP.

DEHP can enter the body through the skin, inhalation, or when a person drinks water containing this compound. After DEHP enters the body, it is poorly absorbed from the gut and much leaves the body in stool. DEHP and its metabolites that do enter the body can travel to other organs through the bloodstream and may be stored in the fat, but most will leave the body within 24 hours [ATSDR 2002].

In rats and mice, high-dose, long-term exposures caused health effects in the liver and testes. DEHP induced these effects at levels much higher than those received by humans from typical environmental exposures did. Although a few animal studies report effects in the thyroid, ovaries, kidneys, and blood, toxicity of DEHP in tissues other than the liver and testes is less well known. The potential for kidney effects is a particular concern for humans because dialysis exposes the kidney to DEHP in tubing and because exposed rats have shown structural and functional kidney changes.

Animal studies associate DEHP exposure with liver cancer in rats and mice, EPA classifies it as a possible human liver carcinogen [EPA 2013g].

***Cis*-1,2-Dichloroethene (*cis*-1,2-DCE)** is a manufactured chemical that is used to produce solvents and in chemical mixtures. C*is*-1,2-DCE also forms as PCE and TCE break down.

In addition to causing health effects typical of VOCs, in animal studies *cis*-1,2-DCE exposure decreased the numbers of red blood cells and adversely affected livers. One animal study suggested *cis*-1,2-DCE exposure caused slower fetal growth [ATSDR 1996].

No studies have been done to see whether *cis*-1,2-DCE exposures cause cancer in people or animals [EPA 2013g].

Ethylbenzene comes from industrial and natural sources. It is highly flammable. It is a component of gasoline, other fuels, inks, pesticides, and paints.

While ethylbenzene may cause health effects typical of VOCs, exposure to high levels in air for short periods can also cause eye and throat irritation. In addition, animal studies showed exposure to relatively low concentrations of ethylbenzene for several days to weeks resulted in potentially irreversible damage to the inner ear and hearing. Animal studies showed longer exposures to low levels caused kidney damage [ATSDR 2010b].

Long-term ethylbenzene inhalation caused an increase in kidney tumors in rats and liver and lung tumors in mice. Ethylbenzene exposure has not been associated with cancer in humans [EPA 2013b].

Methylene chloride (also known as dichloromethane) is a manufactured chemical. Because it is not very flammable, it is widely used as a paint-stripper. Methylene chloride may also be a component of pesticides, cleaners, and paints.

While methylene chloride may cause health effects typical of VOCs, workers' exposures to high levels in air for short periods have also caused slowed reaction times and difficulty performing tasks requiring precise hand movements. In addition to typical CNS depression symptoms, methylene chloride may cause tingling or numbness of the fingers and toes. Methylene chloride vapors can cause eye irritation and cornea damage. Direct contact with the liquid can cause skin and eye damage similar to burns. Animal studies showed exposures to low levels for long periods caused liver and kidney changes, but researchers have not observed similar effects in people [ATSDR 2000b, ATSDR 2010c].

Long-term methylene chloride inhalation caused an increase in liver and lung tumors in mice. Long-term ingestion exposure caused liver tumors in male mice. Based on these studies, the EPA classifies methylene chloride as a likely human carcinogen linked to cancers or tumors of the liver [EPA 2013g].

Naphthalene is a component of gasoline, other fuels, and pesticides. It is flammable when mixed with air. While exposure to naphthalene can cause some health effects typical of other VOCs, exposure to high levels of naphthalene may damage or destroy red blood cells. This could cause exposed persons to have too few red blood cells until their body replaces the destroyed cells (a disease called hemolytic anemia). Symptoms are fatigue, lack of appetite, restlessness, and pale skin. Doctors have reported these symptoms from studies of people who have eaten mothballs containing naphthalene [ATSDR 2005a].

Long-term naphthalene inhalation caused an increase in nasal tumors in rats and an increase in nasal and lung tumors in mice. While EPA classifies naphthalene as a possible human carcinogen, they have not calculated a cancer slope factor [EPA 2013c].

Tetrachloroethene (also known as Perchloroethylene, PCE) is a manufactured chemical that is widely used for dry cleaning of fabrics and for degreasing metal. Consumer products that may contain PCE include water repellents, silicone lubricants, fabric finishers, spot removers, glues, and wood cleaners. Manufacturers also use PCE to make other chemicals.

PCE affects the central nervous system following either oral or inhalation exposure. In the past, doctors used PCE as a general anesthetic, because at high concentration it causes loss of consciousness. Other effects known from medical studies of exposed workers include loss of color vision, slowed reactions, slowed thinking, sleepiness, and nausea. At elevated levels, PCE also affects the immune, developmental, reproductive, and blood-forming systems [ATSDR 1997a].

Epidemiologic studies associate PCE exposure with bladder cancer, non-Hodgkin's lymphoma, and multiple myeloma. Limited epidemiological data suggest an association between PCE exposures and esophageal, kidney, liver, cervical, and breast cancer. EPA extrapolates the cancer slope factor for PCE from studies of liver cancer in animals [EPA 2013d].

Toluene comes from industrial and natural sources. It is highly flammable. It is a component of gasoline, other fuels, paints, adhesives, and synthetic rubber. Workers use toluene in printing and leather tanning.

While toluene may cause health effects typical of VOCs, worker studies show that low to moderate day-after-day exposures can cause tiredness, confusion, weakness, memory loss, nausea, and loss of appetite [ATSDR 2000a]. Workers with long-term exposure also had hearing loss and loss of color vision, although studies did not note if these changes are permanent. Medical studies show high levels of toluene exposure may cause kidney damage. Toluene compounds the effects of alcohol on the liver and of aspirin and acetaminophen on hearing [ATSDR 2004a].

Toluene exposure has not been associated with cancer in humans [EPA 2013e].

Trichloroethene (TCE) is a manufactured chemical that is widely used for degreasing metal. Manufacturers also use TCE in correction fluid, solvents, paint removers, glues, and spot removers. TCE also forms as PCE breaks down.

TCE affects the central nervous system following either oral or inhalation exposure. In the past, doctors used TCE as an anesthetic, because at high concentration it causes sleepiness and loss of consciousness. In addition to typical CNS effects, TCE-exposed workers also experienced higher rates of death from asthma. People who breathe high levels of TCE may have damage to their facial nerves. High exposure levels in humans associated with work environments have also resulted in changes in heartbeat and liver and kidney damage. Exposed workers experienced a significant increased risk of death from ischemic heart disease [ATSDR 1997b, 2013]. Even low levels of worker exposure to TCE affected balance and caused tremors, showing neuromotor function effects. Some workers who got TCE on their skin developed skin rashes. Health scientists believe these skin disorders have an immune component [ATSDR 2013].

Animal inhalation studies link hearing loss caused by the loss of nerve cells in the inner ear with inhalation of TCE vapors. In animal studies, inhalation and ingestion exposures also caused fetal heart defects, decreased thymus weights (the primary gland of the body's immune system), and changes in kidney tissue, which could lead to cancer [EPA 2013f].

Human epidemiologic studies associate TCE exposure with kidney cancer and non-Hodgkin's lymphoma. There are weaker epidemiologic associations with liver and biliary tract cancers. The biliary tract is the pathway of bile from the gallbladder to the small intestine. Human epidemiologic studies also provide weaker associations with TCE exposure and other types of cancer, including bladder, esophageal, lung, prostate, cervical, breast, and childhood leukemia [EPA 2013f].

Vinyl chloride is a colorless gas at room temperature. Although breakdown of PCE and TCE are the sources of site-related vinyl chloride, most studies involve exposures to manufactured PVC. Manufactured vinyl chloride is a liquid when stored at high pressures and low temperatures. It is the raw material for a polymer called polyvinyl chloride or PVC. Manufacturers use PVC plastic to make pipes, wire and cable coatings, packaging materials, upholstery fabric, wall coverings, and car parts [ATSDR 2013].

In addition to the health effects typical of VOCs, workers breathing very high levels of vinyl chloride have lost consciousness and died if they did not return to fresh air within a short time period. Workers exposed to vinyl chloride vapors at the highest studied levels had liver structure changes and nerve damage. Animal studies have shown that inhaling high levels of vinyl chloride can damage the liver, lungs, kidneys, and heart.

Long-term worker studies associate vinyl chloride inhalation exposure with liver cancer. Animal ingestion studies also show liver cancer risk. In worker inhalation studies, there are weaker associations with brain, lung, and blood cancers [ATSDR 2006].

Site Specific Effects of VOCs and other COCs

The following sections describe the results of the calculations we made for residential use of groundwater. We used the highest measured levels of individual VOCs in our calculations. City of Winter Springs municipal water and private well use in the past are completed exposure pathways. Tests identified very low levels (below the MCL) of *cis*-1,2-dichloroethene in finished City of Winter Springs tap-ready water pumped to homes (also known as point of entry, POE). Tests identified low levels of benzene, trichloroethene, and vinyl chloride in private potable wells in the early 1990s, which were slightly above their MCLs. The number of well water samples was insufficient for determining an average value for each contaminant.

Completed Exposure Pathways

City of Winter Springs Municipal Water

***Cis*-1,2-Dichloroethene** non-cancer risk—The highest dose calculated for children for 0.00159 milligrams per liter (mg/L) (at WTP3, 9/18/2008) with maximum exposure for birth to one year–0.0005 mg/kg/day–is 4 times less than the chronic reference dose of 0.002 mg/kg/day [EPA 2012]. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Therefore, use of this water was unlikely to have caused—is unlikely to cause—any non-cancer illnesses. Effects seen in animals at the lowest dose showing effects were increased liver weights in female rats.

***Cis*-1,2-Dichloroethene** cancer risk—EPA has not classified *cis*-1,2-dichloroethene as a carcinogen due to lack of human epidemiological studies or animal studies.

Private Well Water

Benzene non-cancer risk—Drinking and showering with private well water containing the highest concentration of benzene (0.0021 mg/L) was not a likely cause of non-cancer illness in residents. The estimated daily dose of benzene varies from a maximum of 0.0006 mg/kg/day for 0 to 1 year olds to an average of 0.00006 mg/kg/day for adults (Table 8). While the calculated 0–1 year old dose is slightly higher than the ATSDR Minimum Risk Level (MRL), 0.0005 mg/kg, all doses are over 400 times lower than the Lowest Observable Adverse Effect Level (LOAEL) dose, 0.29 mg/kg/day.[3] Therefore, non-cancer illness is unlikely.

Benzene cancer risk—The estimated increased lifetime cancer risk for residents drinking and showering with private well water containing the highest level of benzene, 0.0021 mg/L, would have varied from 4×10^{-7} to 4×10^{-6} (Table 8). These are extremely low estimated increased cancer risks of 4 additional cases in 10 million to 4 additional cases in 1 million people. The actual risks are probably lower, because residents stopped drinking this water in 1994 and are unlikely to have been drinking water contaminated at the highest measured level for 30 years (for the benzene level and daily water use period we used in our calculations).

Trichloroethene non-cancer risk—Drinking and showering with private well water containing 0.0078 mg/L trichloroethene was not a likely cause of non-cancer illness in residents. The estimated daily dose varies from a maximum of 0.002 mg/kg/day for 0 to 1 year olds to an average of 0.0002 mg/kg/day for adults. While 5 of the 7 doses calculated for maximum exposure are slightly higher than the ATSDR Minimum Risk Level (MRL) of 0.0005 mg/kg, they are 24 to 240 times lower than the 0.048 mg/kg/day LOAEL and are thus not likely to cause non-cancer illness (Table 8).[4]

Trichloroethene cancer risk—The estimated increased lifetime cancer risk for residents drinking and showering with private well water containing the highest level of trichloroethene, 0.0078 mg/L, varies from 2 to 4×10^{-5} (Table 8). These are very low estimated increased cancer risks of 2 to 4 additional cases in 100 thousand people.

Vinyl chloride non-cancer risk—Drinking and showering with private well water containing the highest concentration of vinyl chloride (0.0043 mg/L) was not likely to cause non-cancer illness in residents. The estimated daily dose varies from a maximum of 0.001 mg/kg/day for 0 to 1 year olds to an average of 0.0001 mg/kg/day for adults (Table

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[3] A LOAEL is the lowest concentration or amount of a substance found by experiment or observation that causes an adverse alteration of shape, function, capacity, growth, development, or lifespan of a target organism distinguished from normal organisms for the same species under defined exposure conditions. The Lowest Observable Adverse Effect Level (LOAEL) for chronic benzene exposure is 0.29 mg/kg [ATSDR 2007]. ATSDR extrapolated route-to-route exposure for occupational inhalation exposure at 0.57 ppm that resulted in reduced white blood cell and platelet counts (blood cell levels were approximately 7-18% lower than controls).
[4] The LOAEL for chronic (lifetime) trichloroethene exposures is 0.048 mg/kg/day (maternal dose for increased incidence of cardiac malformations in the fetus of female rats) [ATSDR 2013]. Human epidemiologic studies also show developmental effects including cardiac malformations for children born to women who drank water with solvents, including TCE [ATSDR 1997].

8). None of the calculated doses is higher than the ATSDR Minimum Risk Level (MRL) of 0.003 mg/kg. Therefore, non-cancer illness is unlikely.

Vinyl chloride cancer risk—The estimated increased lifetime cancer risk for residents drinking and showering with private well water containing the highest level of vinyl chloride ranges from 2×10^{-4} to 4×10^{-5} (Table 8). These are low to very low estimated increased cancer risks of 2 additional cases in 10 thousand to 4 additional cases in 100 thousand people.

Potential Exposure Pathways (future)

On-site Groundwater

FDOH calculated doses to evaluate health risks for future residents who might use on-site groundwater for drinking, showering, and other household uses (Table 9). We used the highest measured level of each chemical. Based on these calculations, we found use of on-site groundwater for drinking, showering, and other household uses would cause illness. Currently the site is supplied city water, it is a commercial site, and the state regulates on-going contamination cleanup plans. Therefore, our exposure scenario assumptions are not likely to occur. The following estimates are hypothetical and support the need for site cleanup.

On-site groundwater has 6 chemicals with doses that exceed their minimum risk levels (Table 9). These are benzene, *cis*-1,2-dichloroethene, methylene chloride, tetrachloroethene, toluene, and trichloroethene. We compared the doses of these 6 VOCs with their LOAEL doses to estimate the likelihood of non-cancer health effects. Some benzene and *cis*-1,2-dichloroethene doses were close enough to their LOAELs that we could not rule out the possibility of non-cancer illness for future groundwater use. Animal studies showed changes in red blood cell synthesis and increases in kidney weight at these *cis*-1,2-dichloroethene exposure levels [ATSDR 2007, 1996]. The highest estimated dose for trichloroethene was associated with decreased thymus weights in female mice, developmental toxicity in mice, and increased cardiac malformation in fetal rats [ATSDR 1997b].

We evaluated eight on-site chemicals for their potential to increase cancer risks (Table 9). If people drank and used on-site groundwater for residential water supplies, the estimated increased cancer risks for the highest measured levels would be:

- extremely high for trichloroethene,
- moderate to low for benzene,
- very low for 1,2-dichloroethane and 1,1,2-trichloroethane,
- very low to extremely low for 1,2-dibromoethane and vinyl chloride, and
- extremely low for *bis*(2-ethyl-hexyl phthalate) and tetrachloroethene.

Groundwater Adjacent to the Site

Five chemicals in groundwater adjacent to the site have doses that exceed their minimum risk level (Table 10). For benzene, *c*is-1,2-dichloroethene, toluene, and vinyl chloride, the highest estimated dose for daily ingestion of this water is well below the LOAEL, meaning while they exceed their MRLs, non-cancer health effects are unlikely. For trichloroethene, however, the highest estimated dose for daily ingestion is only 2.5 to 10 times less than the LOAEL for fetal heart malformation. Therefore, the dose of TCE from drinking this water is too close to the LOAEL to rule out the possibility of non-cancer illness.

Four of these off-site chemicals could increase cancer risks (Table 10). For the highest measured levels, the increased cancer risks are:

- moderate for vinyl chloride,
- very low for trichloroethene,
- very low to extremely low for benzene, and
- extremely low for 1,2-dichloroethane.

Health Outcome Data

FDOH did not evaluate health outcome data. Our calculations of the highest doses for each chemical with completed exposure pathways–potable well water prior to 1994–were too low to indicate a risk for non-cancer illness. The population exposed consisted of 5 households. Determining whether cancer is more prevalent in such a small exposed population may not be statistically possible for estimated increased risks this small: from 2 in 10,000 for vinyl chloride to 4 in 1 million for benzene.

Child Health Considerations

In communities faced with air, water, soil, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults are for certain kinds of exposure to hazardous substances. Children play outdoors and sometime engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults are; this means they breathe dust, soil, and vapors closer to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body system of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

In general, premature babies and newborns with immature/developing organs are more vulnerable to toxic substances than are healthy adults. In addition, if the metabolic products are more toxic than the parent compound, children and adolescents (with higher metabolic rates) are more vulnerable than healthy adults [ATSDR 1997b].

Completed Exposure Pathway Chemicals

Of the chemicals in the private drinking water wells near this site prior to 1994, only trichloroethene and vinyl chloride might pose greater health risks for children than adults for the following reasons.

- Based on animal studies, the developing fetal heart may be susceptible to the toxic effects of trichloroethene. In addition, an epidemiologic study showed that maternal age at delivery and trichloroethene exposure might be factors in increasing the risk of congenital health defects. The fetal immune system may also be susceptible to the toxic effects of trichloroethene. A study with mice showed that a single trichloroethene exposure resulted in increased thymocyte cellularity, a condition associated with altered immune system regulation [ATSDR 2013].

- Animal studies suggest early life exposure to vinyl chloride increases cancer risk. We used a cancer slope factor in our dose calculations to account for this early life-stage sensitivity to vinyl chloride [ATSDR 2006].

Potential Exposure Pathway Chemicals

If children are exposed to contaminated groundwater from on-site sources in the future, 1,2-dibromoethane, 1,2-dichloroethane, *bis*-2-ethyl-hexyl)phthalate, ethylbenzene, naphthalene, tetrachloroethene, and toluene may put them at greater risk of illness than adults. We include information on children's special sensitivity to these chemicals in Appendix D.

Other Susceptible Populations

Other susceptible populations may have different or enhanced susceptibilities to chemicals than will most persons exposed to the same levels of that chemical in the environment. Reasons may include genetic makeup, age, health, nutritional status, and exposure to other toxic substances (like cigarette smoke and alcohol). These factors may limit that person's ability to detoxify or excrete harmful chemicals or may increase the effects of damage to their organs or systems. ATSDR and EPA comparison values and standards include safety factors that take into account and protect these susceptible populations.

Only benzene, trichloroethene, and vinyl chloride had completed exposure pathways and exceeded their cancer-risk based comparison values.

Benzene:

- Genetic differences associated with metabolism may cause variability in human susceptibility to benzene toxicity. Workers with genes for both negligible NQ01 activity and rapid CYP2E1 activity exhibited greater than seven-fold increased risk of benzene poisoning than workers not expressing these polymorphisms. These genes make enzymes that protect cells, especially fatty membranes, from oxidation (NQ01) and metabolize foreign chemicals (CYP2E1).

- Individuals with reduced bone marrow function or decreased blood factors would be at increased risk for benzene toxicity. Treatments for medical conditions might result in decreases in particular blood factors, which could lead to increased susceptibility to benzene poisoning.

- The enhancement of the blood-toxicity effects of benzene by ethanol is of particular concern for benzene-exposed workers who consume alcohol. Accordingly, increased central nervous system depression may follow concurrent exposure to benzene and ethanol. Ethanol can increase the severity of benzene-induced anemia, lymphocytopenia (abnormally low lymphocytes, white blood cells), reduce bone marrow cellularity, produce transient increases in normoblasts (unusually large nucleated-red blood cells associated with pernicious anemia and folic acid deficiency) in the peripheral blood, and facilitate atypical cellular morphology.

- Benzene caused gender-related differences in susceptibility in animals showing greater genotoxicity (chemicals that damage the genetic information in cells) in males, relative to females. Physiologically-based pharmacokinetic modeling suggests that women exhibit a higher blood/air partition coefficient and maximum velocity of benzene metabolism than men, and that women metabolize 23-26% more benzene than men under similar exposure scenarios. However, gender-related differences in susceptibility among benzene-exposed workers were not located in available reports.

Trichloroethene:

- Workers who used TCE for long periods may develop an allergy to it or become particularly sensitive to its effects on the skin. People who smoke may increase their risk of toxic effects from TCE. However, these data are equivocal and limited. People who consume alcohol or who take disulfiram may be at greater risk of TCE poisoning because ethanol and disulfiram can both inhibit the metabolism of trichloroethene and can cause it to accumulate in the bloodstream, potentiating its effects on the nervous system.

- Compromised liver and kidney function increases the risk from exposure to trichloroethene or its metabolites since the liver serves as the primary site of TCE metabolism and the kidney as the major excretory organ for TCE metabolites.

- Because inhaled TCE can cause cardiac arrhythmias, individuals with a history of cardiac rhythm disturbances may be more susceptible to high-level trichloroethene exposure.

- Women are more susceptible than men are to TCE. Women excrete more urinary metabolites than men do. Studies showed testosterone as a factor in the lower absorption of trichloroethene in male rats compared with females [ATSDR 1997a].

Vinyl Chloride:

- Studies have shown that some workers are more susceptible than others are to high levels of vinyl chloride exposure. These high levels cause problems with blood flow in workers' hands and may cause their fingertips to fuse. Persons with impaired circulation due to some other cause such as connective tissue disorders, systemic sclerosis (thickening of tissues), hyperviscosity of the blood, or use of vibrating tools, may experience more severe impairment of the circulation [ATSDR 2005].

- People with liver disease (such as hepatitis B), irregular heart rhythms, exposure to organochlorine pesticides, and people consuming ethanol or barbiturates or taking Antabuse for alcoholism, are more susceptible to the health effects of vinyl chloride.
- People who possess the HLA-DR5, HLA-DR3, and B8 alleles may be at increased risk of developing liver toxicity and liver cancers than are the general population. These genes regulate the immune responses of the body.

Community Health Concerns Evaluation

Past exposures to contaminants in the private potable wells in the Foxmoor East neighborhood one-half mile northeast of Technitronics were not likely to have caused non-cancer illness. The increased lifetime cancer risk for drinking and household use of water from these wells ranges from "low" to "extremely low" (see cancer risk descriptors on page 14). The highest dose for the highest level of *cis*-1,2-dichloroethene measured in the tap-ready water from the Winter Springs well field 1 mile northeast of Technitronics was 4 times less that the EPA RfD. Therefore, at this level and at other lower measured levels, traces of *cis*-1,2-dichloroethene in municipal water are not likely to have caused illness.

Testing of private potable wells and city-water has assured that both private and municipal users have not consumed contaminated water since 1994. Additional testing did not find other completed exposure pathways on or near the site. The FDOH staff in Seminole County tests private wells when warranted.

Conclusions

1. Shallow groundwater under the Technitronics site is highly contaminated. Shallow groundwater northeast of the site is also contaminated. FDOH has not identified anyone ***currently*** using this contaminated groundwater. Future use of contaminated groundwater under or near the site is unlikely due to its strong chemical smell and because municipal water is available. FDEP has not determined how far groundwater contamination extends.

Drinking, showering, and household use of groundwater under the site with the highest TCE levels could cause illness and an extremely high increased cancer risk. Similar use of groundwater northeast of the site with the highest levels of vinyl chloride could cause a moderate increased cancer risk.

2. In 1994, FDOH staff in Seminole County found VOC contamination in private drinking water wells about one-half mile northeast of the Technitronics site. Although levels of benzene, trichloroethene and vinyl chloride were slightly above drinking water standards, residents were not at significant risk of illness. FDEP connected these houses to city water. From time to time, FDOH staff in Seminole County tests the closest private drinking water wells but so far, none is contaminated.

Although VOC levels in these wells were slightly above drinking water standards, FDOH found non-cancer illness was not likely. Increased cancer risks ranged from very low to extremely low. FDOH estimated the health risks for long-term use of water with the highest levels measured in 1994.

3. People using City of Winter Springs municipal well water are currently not at risk of illness from *cis*-1,2-dichloroethene. Tests have not found any solvents in municipal well water other than *cis*-1,2-dichloroethene. In 2002, the highest level of *cis*-1,2-dichloroethene measured in City water (0.00159 mg/L) was 44 times less than the drinking water standard of 0.070 mg/L.

4. Workers and others on the site are not at risk from chemicals in surface soil or vapor intrusion. FDEP did not find elevated solvent levels in on-site surface soil, soil gas, or indoor air. Because solvents at the groundwater surface are limited to areas away from on-site buildings, vapor intrusion is unlikely.

5. Solvents in groundwater are not likely to enter nearby homes via vapor intrusion. Chlorinated solvents sink in groundwater because they are denser than water. Once they sink through the groundwater, they do not come back up. Offsite monitoring wells show that the solvents in groundwater are well below the surface and therefore unlikely to move up into soil gas or through cracks in the foundation of nearby homes.

Recommendations

1. FDOH recommends people not install drinking water wells on or near the Technitronics site. FDOH also recommends FDEP or EPA determine the full extent of groundwater contamination.

2. FDOH recommends the FDOH staff in Seminole County continue testing private drinking water wells northeast of the Technitronics site as warranted.

3. FDOH recommends the City of Winter Springs continue to test their water for solvents.

Public Health Action Plan

Actions Undertaken

In 1994, FDOH staff in Seminole County found solvent contamination in private drinking water wells about one-half mile northeast of the Technitronics site. FDEP connected these houses to city water. FDOH staff in Seminole County continues to test the closest private drinking water wells as warranted. These tests have not identified additional contaminated wells.

On August 25, 2014, FDOH posted the public comment draft of this report on our website http://www.floridahealth.gov/environmental-health/hazardous-waste-sites/health-assessments.html. On August 22, 2014, we mailed out a community update to approximately 900 nearby residents and other interested parties. This update summarized the draft report, gave the web address for the complete report, solicited public comments, and announced the date and location of the upcoming Open House. The Community Update included a survey response to evaluate peoples' understanding of our report summary.

FDOH hosted an Open House meeting from 3:00 to 7:30, Tuesday September 9, 2014 at the Seminole County Public Library, Jean Rhein Central Branch—215 North Oxford Road, Casselberry Florida. Staff from FDOH staff in Seminole County and FDEP Central Office co-hosted the Open House with us.

The public comment period closed September 26, 2014. FDOH received the five written comments from nearby residents and property owners that we address in Appendix C. FDOH posted the final report at http://www.floridahealth.gov/environmental-health/hazardous-waste-sites/health-assessments.html.

Actions Underway

FDEP is working with the site owners to find and remediate site-related contamination. FDEP has also asked EPA for remediation help.

Actions Planned

The FDOH staff in Seminole County will continue to test private drinking water wells northeast of the Technitronics site as warranted.

The City of Winter Springs will continue to test their water monthly for *cis*-1,2-dichloroethene and other solvents from the Technitronics site.

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The Florida Department of Health prepared this health consultation for the Technitronics site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. ATSDR, the cooperative agreement partner, completed editorial review and concurs with its findings based on the information presented.

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Appendix A—Tables and Figures

Table 1. VOC Concentrations in Groundwater below the Technitronics Site

Contaminants of Concern	Concentration Range (µg/L)	Screening Guideline (µg/L)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1,2-Trichloroethane	<0.2-31	0.61 CREG	ATSDR	12/118
1,2-Dibromoethane	<0.1-0.76	0.018 CREG	ATSDR	7/118
1,2-Dichloroethane	<0.2-190	0.38 CREG	ATSDR	46/118
Benzene	<0.2-2900	0.64 CREG	ATSDR	78/118
Bis(2-ethylhexyl)phthalate	<3.6-11	2.5 CREG	ATSDR	4/118
Cis-1,2-Dichloroethene	<0.5-10,000	20/70 RMEG	ATSDR	13/118
Ethylbenzene	<0.5-1,400	700 LTHA	EPA	5/118
Methylene Chloride	<0.5-570	5 MCL	EPA	3/118
Naphthalene	<0.23-260	100 LTHA	EPA	3/118
Tetrachloroethene (PCE)	< 0.25-47	17 CREG	ATSDR	5/118
Toluene	< 0.5-8,600	200/700 EMEG	ATSDR	13/118
Trichloroethene (TCE)	< 0.5-270,000	0.76 CREG	ATSDR	72/118
Vinyl Chloride	<0.5-0.56	0.2 CREG	ATSDR	2/118

µg/L = micrograms per liter
ATSDR–Agency for Toxic Substances and Disease Registry
CREG–Cancer Risk Evaluation Guide
RMEG–Reference Dose Media Evaluation Guide
LTHA–Lifetime Health Advisories
MCL–Maximum Concentration Level
EMEG–Environmental Media Evaluation Guides

Data Sources: FDEP 2007, FDEP 2013, E&E 2013

Table 2. VOC Concentrations in Groundwater Adjacent to (Downgradient of) the Technitronics Site

Contaminants of Concern	Concentration Range (µg/L)	Screening Guideline (µg/L)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1,2-Trichloroethane	<0.2	0.61 CREG	ATSDR	0/16
1,2-Dibromoethane	<0.1	0.018 CREG	ATSDR	0/16
1,2-Dichloroethane	<0.2-0.62	0.38 CREG	ATSDR	1/16
Benzene	<0.2-27	0.64 CREG	ATSDR	3/16
Bis(2-ethylhexyl)phthalate	<3.6	2.5 CREG	ATSDR	0/16
Cis-1,2-Dichloroethene	<0.5-290	20/70 RMEG	ATSDR	4/16
Ethylbenzene	<0.5-8.1	700 LTHA	EPA	0/16
Methylene Chloride	<0.5-35	5 MCL	EPA	2/16
Naphthalene	<0.23	100 LTHA	EPA	0/16
Tetrachloroethene (PCE)	<0.5-1.3	17 CREG	ATSDR	0/16
Toluene	<0.48-1,900	200/700 EMEG	ATSDR	1/16
Trichloroethene (TCE)	<0.5-7.6	0.76 CREG	ATSDR	4/16
Vinyl Chloride	<0.5-12	0.2 CREG	ATSDR	3/16

µg/L = micrograms per liter
ATSDR–Agency for Toxic Substances and Disease Registry
CREG–Cancer Risk Evaluation Guide
RMEG–Reference Dose Media Evaluation Guide
LTHA–Lifetime Health Advisories
MCL–Maximum Concentration Level
EMEG–Environmental Media Evaluation Guides

Data Sources: FDEP 2007, FDEP 2013, E&E 2013

Table 3. VOC Concentrations in the Foxmoor East Neighborhood Private Drinking Water Wells Downgradient from Technitronics

Contaminants of Concern	Concentration Range (µg/L)	Screening Guideline (µg/L)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1,2-Trichloroethane	<0.2	0.61 CREG	ATSDR	0/10
1,2-Dibromoethane	<0.1	0.018 CREG	ATSDR	0/10
1,2-Dichloroethane	<0.2	0.38 CREG	ATSDR	0/10
Benzene	<0.2-2.1	0.64 CREG	ATSDR	2/10
Bis(2-ethylhexyl)phthalate	<3.6	2.5 CREG	ATSDR	0/10
Cis-1,2-Dichloroethene	<0.3-15	20/70 RMEG	ATSDR	0/10
Ethylbenzene	<0.5-8.8	700 LTHA	EPA	0/10
Methylene Chloride	<0.5	5 MCL	EPA	0/10
Naphthalene	<0.23	100 LTHA	EPA	0/10
Tetrachloroethene (PCE)	<0.5	17 CREG	ATSDR	0/10
Toluene	<0.48-1.8	200/700 EMEG	ATSDR	0/10
Trichloroethene (TCE)	<0.17-7.8	0.76 CREG	ATSDR	2/10
Vinyl Chloride	<0.5-4.3	0.2 CREG	ATSDR	6/10

µg/L = micrograms per liter
ATSDR–Agency for Toxic Substances and Disease Registry
CREG–Cancer Risk Evaluation Guide
RMEG–Reference Dose Media Evaluation Guide
LTHA–Lifetime Health Advisories
MCL–Maximum Concentration Level
EMEG–Environmental Media Evaluation Guides

Data Sources: FDEP 2007, FDEP 2013, E&E 2013

Table 4. VOC Concentrations in the Winter Springs Municipal Water Supply (Wells Downgradient from Technitronics)

Contaminants of Concern	Concentration Range (µg/L)	Screening Guideline (µg/L)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1,2-Trichloroethane	<0.2	0.61 CREG	ATSDR	0/9
1,2-Dibromoethane	<0.1	0.018 CREG	ATSDR	09
1,2-Dichloroethane	<0.2	0.38 CREG	ATSDR	0/9
Benzene	<0.2	0.64 CREG	ATSDR	0/9
Bis(2-ethylhexyl)phthalate	<3.6	2.5 CREG	ATSDR	0/9
Cis-1,2-Dichloroethene	<0.5-1.59	20/70 RMEG	ATSDR	0/9
Ethylbenzene	<0.5-79	700 LTHA	EPA	0/9
Methylene Chloride	<0.5	5 MCL	EPA	0/9
Naphthalene	<0.23	100 LTHA	EPA	0/9
Tetrachloroethene (PCE)	<0.5	17 CREG	ATSDR	0/9
Toluene	<0.48	200/700 EMEG	ATSDR	0/9
Trichloroethene (TCE)	<0.5	0.76 CREG	ATSDR	0/9
Vinyl Chloride	<0.5	0.2 CREG	ATSDR	0/9

µg/L = micrograms per kilogram
ATSDR–Agency for Toxic Substances and Disease Registry
CREG–Cancer Risk Evaluation Guide
RMEG–Reference Dose Media Evaluation Guide
LTHA–Lifetime Health Advisories
MCL–Maximum Concentration Level
EMEG–Environmental Media Evaluation Guides

Data Sources: FDEP 2007, FDEP 2013, E&E 2013

Table 5. Completed Human Exposure Pathways for the Technitronics Hazardous Waste Site

COMPLETED PATHWAY NAME	COMPLETED EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	ENVIRON-MENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULA-TION	
Public Water Supply	VOCs from Technitronics and other nearby sites	Groundwater	Residences and Businesses, Tap	Ingestion, Dermal, Vapor Inhalation	Winter Springs public water supply users	Past (since 1999), present, and future
Private Wells	VOCs from Technitronics and other nearby sites	Groundwater	Residences, Tap	Ingestion, Dermal, Vapor Inhalation	Private potable well users	Past (the users of the 4 remaining private wells should not have completed exposures as long as periodic testing verifies that these wells remain uncontaminated).

Table 6. Potential Human Exposure Pathways for the Technitronics Hazardous Waste Site

POTENTIAL PATHWAY NAME	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	ENVIRON-MENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION	
Future potable wells	VOCs from Technitronics	Groundwater	Tap Water at Residences and Businesses	Ingestion, Dermal Absorption, and Vapor Inhalation	Users of new potable wells	Future

Table 7. Eliminated Human Exposure Pathways for the Technitronics Hazardous Waste Site

ELIMINATED PATHWAY NAME	ELIMINATED EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	ENVIRON-MENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Vapor intrusion into on-site and nearby off-site buildings	VOCs from Technitronics and other nearby sites	Soil gas	Inside nearby commercial and residential buildings	Inhalation	None	---
Surface soil on and near the site	VOCs from Technitronics and other nearby sites	Surface soil	On-site and on nearby properties	Incidental ingestion	None	---
Private wells on Tradewinds East, Tradewinds West, and Jackson Circle	VOCs from Technitronics and other nearby sites	Groundwater	Off-site private well water	Ingestion, inhalation of vapors or skin contact with groundwater	Users of private potable wells who had contamination identified and were hooked up to municipal supplies in 1994	Present and Future

Table 8. Increased Cancer Risks for Highest VOC Levels Measured in Private Potable Supply Wells; Maximum and Central Tendency Dose Estimates for Past Ingestion, Inhalation, and Dermal Contact

Chemical	Max. Conc. in Water (mg/L)	Estimated Doses by Age Group							ATSDR MRL or EPA RfD (mg/kg/day)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Estimated Increased Lifetime Cancer
		Birth to <1 yr (mg/kg/day)	1 to <2 yrs (mg/kg/day)	2 to < 6 yrs (mg/kg/day)	6 to <11 yrs (mg/kg/day)	11 to <21 yrs (mg/kg/day)	21 to <65 yrs (mg/kg/day)	65 to <78 yrs (mg/kg/day)			
1,1,2-Trichloroethane (Max.)	<.0002								0.04 Int^{O} 0.3 Acute^{O}		
1,1,2-Trichloroethane (Avg.)	<.0002										
1,2-Dibromoethane (Max.)	<.0001								0.009 Chr RfD^{O}		
1,2-Dibromoethane (Avg.)	<.0001										
1,2-Dichloroethane (Max.)	<.0001								0.2 Int^{O}		
1,2-Dichloroethane (Avg.)	<.0001										
Benzene (Max.)	0.0021	0.0006	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0005 Chr^{O}	0.015-0.055	1×10^{-6} 4×10^{-6}
Benzene (Avg.)	0.0021	0.0003	0.0001	0.0001	0.00006	0.00005	0.00006	0.00007		0.015-0.055	4×10^{-7} 2×10^{-6}
Bis(2-ethylhexyl)phthalate (Max.)	<0.004								0.1 Int^{O} 0.06 Chr^{O}		
Bis(2-ethylhexyl)phthalate (Avg.)	<0.004										
Cis-1,2-Dichloroethene (Max.)	0.015Ω								0.03 Int^{O} 1 Acute^{O}		
Cis-1,2-Dichloroethene (Avg.)	0.005Ω										
Ethylbenzene (Max.)	0.009Ω								0.4 Int^{O}		
Ethylbenzene (Avg.)	0.009Ω										
Methylene Chloride (Max.)	<.0005								0.06 Chr^{O}		
Methylene Chloride (Avg.)	<.0005										
Naphthalene (Max.)	<.0002								0.6 Int^{O}		
Naphthalene (Avg.)	<.0002										
Tetrachloroethene (Max.)	<.0005								0.05 Acute^{O} Candidate RfDs^{O} 0.0097/0.0026		
Tetrachloroethene (Avg.)	<.0005										
Toluene (Max.)	0.002Ω								0.02 Int^{O}		
Toluene (Avg.)	0.002Ω										
Trichloroethene (Max.)	0.0078	0.002	0.001	0.0009	0.0006	0.0005	0.0006	0.0005	0.0005 Chr^{O}	0.046*	4×10^{-5}
Trichloroethene (Avg.)	0.0078	0.0005	0.0004	0.0003	0.0002	0.0002	0.0002	0.0003		0.046*	2×10^{-5}
Vinyl Chloride (Max.)	0.0043	0.001	0.0007	0.0005	0.0003	0.0003	0.0003	0.0003	0.003 Chr^{O}	0.72-1.5**	1×10^{-4} 2×10^{-4}
Vinyl Chloride (Avg.)	0.0043	0.0006	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001		0.72-1.5**	4×10^{-5} 9×10^{-5}

See page following Table 10 for all abbreviations/explanations for Tables 8-10 and a sample dose calculation.

Table 9. Increased Cancer Risks for Highest VOC Levels Measured in Groundwater on the Technitronics Site; Maximum and Central Tendency Dose Estimates for Ingestion, Inhalation, and Dermal Contact

Chemical	Max. Conc. in Water (mg/L)	Estimated Doses by Age Group							ATSDR MRL or EPA RfD (mg/kg/day)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Estimated Increased Lifetime Cancer
		Birth to <1 yr (mg/kg/day)	1 to <2 yrs (mg/kg/day)	2 to < 6 yrs (mg/kg/day)	6 to <11 yrs (mg/kg/day)	11 to <21 yrs (mg/kg/day)	21 to <65 yrs (mg/kg/day)	65 to <78 yrs (mg/kg/day)			
1,1,2-Trichloroethane (Max.)	0.031	0.009	0.005	0.004	0.002	0.002	0.002	0.002	0.04 Int^{O} 0.3 Acute^{O}	0.057	6×10^{-5}
1,1,2-Trichloroethane (Avg.)	0.031	0.004	0.002	0.001	0.0009	0.007	0.0009	0.001		0.057	2×10^{-5}
1,2-Dibromoethane (Max.)	0.00076	0.0002	0.0001	0.0001	0.00006	0.00004	0.00006	0.00006	0.009 Chr RfD^{O}	2	5×10^{-5}
1,2-Dibromoethane (Avg.)	0.00076	0.0001	0.00004	0.00003	0.00002	0.00002	0.00002	0.00002		2	2×10^{-5}
1,2-Dichloroethane (Max.)	0.19	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.2 Int^{O}	0.091	6×10^{-4}
1,2-Dichloroethane (Avg.)	0.19	0.03	0.01	0.008	0.006	0.004	0.006	0.006		0.091	2×10^{-4}
Benzene (Max.)	2.9	0.8	0.5	0.4	0.2	0.2	02	0.2	0.0005 Chr^{O}	0.015-0.055	1×10^{-3} 5×10^{-3}
Benzene (Avg.)	2.9	0.4	0.2	0.1	0.09	0.07	0.09	0.09		0.015-0.055	6×10^{-4} 2×10^{-3}
Bis(2-ethylhexyl)phthalate (Max.)	0.011	0.003	0.002	0.001	0.0009	0.0007	0.0008	0.0008	0.1 Int^{O} 0.06 Chr^{O}	0.014	5×10^{-6}
Bis(2-ethylhexyl)phthalate (Avg.)	0.011	0.001	0.0006	0.0005	0.0003	0.0003	0.0003	0.0004		0.014	2×10^{-6}
Cis-1,2-Dichloroethene (Max.)	10	3	2	1	0.8	0.6	0.7	0.7	0.03 Int^{O} 1 Acute^{O}		
Cis-1,2-Dichloroethene (Avg.)	10	1.3	0.5	0.5	0.3	0.2	0.3	0.3			
Ethylbenzene (Max.)	1.4	0.4	0.2	0.2	0.1	0.09	0.1	0.1	0.4 Int^{O}		
Ethylbenzene (Avg.)	1.4	0.2	0.08	0.06	0.04	0.03	0.04	0.05			
Methylene Chloride (Max.)	0.57	0.2	0.09	0.07	0.04	0.04	0.04	0.04	0.06 Chr^{O}		
Methylene Chloride (Avg.)	0.57	0.07	0.03	0.03	0.02	0.01	0.02	0.02			
Naphthalene (Max.)	0.26	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.6 Int^{O}		
Naphthalene (Avg.)	0.26	0.03	0.01	0.01	0.008	0.006	0.008	0.008			
Tetrachloroethene (Max.)	0.047	0.01	0.007	0.006	0.004	0.003	0.004	0.003	0.05 Acute^{O} Candidate RfDs 0.0097/0.0026	0.0021	3×10^{-6}
Tetrachloroethene (Avg.)	0.047	0.003	0.001	0.001	0.0007	0.0006	0.0007	0.0008		0.0021	1×10^{-6}
Toluene (Max.)	8.6	2.5	1.3	1.03	0.7	0.5	0.6	0.6	0.02 Int^{O}		
Toluene (Avg.)	8.6	1.1	0.5	0.4	0.5	0.2	0.3	0.3			
Trichloroethene (Max.)	270	77.05	42.3	32.6	21.2	17.18	19.2	18.5	0.0005 Chr^{O}	0.046*	1
Trichloroethene (Avg.)	270	34.9	14.6	12.4	8.2	6.4	8.0	8.8		0.046*	6×10^{-1}
Vinyl Chloride (Max.)	0.00056	0.0002	0.00008	0.00006	0.00004	0.00004	0.00004	0.00004	0.003 Chr^{O}	0.72-1.5**	1×10^{-5} 3×10^{-5}
Vinyl Chloride (Avg.)	0.00056	0.00007	0.00003	0.00003	0.00002	0.00001	0.00002	0.00002		0.72-1.5**	5×10^{-6} 1×10^{-5}

See page following Table 10 for all abbreviations /explanations for Tables 8-10 and a sample dose calculation.

Table 10. Increased Cancer Risks for Highest Measured VOC Levels in Off-site Groundwater Downgradient of the Technitronics Site; Maximum and Central Tendency Dose Estimates for Ingestion, Inhalation, and Dermal Contact

Chemical	Max. Conc. in Water (mg/L)	Estimated Doses by Age Group							ATSDR MRL or EPA RfD (mg/kg/day)	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$	Estimated Increased Lifetime Cancer
		Birth to <1 yr (mg/kg/day)	1 to <2 yrs (mg/kg/day)	2 to < 6 yrs (mg/kg/day)	6 to <11 yrs (mg/kg/day)	11 to <21 yrs (mg/kg/day)	21 to <65 yrs (mg/kg/day)	65 to <78 yrs (mg/kg/day)			
1,1,2-Trichloroethane (Max.)	<.0002								0.04 Int^{O} 0.3 Acute^{O}		
1,1,2-Trichloroethane (Avg.)	<.0002										
1,2-Dibromoethane (Max.)	<.0001								0.009 Chr RfD^{O}		
1,2-Dibromoethane (Avg.)	<.0001										
1,2-Dichloroethane (Max.)	0.00062	0.0002	0.0001	0.00008	0.00004	0.00004	0.00004	0.00004	0.2 Int^{O}	0.091	2×10^{-6}
1,2-Dichloroethane (Avg.)	0.00062	0.00008	0.00003	0.00003	0.00002	0.00001	0.00002	0.00002		0.091	8×10^{-7}
Benzene (Max.)	0.027	0.008	0.004	0.003	0.002	0.002	0.002	0.002	0.0005 Chr^{O}	0.015-0.055	1×10^{-5} 5×10^{-5}
Benzene (Avg.)	0.027	0.003	0.001	0.001	0.0008	0.0006	0.0008	0.0009		0.015-0.055	5×10^{-6} 2×10^{-5}
Bis(2-ethylhexyl)phthalate (Max.)	<0.004								0.1 Int^{O} 0.06 Chr^{O}		
Bis(2-ethylhexyl)phthalate (Avg.)	<0.004										
Cis-1,2-Dichloroethene (Max.)	0.29	0.08	0.05	0.04	0.02	0.02	0.02	0.02	0.03 Int^{O} 1 Acute^{O}		
Cis-1,2-Dichloroethene (Avg.)	0.29	0.04	0.02	0.01	0.009	0.007	0.009	0.009			
Ethylbenzene (Max.)	0.008Ω								0.4 Int^{O}		
Ethylbenzene (Avg.)	0.008Ω										
Methylene Chloride (Max.)	0.035	0.01	0.005	0.004	0.003	0.002	0.003	0.002	0.06 Chr^{O}		
Methylene Chloride (Avg.)	0.035	0.005	0.001	0.002	0.001	0.0008	0.001	0.001			
Naphthalene (Max.)	<.0002								0.6 Int^{O}		
Naphthalene (Avg.)	<.0002										
Tetrachloroethene (Max.)	0.0013†								0.05 Acute^{O} Candidate RfDs 0.0097/0.0026		
Tetrachloroethene (Avg.)	0.0013†										
Toluene (Max.)	1.9	0.5	0.3	0.2	0.1	0.1	0.1	0.1	0.02 Int^{O}		
Toluene (Avg.)	1.9	0.2	0.1	0.09	0.06	0.04	0.06	0.06			
Trichloroethene (Max.)	0.0076	0.002	0.001	0.0009	0.0006	0.0005	0.0005	0.0005	0.0005 Chr^{O}	0.046*	4×10^{-5}
Trichloroethene (Avg.)	0.0076	0.001	0.0004	0.0004	0.0002	0.0002	0.0002	0.0002		0.046*	2×10^{-5}
Vinyl Chloride (Max.)	0.012	0.003	0.002	0.001	0.0009	0.0008	0.0009	0.0008	0.003 Chr^{O}	0.72-1.5**	3×10^{-4} 6×10^{-4}
Vinyl Chloride (Avg.)	0.012	0.002	0.0006	0.0006	0.0004	0.0003	0.0004	0.0004		0.72-1.5**	1×10^{-4} 2×10^{-4}

See the following page for all abbreviations/explanations for Tables 8-10 and a sample dose calculation.

Abbreviations and explanations for Tables 8-10:

Exposure intervals: **Chr** = Chronic, **Int** = Intermediate, and **Acute**. Chronic screening levels are for exposures lasting more than 365 days. Intermediate screening levels are for exposures lasting 14 to 365 days. Acute screening levels are for exposures lasting 14 days or less.
kg = kilograms
mg/L = milligrams per liter
ppm = parts per million, with liquids this is milligrams per liter
mg/kg/day = milligrams per kilogram per day
Max. = Maximum, dose calculations assume a higher age-adjusted ingestion rate
Avg. =Average, dose calculations assume an average age-adjusted ingestion rate
ATSDR MRL = Agency for Toxic Substances and Disease Registry's Minimal Risk Level. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.
EPA RfD = US Environmental Protection Agency's Reference Dose. The oral Reference Dose (RfD) is based on the assumption that thresholds exist for certain toxic effects such as cell death. We express doses in units of mg/kg-day. The RfD is an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer effects during a lifetime.
[o]The MRLs and RfDs are for oral exposures.
Shaded cells contain values that exceed the MRL or RfD.

*For mutagenic carcinogenic chemicals without chemical-specific data on early life exposures, we apply the following age-dependent adjustment factors (ADAFs):

Children 0 < 2 years	10
Children 2 to < 16 years	3
Children and adults 16 and older	1

**Vinyl chloride has a mutagenic mode of action and sufficient data are available to derive age-specific cancer slopes. Because vinyl chloride has cancer slope factors for both early life exposure and adult exposure, we did not use the generic EPA age dependent adjustment factors (ADAFs).

†This value is below this chemical's Cancer Risk Evaluation Guide (CREG), and is included in this table because testing detected this chemical on-site above the CREG; however, because of the low level, we did not calculate a dose.

Ω We did not calculate a dose because the highest concentration is at or below the ATSDR screening value and thus unlikely to cause non-cancer illness.

Example: Residential Exposure Calculations for Children and Adults:

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

Where:
D = exposure dose (mg/kg/day)
C = contaminant concentration **(0.0078 mg/kg)**
IR = intake rate (amount per day) **(200 mg for a child, 100 mg for an adult)**
EF = exposure factor (unitless) **(1)**
CF = conversion factor **(10^{-6} kg/mg)**
BW = body weight (kilograms or kg) **(11.4 for a child 1-2 years old, 80 kg for adults 21 to 65 years old)**

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

Where:
EF = exposure factor (unitless)
F = frequency of exposure (days/year) **(365 days/year)**
ED = exposure duration **(1 year for a child, 44 years for an adult)**
AT = averaging time (days) (**ED × 365 days/year for non-carcinogens; 78 years x 365 days/year for carcinogens) (arsenic is a carcinogen)**

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

For 1-2 year old children, the dose 8.0×10^{-4} mg/kg/day = 85.01 mg/kg × 200 mg × 1 × 10^{-6} kg/mg /11.4 kg

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

For 21-65 year old adults the dose 6.0×10^{-5} mg/kg/day = 85.01 mg/kg × 100 mg × 1 × 10^{-6} kg/mg /80 kg

Date: 6/14/2013

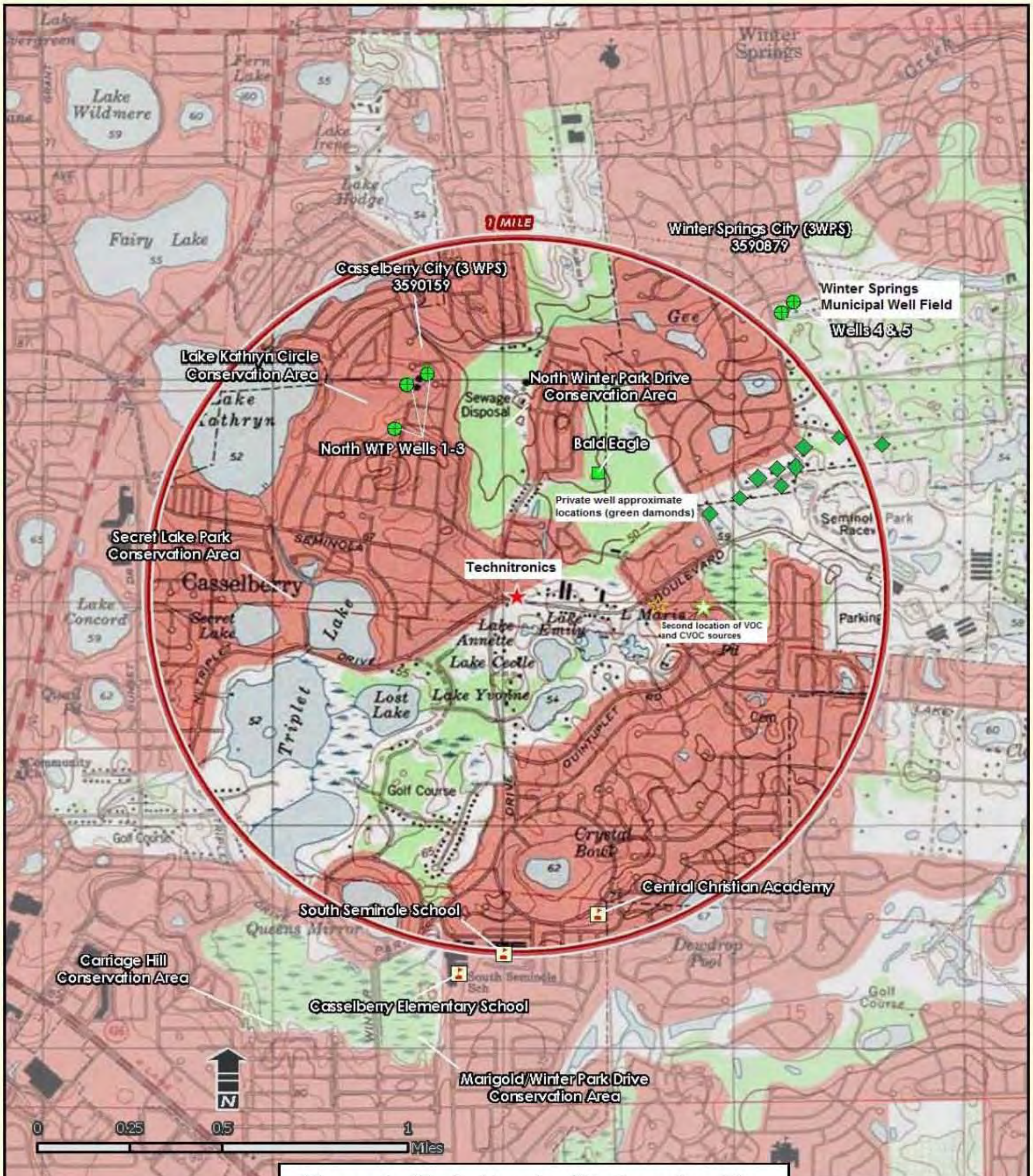


Figure 1. Technitronics Site Location Map [E&E 2013]

- ★ Project Site
- Project Site 1-Mile Buffer
- Bald Eagle
- Well
- School

Technitronics Inc. Site
1041 & 1043 Seminola Boulevard
Casselberry, Seminole County, Florida, Feb 2013

ecology and environment, inc.
Global Environmental Specialists

Source: ESRI 2012; NGS 2012

Date: 6/14/2013

Parcel Boundary

Project Parcel Boundary

Figure 2. Technitronics Site Vicinity Map [E&E 2013]

1041 & 1043 Seminola Boulevard
Casselberry, Seminole County, Florida, Feb 2013

ecology and environment, inc.
Global Environmental Specialists

Source: ESRI 2012; Bing 2012

Date: 5/10/2013

Figure 3. Technitronics Site Historic Usage [E&E 2013]

Parcel Boundary

Project Parcel Boundary

Technitronics Inc. Site
1041 & 1043 Seminola Boulevard
Casselberry, Seminole County, Florida, Feb 2013

ecology and environment, inc.
Global Environmental Specialists

Source: ESRI 2012; Bing 2012

Figure 4. Technitronics Site Groundwater Trichloroethene Detections by Depth (Approximates Chlorinated VOC Plume) [modified from FDEP 2013]

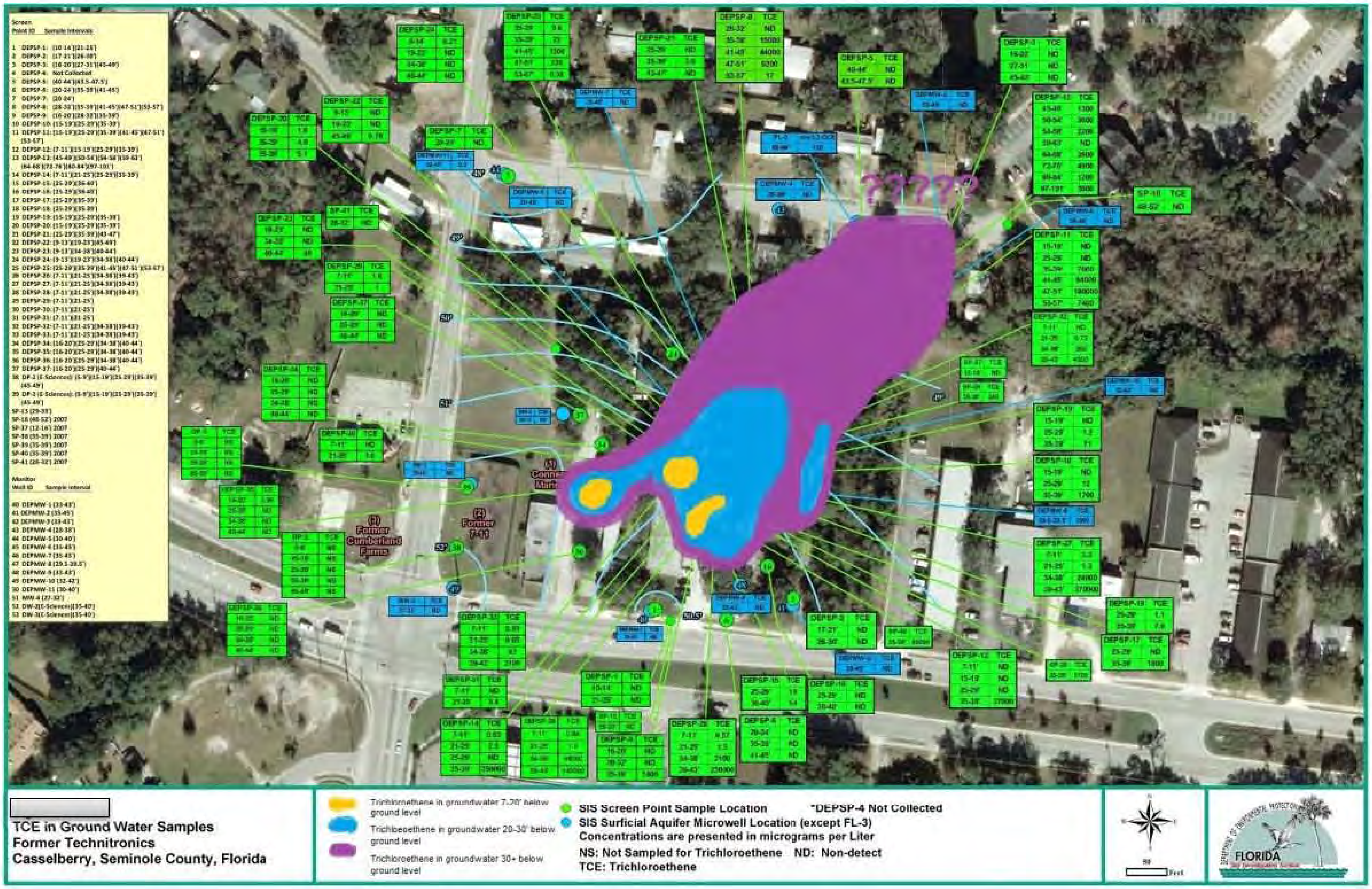


Figure 5. Technitronics Site Groundwater Benzene, Toluene, Ethylbenzene, Xylene Detections by Depth [modified from FDEP 2013]

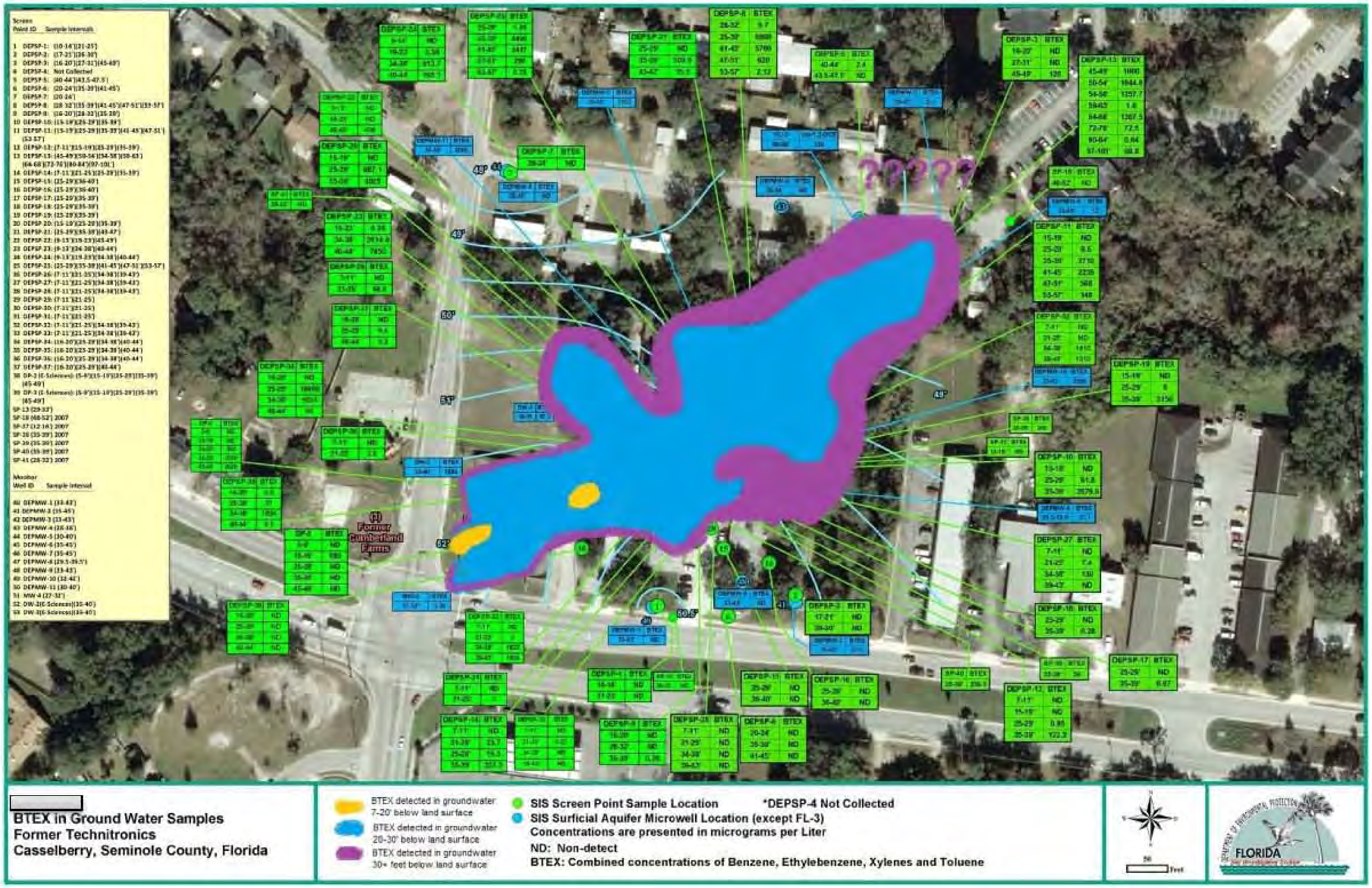
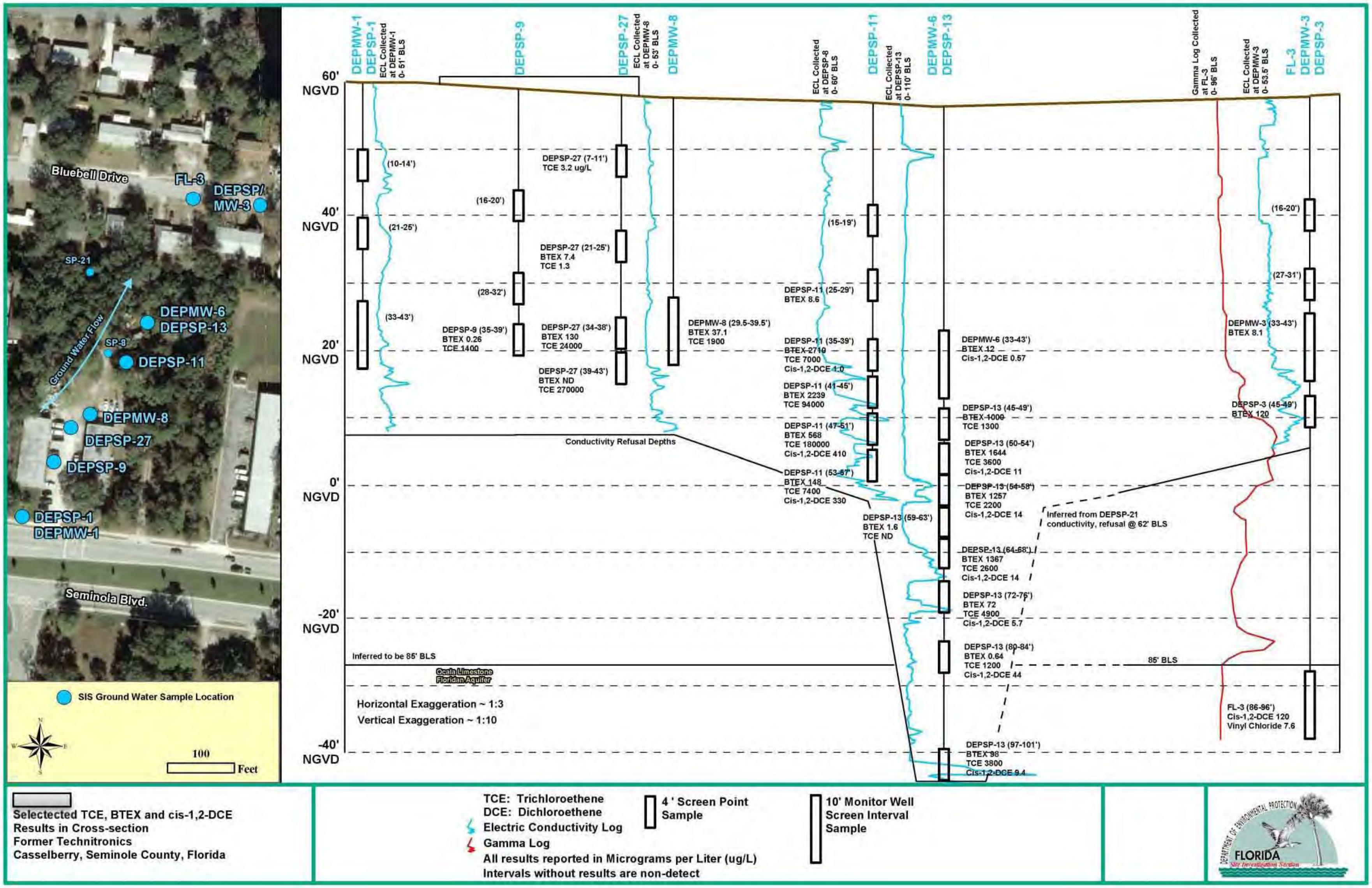


Figure 6. Technitronics Site Cross-Section showing VOC Detections by Depth and In-filled Sink Hole [FDEP 2013]



Appendix B—Photos

Photograph 1. Western Technitronics building (#1041) looking northwest (from FDEP 2013).

Photograph 2. Eastern Technitronics building (#1043) looking northeast (from FDEP 2013).

Photograph 3. Bird's eye view of site looking north [Bing Maps, ©2014 Microsoft Corporation, ©2012 Pictometry International Corporation].

Appendix C—Response to Public Comments

On August 25, 2014, FDOH posted the public comment draft of this report on our website http://www.floridahealth.gov/environmental-health/hazardous-waste-sites/health-assessments.html . On August 22, 2014, we mailed out a community update to approximately 900 nearby residents and other interested parties. This update summarized the draft report, gave the web address for the complete report, solicited public comments, and announced the date and location of an upcoming open house. The Community Update included a survey response to evaluate peoples' understanding of our report summary. FDOH received survey responses from 20 residents, indicating they had understood the Community Update.

FDOH hosted an Open House meeting from 3:00 to 7:30, Tuesday September 9, 2014 at the Seminole County Public Library, Jean Rhein Central Branch—215 North Oxford Road, Casselberry Florida. Staff from FDOH staff in Seminole County and FDEP Central Office co-hosted the Open House with us. One of owners of a nearby property was interested in the remediation process. This participant was interested in the location of groundwater contamination and future involvement by state and federal agencies and so spoke with FDOH and FDEP.

The public comment period closed September 26, 2014. FDOH received the following written comments from nearby residents and property owners.

<u>Nearby Residents and Property Owners</u>

<u>Comment #1:</u> Did my drinking (water) cause my cancer?
<u>Response #1:</u> We assume this person means that they think contaminants from the site entered their drinking water. For a person to have exposure to groundwater contaminants; first, contaminants must be in the groundwater under their property, and second, the person must have a way to contact the contaminated water, like a private well on their property. The commenter gave an address southwest of the site. Groundwater contamination on and near the site is moving to the north and northeast, for this reason we would not expect groundwater contamination beneath this persons' home. In addition, FDOH Seminole County staff looked for private wells near the site and did not identify any in this subdivision.

FDOH responded to this commenter with a letter. We asked the responder to confirm with us whether they use private well water. If they do, FDOH Seminole County staff can test their well water to find out if their water is contaminated. Otherwise, they are being supplied municipal supply water, which cities are required to test regularly.

Often the causes of cancer cannot be determined [NCI 2014]. The harmful health effects of chemicals depend on the dose, strength of the chemical compound, the length of exposure, and the general health of the individual. Although we know some chemicals cause cancer in humans due to workplace exposures, such exposures will generally tend to be at much higher doses and for longer durations than non-workplace exposures.

Outside the workplace, it is often very difficult to link exposure to chemicals in the environment to cancer because we lack information on the levels (doses) and exposure duration. Incomplete understanding of the mechanisms of cancer development adds to the uncertainty caused by lack of exposure level and exposure duration information [IDPH 2014, NCI 2014]. While some cancers are linked to non-chemical causes such as exposure to viruses like Hepatitis B and bacteria such as Helicobacter pylori, the causes of some other types of cancers are unknown. Studies have shown that individual and genetic variations affect cancer susceptibility [NCI 2014].

Comment #2: Will the state hold the former Technitronics site owners responsible for remediation costs?
Response #2: The areas on Figures 4 and 5 that show yellow circles indicate shallow sources of chemicals, which indicate businesses operating on three properties discharged chemicals that resulted in groundwater contamination on and near the former Technitronics site.

FDEP is having the site evaluated by EPA for inclusion on the National Priorities Site List (NPL). The EPA will conduct the site remediation if it includes this groundwater contamination site on the NPL; sometimes the EPA is able to recover cleanup costs from the responsible parties. Because there are several sources for the chemicals found in the plumes on the site, there are likely to be a number of responsible parties from the past.

Comment #3: Include a map of the site's location in the Community Update.
Response #3: FDOH will include a site location map in future updates. The complete report with figures and maps is available on-line at http://www.floridahealth.gov/environmental-health/hazardous-waste-sites/.

Comment #4: The commenter mentioned knowing of three other sources of groundwater contamination in the area, in addition to this site.
Response #4: Groundwater contamination is a common problem in central Florida due to past waste handling practices, past use of septic tanks, rapid development, and vulnerability of the aquifers. FDEP and FDOH work together with city utilities to ensure clean sources of drinking water.

Appendix D—Susceptibility to Potential Pathway Chemicals

Children's Susceptibility to Potential Exposure Pathway Chemicals

If, in the future, on-site residents use groundwater for drinking and showering (potential pathways), children may be more vulnerable than adults are to some chemicals found there now in groundwater. These include 1,2-dibromoethane, 1,2-dichloroethane, bis-2(ethyl-hexyl) phthalate, ethylbenzene, naphthalene, trichloroethene, and toluene.

- Increased toxicity in children may result from immature metabolic processes, which leave the body exposed to more toxic intermediate metabolic forms of 1,2-dibromoethane [ATSDR 1992].
- Children may experience decreased immune responses resulting from 1,2-dichloroethane exposure based on animal inhalation and ingestion studies [ATSDR 2001].

  If the response of humans is similar to that of animals, newborns with immature lungs might be at risk from exposure to di(2-ethylhexyl) phthalate (DEHP) in respiratory equipment, due to interference with formation or turnover of alveolar surfactant. In addition, in rodents, testicular damage and brain damage from exposure to DEHP are more likely to occur with exposures during the prenatal or early postnatal period [ATSDR 2002].
- Children's immature metabolism and eliminations kinetics may also reduce their ability to process ethylbenzene [ATSDR 2010b].
- Newborn infants appear to be susceptible to naphthalene-induced hemolysis presumably due to a decreased ability to conjugate and excrete naphthalene metabolites [ATSDR 2005a].
- The developing fetal nervous system may be particularly susceptible to the toxic effects of trichloroethene (TCE). Studies in mice suggest that TCE can cross the placenta and that its breakdown metabolite, trichloroacetic acid, concentrates in the fetus. Researchers found unmetabolized TCE in breast milk and in an exposed infant with liver damage. Researchers detected health effects in children in Woburn, Massachusetts who may have been exposed to solvent-contaminated drinking water as infants or in the womb. This exposure possibly contributed to elevated incidences of acute lymphocytic leukemia or impaired immunity [ATSDR 1997a]. EPA's database also notes increased early-life susceptibility due to TCE's mutagenic mode of action for kidney tumors [IRIS 2012].
- Animal studies have shown toluene can retard fetal growth and skeletal development and adversely influence developmental behavior [ATSDR 2000a].

Other Unusually Susceptible Populations

If on-site groundwater is used for drinking and showering (potential pathways) in the future, some people may be more vulnerable than others are to some chemicals found there now in groundwater. These include 1,1,2-trichloroethane, 1,2-dibromoethane, 1,2-

dichloroethane, *cis*-1,2-dichloroethene, bis-2(ethyl-hexyl) phthalate, ethylbenzene, naphthalene, tetrachloroethene (PCE), and toluene.

- Persons with untreatable or untreated diabetes or with prior exposure to polybrominated biphenyls, isopropyl/ethyl alcohol, or acetone may be more susceptible to the hepatotoxic (liver toxic) effects of 1,1,2-trichloroethane, [ATSDR 1989] and *cis*-1,2-dichloroethene[ATSDR 1996]. Prior exposure to other enzyme-inducing drugs or chemicals could potentially have the same effects.
- Chronic alcoholics receiving Antabuse (disulfiram) therapy and those in the rubber industry (which also uses disulfiram) are potentially more susceptible to the toxic and neoplastic effects of 1,2-dibromoethane [ATSDR 1992]. Individuals with compromised liver or renal function or with asthma or other chronic respiratory diseases may have increased susceptibility to the toxic effects of 1,2-dibromoethane; however, chemical-specific effects have not been identified.
- Smokers as well as those exposed to passive smoke may be more susceptible to lung emphysema following repeated exposure to 1,2-dichloroethane.
- Most risks of exposure to bis-2(ethyl-hexyl) phthalate described centered on its use in medical devices and not its ingestion in water. Changes that occur in critically ill or injured patients might place them at increased risk for developing adverse health effects following exposure to DEHP. DEHP can be released from plastic medical devices used in various procedures including blood transfusion, cardiopulmonary bypass, and extracorporeal membrane oxygenation (oxygenation that takes place outside the body). Factors that increase lipase-mediated metabolism will increase the potential for DEHP to induce adverse effects in exposed patients. Additional factors that can place patients at increased risk include increased reduced kidney elimination capacity, uremia (waste products in the blood due to kidney failure), protein malnutrition, reduced levels of antioxidants, and impaired cardiovascular status [ATSDR 2002].
- Groups that might be more susceptible to the toxic effects of ethylbenzene are individuals with hearing loss; diseases of the respiratory system, liver, kidney, or skin; pregnant women; and individuals taking certain medications such as hepatotoxic medications or drugs [ATSDR 2010].
- Methylene chloride exposure at high concentrations may pose an additional human health burden to smokers (who have higher levels of carbon monoxide), and persons with existing cardiovascular disease. In addition, higher than normal blood levels of carbon monoxide may result when alcoholics are exposed to methylene chloride, because ethanol increases the expression and activity of the metabolic enzyme, CYP2E1. Similarly, enhanced expression of CY2E1 occurs in the condition of diabetes, although insulin erases that effect.
- Populations with a genetic G6PD enzyme deficiency may be more susceptible to the hemolytic effects of naphthalene exposure. Females more often have these deficiencies. Results from a recent study indicate that female mice are more

susceptible than male mice to lung injury from acute parenteral exposure to naphthalene [ATSDR 2005a].

- Workers with the human lymphocyte allele (HLA-DR5) may have an increased likelihood of developing vinyl chloride disease. Those with the alleles HLA-DR3 and B8 may have an increased severity of the disease. Vinyl chloride disease is a syndrome consisting of Raynaud's phenomenon (a circulatory condition with the symptoms of numbness, tingling, and sensitivity to cold), acroosteolysis (bone erosion at the fingertips and other extremities), joint and muscle pain, enhanced collagen deposition, stiffness of the hands, and scleroderma-like skin changes (extreme thickening). These symptoms indicate that vinyl chloride disease may have an immunologic basis.
- Workers taking barbiturates or exposed to organochlorine pesticides that are known to induce microsomal enzymes (such as Aroclor 1254) would be at increased risk for developing vinyl chloride-induced liver toxicity.
- Workers with CYP2E1 and glutathione S-transferase genotypes who are exposed to vinyl chloride are at increased risk of abnormal liver function, vinyl chloride disease, and angiosarcomas (cancer of the lining of vessel walls).
- Vinyl chloride workers' risk of developing liver cancer also appears elevated in those with a history of hepatitis B viral infection.
- Based on animal studies, workers who drink alcohol and are exposed to vinyl chloride may have a higher incidence of cancer and a shorter lifespan.
- Workers who take Antabuse (disulfiram) to curb the desire for alcohol and are exposed to vinyl chloride, may be at increased risk for hepatotoxicity, cancer, and death at an early age.
- Based on animal studies, workers with a propensity for cardiac arrhythmias may be at an increased risk of cardiac arrhythmias when exposed to high concentrations of vinyl chloride.
- Workers with impaired circulation due to connective tissue disorders, systemic sclerosis, hyperviscosity (thickening) of the blood, or use of vibrating tools, may experience more severe impairment of the circulation when exposed to vinyl chloride.

Appendix E—Uncertainty

All risk assessments, to varying degrees, require the use of assumptions, judgments, and incomplete data. These contribute to the uncertainty of the final risk estimates. Some more important sources of uncertainty in this public health assessment include environment sampling and analysis, exposure parameter estimates, use of modeled data, and present toxicological knowledge. These uncertainties may cause health scientists to over- or underestimate risk. Because of the uncertainties described below, this public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the Technitronics site.

Environmental chemistry analysis errors can arise from random errors in the sampling and analytical processes, resulting in either an over- or under-estimation of risk. We can control these errors to some extent by increasing the number of samples collected and analyzed and by sampling the same locations over several different periods. The above actions tend to minimize uncertainty contributed from random sampling errors.

There are two areas of uncertainty related to exposure parameter estimates. The first is the exposure-point concentration estimate. The second is the estimate of the total chemical exposures. In this assessment, we used maximum detected concentrations as the exposure point concentration. We believe using the maximum measured value to be appropriate because we cannot be certain of the peak contaminant concentrations, and we cannot statistically predict peak values. Nevertheless, this assumption introduces uncertainty into the risk assessment that may over- or under-estimate the actual risk of illness. When selecting parameter values to estimate exposure dose, we used default assumptions and values within the ranges recommended by the ATSDR or the EPA. These default assumptions and values are conservative (health protective) and may contribute to the over-estimation of risk of illness. Similarly, we assumed the maximum exposure period occurred regularly for each selected pathway. Both assumptions are likely to contribute to the over-estimation of risk of illness.

There are also data gaps and uncertainties in the design, extrapolation, and interpretation of toxicological experimental studies. Data gaps contribute uncertainty because information is either not available or is addressed qualitatively. Moreover, the available information on the interactions among chemicals found at the site, when present, is qualitative (that is, a description instead of a number) and we cannot apply a mathematical formula to estimate the dose. These data gaps may tend to underestimate the actual risk of illness. In addition, there are great uncertainties in extrapolating from high-to-low doses, and from animal-to-human populations. Extrapolating from animals to humans is uncertain because of the differences in the uptake, metabolism, distribution, and body organ susceptibility between different species. Human populations are also variable because of differences in genetic constitution, diet, home and occupational environment, activity patterns, and other factors. These uncertainties can result in an over or underestimation of risk of illness.

Finally, there are great uncertainties in extrapolating from high doses to low doses, and controversy in interpreting these results. Because the models used to estimate dose-response relationships in experimental studies are conservative, they tend to overestimate the risk. Techniques used to derive acceptable exposure levels account for such variables by using safety factors. Currently, there is debate in the scientific community about how much we overestimate the actual risks and what the risk estimates really mean.

Appendix F—Glossary of Environmental Health Terms

This glossary defines words used by the Agency for Toxic Substances and Disease Registry (ATSDR) in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-422-8737.

Acute
Occurring over a short time.

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days).

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

The Agency for Toxic Substances and Disease Registry (ATSDR)
The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

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

Cancer risk
An estimated risk for getting cancer if exposed to a substance every day for 78 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

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

Chronic
Occurring over a long time.

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year).

Completed exposure pathway see exposure pathway.

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

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

Contaminants of Concern
Chemicals found on-site above their health-based comparison values that we investigate further.

Dermal

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

Dermal contact

Contact with (touching) the skin.

Dose (for chemicals that are not radioactive)

The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental media

Soil, water, air, plants, and animals, or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

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

EPA

United States Environmental Protection Agency.

Epidemiology

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

Exposure

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

Exposure assessment

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

Exposure pathway

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

Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces.

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

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

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

Inhalation
The act of breathing. A hazardous substance can enter the body this way.

mg/kg
Milligram per kilogram.

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

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

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

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

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

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

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

Receptor population
People who could come into contact with hazardous substances.

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

Risk
The probability that something will cause injury or harm.

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

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

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Substance
A chemical.

Superfund
Federal monies to clean up hazardous waste sites where no company would or could handle the financial responsibility of site cleanup. From the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA).

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

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs.

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

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