Final

Public Health Assessment

Former Hurley's Dry Cleaners

Winter Park, Orange County, Florida

HWC # 180

May 19, 2015

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
BDL	Below Detection Limit
bls	below land surface
BW	Body Weight
C	Contaminant Concentration
CF	Conversion Factor
cis-1,2-DCE	*cis*-1,2-dichloroethene
CNS	Central Nervous System
CRA	Conestoga-Rovers and Associates (Environmental Firm)
CREG	ATSDR's Cancer Risk Evaluation Guide
D	Dose
ED	Exposure Duration
EF	Exposure Factor
EMEG	ATSDR's Environmental Media Evaluation Guide
EPA	Environmental Protection Agency
F	Frequency of Exposure
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
HSA	Environmental Firm company name, merged with CRA
IR	Intake Rate
LOAEL	Lowest Observable Adverse Effect Level
MCL	ATSDR's Maximum Concentration Level
mg/kg	milligrams per kilogram
MRL	Minimum Risk level
NUS	Environmental Firm company name, merged with Tetra Tech
PFC	Plaque-Forming Cell
PCE	Perchloroethylene or Tetrachloroethene
PID	Photo Ionization Detector
R	Risk (Cancer)
RfD	EPA's Reference Dose
RMEG	ATSDR's Reference Media Evaluation Guide
SF	Slope Factor
TCE	Trichloroethene
TTNUS	Tetra Tech (TT), merged with NUS Corporation
µg/L	micrograms per cubic meter
$\mu g/m^3$	micrograms per cubic meter
URS	United Research Services Corporation
VOCs	Volatile Organic Compounds

Foreword

The Florida Department of Health (FDOH) evaluates the public health risk of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR) in Atlanta, Georgia. This is a state-lead report, meaning the Florida Department of Environmental Protection (FDEP) is overseeing the remediation of the site and FDOH health professionals reviewed this report. FDOH prepared this report using the same guidelines and equations we use for US Environmental Protection Agency (EPA)-lead sites that ATSDR reviews by mandate. This public health assessment report is part of an effort to evaluate health effects associated with groundwater, soil, and soil gas from the former Hurley's Dry Cleaners site. The FDOH evaluates site-related public health issues through 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 potential health threats 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 or health consultations will typically recommend actions for other agencies, in this case 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 with the regulatory agencies 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 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 former Hurley's Dry Cleaners site, the Florida Department of Health's (FDOH) top priority is to ensure nearby residents have the best information to safeguard their health. The one-tenth acre former Hurley's Dry Cleaners site is at 620 West Lyman Avenue in Winter Park, Orange County, Florida. The building on the site housed Hurley's Dry Cleaners from 1948 until 1984 when the new owner converted it to a residence. The Florida Department of Environmental Protection (FDEP) discovered groundwater contamination under the site in 2007 while investigating the source of dry cleaning solvents found at a nearby former gas station (Pennsylvania Station). In 2014, two renters of the house reported smelling strong odors and having symptoms of headache, nausea, and stomach upset after contractors drilled holes through the foundation as part of FDEP's site remediation. The purpose of this public health assessment is to assess the public health threat from toxic chemicals in groundwater, soil, and soil gas at this site. FDEP requested this assessment.
CONCLUSION #1	Chemical vapors from the holes drilled through the foundation of the house on the former Hurley's Dry Cleaners site may have caused the headache, nausea, and stomach upset reported by the residents. FDOH cannot be certain, however, without laboratory identification of individual chemicals and levels, because strong odors from non-toxic sources may also cause these effects.
BASIS FOR DECISION #1	On the day contractors started site remediation, the two renters reported smelling strong odors at the home located on the former Hurley's site. The symptoms they reported at the hospital emergency room that night are consistent with breathing tetrachloroethene (PCE) vapors or its breakdown products found in the groundwater under their house.
NEXT STEP #1	Although the remediation system is now functional at the site, FDOH in Orange County has offered to test indoor air for the owner if he wants to rent the house again. We recommend collection of air samples with the windows shut and the air conditioner or heater on, because each system may affect vapor intrusion. We also want testing to reflect normal living conditions.

	We recommend laboratory analysis for individual compounds using gas chromatography/mass spectrometry.
CONCLUSION #2	Tetrachloroethene (PCE), trichloroethene (TCE), and other volatile organic compounds (VOCs) contaminate shallow groundwater under the site. Testing also found these chemicals in groundwater as far as one-third of a mile to the southeast. Future use of this groundwater could cause illness.
BASIS FOR DECISION #2	FDOH has not identified anyone using this contaminated groundwater. Future use could increase the risk of heart defects in unborn children, damage the thymus, and suppress the immune system. Levels are also too high to rule out the possibility of kidney and nervous system damage and developmental delays.
NEXT STEP #2	Although future use of this contaminated water is unlikely due to its chemical smell and the availability of municipal water, FDOH recommends people not install drinking water wells in areas with groundwater contamination on the site or one-quarter mile or more southeast of the site.
CONCLUSION #3	On-site residents or workers were not at risk from incidental ingestion exposure to chemicals measured in the soil for this study.
BASIS FOR DECISION #3	FDEP's contractors did not find solvents or their breakdown products in on-site surface or deeper soils.
CONCLUSION #4	Levels of PCE measured in on-site soil gas in 2013 are not likely to have caused illness via vapor intrusion.
BASIS FOR DECISION #4	We estimated amounts of PCE that could have entered the house by vapor intrusion. We found no likelihood of non-cancer illness and we estimated extremely low increased cancer risks. The issue of odors that prompted this report arose after FDEP's contractor drilled holes in the foundation for site remediation. Strong smells can cause nausea and other symptoms, whether or not they are toxic.
LIMITATIONS OF FINDINGS	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 environmental sampling and analysis, exposure parameter

estimates, use of modeled (average) data, and present toxicological knowledge. We may overestimate or underestimate risk because of these uncertainties. This public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the former Hurley's Dry Cleaners site.

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 former Hurley's Dry Cleaners site.

Background and Statement of Issues

The purpose of this public health assessment is to assess the public health threat from toxic chemicals in indoor air, groundwater, soil, and soil gas at the former Hurley's Dry Cleaners site. The site is at 620 West Lyman Avenue in Winter Park, Orange County, Florida, 32789 (Figures 1 and 2). The Florida Department of Environmental Protection (FDEP) requested the Florida Department of Health (FDOH) do this assessment.

Health scientists look at what chemicals are present and in what amounts. We compare those amounts to national 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 would not likely harm adults.

This assessment considers health concerns of on-site and 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.

Site Description

The one-tenth acre Hurley's Dry Cleaners site contains a small 50 by 90 foot, one-story house. A concrete driveway/parking area covers the majority of the front yard. The 20 by 40 foot backyard is fenced and locked. Houses border the site on the south and west, Mount Moriah Church borders the site on the east, and West Lyman Avenue and a partially paved parking lot border the site on the north (Figure 2).

Dry cleaning operations began at this site in 1948 and continued until 1984 [URS 2008]. FDEP discovered groundwater contamination in 2007 and they are currently overseeing site remediation. FDEP's contractor drilled four holes in the foundation of the house on the site to install a soil vapor extraction system (SVES) on May 27, 2014. The two tenants reported odors and sought treatment at a hospital emergency room that night for headache, nausea, and stomach upset.

FDEP provided the tenants with alternate housing until their contractor completed the SVES installation. After the contractor finished, they moved. The owner discontinued utility service and the house is now vacant. Although FDOH Orange County staff had arranged with the owner to test the indoor air, they were not able to complete this testing without electrical power.

FDOH visited the site on July 28, 2014. They observed no signs of occupancy and the house windows were open. We observed pumps for the SVES in a trailer on the southwest side of the Mt. Moriah Baptist Church. According to FDEP, it is operating normally.

Demographics

FDOH examines demographic and land use data to identify sensitive populations, such as young children, the elderly, and women of childbearing age who may live near the site and contact contaminants. Demographics also provide details on population mobility and residential history in a particular area. We can use this information to evaluate exposure durations.

Approximately 8,170 people live within 1 mile of the site. Eighty percent (80%) are white, 15% are black, 2% are Asian, and 3% are other. Eleven percent (11%) are younger than 18 years old and 89% are older. Twenty-seven percent (27%) have a high school diploma or less and 8% have at least two years of college. Eighty-eight percent (88%) speak only English and 57% make less than $50,000 a year [EPA 2014a].

Land Use

Land use around the former Hurley's Dry Cleaners site is residential. Within 1 mile of the site, half the residences are owner-occupied and half are rentals. Thirteen places of worship and two schools, Winter Park High School and Rollins College, are also within 1 mile of the site [EPA 2014a].

Two City of Winter Park drinking water wells are less than 1 mile to the north. These two wells (#10 and #12) are part of a six-well network (Figure 1). In 2012, FDOH in Orange County did not find private drinking water wells within a quarter-mile of the site (Figure 3) [FDOH 2014].

Community Health Concerns

On May 27, 2014, FDEP's contractors drilled four holes for vapor extraction wells through the foundation of the house on the site. The two tenants were concerned that these holes let vapors with strong-smelling odors into the house. They were also concerned these vapors were responsible for the headache, nausea, and stomach upset for which they sought treatment at a hospital emergency room that night.

Discussion

Environmental Data

Soil

Between 2007 and 2014, FDEP's consultants collected 21 on-site soil samples between the surface and water table (7-9 feet deep) [URS 2008, TTNUS 2010, HSA 2013, and CRA 2013b]. The concentrations of chlorinated solvents were all at or below their detection limits (Table 1).

Groundwater

Between 2007 and 2013, FDEP's consultants collected 236 groundwater samples at and near the former Hurley's Dry Cleaners site [URS 2008, TTNUS 2010, HSA 2013, CRA 2013b] (Table 2).

FDEP estimated the TCE groundwater contamination had spread about one-third mile to the southeast. Because TCE is denser than water, it sinks as it moves away from the site (Figures 4 and 5). In 2007, PCE contamination was limited to on-site groundwater (Figure 6).

Soil Gas

In July 2013, FDEP's contractor installed seven, 5-foot deep wells around the perimeter of the house on the site and collected a soil gas sample from each using a Summa canister [HSA 2013]. Tests detected PCE in the soil gas in all six samples, but no other chemicals above their screening values (Table 3). These contractors were only able to gather samples of soil gas by applying vacuums to these wells. People do not breathe soil gas; they may be exposed to chemicals in soil gas via vapor intrusion into indoor air, generally at much lower levels than are measured directly. We explain the potential risk of exposure to the highest PCE level measured in the "Site Specific Health Effects of VOCs for Potential Exposure Pathways" section.

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 a 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.

The Exposure Pathway

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, 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

On May 27, 2014, contractors for FDEP drilled four holes through the foundation inside the house on the site to install a SVES. Although the contractors reported sealing the holes, the two residents complained of odors and went to a hospital emergency room that night with headache, nausea, and stomach upset. During the remainder of the SVES installation, the residents were not in the house.

FDOH identified indoor air as a past completed human exposure pathway. For this pathway, spilled or leaked dry cleaning solvents or their breakdown products were the source of contamination. Soil gas was the environmental media. Indoor air was the point of exposure. Inhalation was the route of exposure. Two on-site residents were the exposed population (Table 4).

Potential exposure pathways

Vapor and vapor intrusion: on-site workers—From 1948 to 1984 when Hurley's Dry Cleaners was in business, operations likely exposed workers to PCE via dry cleaning vapors. The source was the dry cleaning and drying processes. In addition, vapors may have come up through the foundation from contaminated groundwater. In either case, indoor air was the point of exposure and inhalation was the route of exposure (Table 5). We are unable to assess these possible past exposure pathways due to the lack of indoor air testing.

Past vapor intrusion: residents—After 1948, nearby residents may have been exposed to dry cleaning solvents from vapor intrusion. Waste dry cleaning solvents from the site were the source, indoor air was the point of exposure, inhalation was the exposure route and nearby residents were the exposed population (Table 5). FDOH does not have information to address past indoor air exposures. From tests, we know that there was a

shallow groundwater source on and near the site in 2007 (yellow plumes on Figures 4 and 5). In 2013, tests only showed shallow groundwater contamination on the site (Figures 4 and 6). Vapor intrusion into indoor air would also have been limited to these areas. Currently no one is living in the house, and a SVES is operating so vapors from the groundwater will bypass the house and the SVES filter will absorb them.

Future drinking water wells—Solvent disposal at Hurley's Dry Cleaners would be the source of contamination for new drinking water wells installed in the area of contamination. Groundwater would be the environmental medium. 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 (Table 5). However, the availability of municipal water in this area makes new private drinking water wells unlikely. In addition, FDOH recommended no installation of new wells within a quarter mile of the site to the southeast, which is the direction of the groundwater plume. FDOH included this recommendation in a community update sent via direct mail to 125 property owners in that direction.

Eliminated exposure pathways

Since May 2014, a SVES has been removing vapors from under the house on the site. Therefore, present and future vapor intrusion is an eliminated exposure pathway for the site (Table 6).

Extensive testing did not find contamination in surface or subsurface soil; therefore, soil is an eliminated exposure pathway (Table 6).

Because surveys did not find private potable wells within one-quarter mile, past and present use of contaminated groundwater both on and off the site is an eliminated pathway (Table 6).

Public Health Implications

This assessment requires the use of assumptions, judgments, and 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.

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. Risk of harm depends on the type/amount of contaminant, how a person is exposed, how long they are exposed, how much contaminant is absorbed, and individual differences in genetics and lifestyles.

For inhalation exposures, FDOH compares contaminated air concentrations directly to air comparison values.

Dose

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. We 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. A milligram is 1/1,000 of a gram; a gram weighs about as much as a small paper clip or raisin, a kilogram is approximately 2 pounds.

To calculate the daily doses of each contaminant, the FDOH uses standard factors for dose calculation [ATSDR 2005; EPA 2011]. FDOH assumes that people have daily exposures to the maximum concentration measured and makes the health protective assumption that 100% of the ingested or inhaled 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) for ingestion or ($\mu g/m^3$) for inhalation
C = contaminant concentration (various units)
IR = intake rate (amount per day)
EF = exposure factor (unit less)
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) (Please note: For air, frequency is continuous for 365 days/year unless otherwise stated)
ED = exposure duration (years)
AT = averaging time (days) (ED × 365 days/year) for non-carcinogens, or
AT = averaging time (days) (33years/78 years × 365 days/year) for carcinogens and lifetime exposure durations

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). ATSDR Toxicological Profiles also provide information on the environmental transport and regulatory status of contaminants.

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].

Groundwater Dose Calculation Assumptions—FDOH uses the following standard assumptions to estimate exposure from 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.
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.
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.
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.
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.
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.
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.
8) Average weights vary with age: (birth to 1 year: 7.8 kg), (1 to 2 years: 11.4 kg), (2 to 6 years: 17.4 kg), (6 to 11 years: 31.8 kg), (11 to 21 years: 64.2 kg), (21 to 65 years: 80 kg), (65 and older: 76 kg).
9) The frequency of exposure is 350 days per year.
10) The residential exposure duration for adults is 33 years.

Air Dose Calculation—For cancer risks related to contaminants in air, FDOH quantifies the estimated increased risk by using the general formula:

$$\text{Risk} = D \times \text{IUR}$$

D = exposure dose in air ($\mu g/m^3$ or parts per million (ppm))
IUR= Inhalation Unit Risk

EPA calculates IURs using a default inhalation rate and body weight. We eliminate these terms in the equation for dose when assessing air.

Non-cancer Doses—Children's doses are generally higher than adults are because their ingestion rates of water compared with their low body weights exceed those of adults. Therefore, if children are not at risk, then adults are not either. For non-cancer illnesses, FDOH first estimates the health risk by comparing the exposure dose for children to chemical-specific minimal risk levels (MRLs).

MRLs are comparison values that establish exposure levels many times lower than levels where scientists observed no effects in animals or human studies. ATSDR designed the MRL to protect the most sensitive, vulnerable individuals in a population. The MRL is an exposure level below which non-cancerous harmful effects are unlikely, even after daily exposure over a lifetime. Although ATSDR considers concentrations at or below the relevant comparison value reasonably safe, exceeding a comparison value does not imply adverse health effects are likely. If contaminant concentrations are above comparison values, FDOH further analyzes exposure variables (for example, duration and frequency), toxicology of the contaminants, past epidemiology studies, and the weight of evidence for health effects. FDOH uses chronic MRLs where possible because exposures are usually longer than a year. If chronic MRLs are not available, we use intermediate length MRLs [ATSDR 2005].

Cancer Dose Calculations—Cancer dose calculations use the same formula as non-cancer dose calculations do, but the exposure factor assumptions are different. Therefore, we make separate dose calculations for estimating increased cancer risk, and then we multiply this dose by the cancer slope factor.

Cancer slope factors differ by chemical. They are upper bounds approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to a carcinogen by ingestion or inhalation. 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 (78 years) to estimate the cancer risk in people.

FDOH and ATSDR use the following equation to estimate increased cancer risk:

$$\text{Risk} = D \times SF$$

D = Age specific exposure dose (mg/kg/day)
SF = Slope factor $(\text{mg/kg-day})^{-1}$

Chemicals with increased early life cancer risks—If the chemical is known to increase cancer risks due to early life exposure, FDOH and ATSDR use the following equation to estimate increased cancer risk:

$$\text{Risk} = D \times SF \times ADAF$$

D = Age specific exposure dose (mg/kg/day)
SF = Slope factor $(\text{mg/kg-day})^{-1}$
ADAF = Age Dependent Adjustment Factor

These cancer dose calculations will give a high 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 may be as low as zero. If a chemical does not have a cancer slope factor, we cannot quantify the cancer risk.

To put the cancer risk into perspective, we use the following descriptors for the different numeric cancer risks:

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

Identifying Contaminants of Concern

FDOH compares the maximum concentrations of contaminants found at a site to ATSDR and other comparison values [ATSDR 2013b]. 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)
- EPA Lifetime Health Advisory (LTHA)
- EPA Reference Concentration for Chronic Inhalation Exposure (RfC)
- Other guidelines

When determining which comparison value to use, FDOH follows ATSDR's general hierarchy and our 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. However, it does indicate the need for further evaluation.

Maximum contaminant concentrations below comparison values are not likely to cause illness and FDOH/ATSDR does not evaluate them further.

Comparing the highest measured concentrations in groundwater to ATSDR and EPA screening guidelines, FDOH selected 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), TCE, and PCE as contaminants of concern. These chemicals are all volatile organic chemicals (VOCs). Laboratory tests did not detect VOCs in soil. In soil gas, PCE was the only VOC detected above its comparison value. Selection of these contaminants does not necessarily mean there is a public health risk. Rather, FDOH selected these contaminants for additional scrutiny. Concentrations of other contaminants are below screening guidelines and we do not evaluate them further because they are not likely to cause illness.

General Health Effects from Exposure to VOCs

All of the groundwater contaminants of concern are VOCs. To avoid repetition, we describe the general health effects of exposure to VOCs before we describe the effects that differentiate them. We do not necessarily expect these health effects at the former Hurley's Dry Cleaners site. We discuss health effects we do expect at this site in the following *Site Specific Health Effects of VOCs for Completed and Potential Exposure Pathways* sections.

VOCs evaporate easily and contain carbon. They enter the body through inhalation, through ingesting water containing them, or absorption through the skin with direct contact. After they enter the body, the blood carries them to the liver, kidney, brain, heart, spleen, and fat.

Most VOCs slow brain activity. Symptoms of central nervous system 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-Dichloroethene (1,1-DCE) is a component of some plastic packaging materials and is used in flame retardant coatings for fibers and carpet. It is a manufactured chemical not found naturally in the environment [ATSDR 1994]. Dry cleaning solvents used at Hurley's Dry Cleaners may have removed 1,1-DCE from flame retardant fabric treatments. 1,1-DCE is also a breakdown product of PCE [EPA 2014b].

The liver, kidney, and lungs are target organs for 1,1-DCE toxicity by both oral and inhalation exposures [ATSDR 2009]. The adverse health effects seen at the lowest exposure level are fatty changes in the liver.

EPA has not calculated a cancer slope factor for 1,1,-DCE.

***cis*-1,2-Dichloroethene (*cis*-1,2-DCE)** is a manufactured chemical that is used to produce solvents and is found in chemical mixtures. *cis*-1,2-DCE is also a breakdown product of PCE and TCE [ATSDR 1997a].

In animal studies *cis*-1,2-DCE exposure affected the blood, decreasing the numbers of red blood cells, and adversely affected the liver. 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 2013a].

Tetrachloroethene (also known as Perchloroethylene or 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 bases its cancer slope factor on studies of liver cancer in animals [EPA 2013b].

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 is also a breakdown product of PCE.

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. TCE-exposed workers experienced higher rates of death from asthma. People who breathe high levels of TCE may have damage to their facial nerves. High workplace exposures 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, 2013a]. Even low-level exposures affected balance and caused tremors. Some workers who got TCE on their skin developed skin rashes. Health scientists believe these skin disorders have an immune component [ATSDR 2013a].

Animal inhalation studies link TCE vapors to hearing loss caused by damage to nerve cells in the inner ear. In animal studies, inhalation and ingestion of TCE also caused fetal heart defects, decreased thymus weights (the primary gland of the body's immune system), and pre-cancerous changes in kidney tissue [EPA 2013a].

Epidemiologic studies associate TCE exposure with kidney cancer, non-Hodgkin's lymphoma, and liver cancer. EPA bases its cancer slope factors on epidemiologic studies [EPA 2013a].

Site Specific Health Effects of VOCs for Completed Exposure Pathways

On May 27, 2014, the two residents living in the house on the former Hurley's Dry Cleaners site reported smelling strong odors. These odors may have come from dry cleaning solvents, solvent breakdown products, or other soil gases from four holes for SVES wells contractors drilled in the building foundation (Figure 7). Although there were no chemical-specific indoor air measurements taken that night, the symptoms they reported at the hospital emergency room that night (headaches, nausea, and stomach upset) are consistent with breathing PCE vapors or its breakdown products found in the groundwater under their house. Inhalation of PCE vapors and other strong-smelling odors may cause headaches and nausea [ATSDR 1997a, ATSDR 1997b, and OHA 2012].

Site Specific Health Effects of VOCs for Potential Exposure Pathways

Vapor and vapor intrusion: on-site workers—We are unable to assess the health threat to workers at this site in the past due to the lack of historical indoor air testing.

Past vapor intrusion: residents— FDOH evaluated seven soil gas values (Table 3) taken from under the site (Figure 7) [HSA 2013]. Based on the shallow groundwater test results, we would expect to find the highest soil gas levels on site. PCE was the only chemical found in soil gas. We multiplied all 7 values by an attenuation factor of one-tenth; this gives a conservative estimate of the concentrations of PCE that might occur in indoor air with vapor intrusion. We compared this highest estimated indoor air concentration of PCE (20.8 $\mu g/m^3$) with the ATSDR Chronic EMEG (270 $\mu g/m^3$) and the EPA Reference dose (40 $\mu g/m^3$). The highest indoor air PCE value we estimated was below these non-cancer, risk-comparison values. Therefore, non-cancer illness from inhalation of PCE from vapor intrusion is unlikely.

The estimated increased cancer risk for residents breathing the highest estimated PCE indoor air concentration (20.8 $\mu g/m^3$) is extremely low, 2×10^{-6}, or an additional 2 in 1 million.

Risk = Concentration × Inhalation Unit Risk × 33 years/78 years or

$2 \times 10^{-6} = 20.8\ \mu g/m^3 \times (2.6 \times 10^{-7}\ (\mu g/m^3))^{-1} \times 0.42$

Because the population potentially exposed via vapor intrusion at this site is very small, we would not expect additional cancer cases from past exposures.

Future drinking water wells—The following sections describe the results of the calculations FDOH made for potential future residential use of groundwater near this site. City water is available, however, and several well surveys have not found private drinking water wells in the area. Nevertheless, we consider future groundwater use because current regulations allow homeowners to install new drinking water wells on their property, even though municipal water is available.

While the levels of TCE appear to have decreased in off-site monitoring wells between 2007 and 2013 (Figures 4 and 5), levels in on-site wells increased between 2007 and 2013. To insure we do not underestimate the risk, we use the highest levels of individual VOCs measured either onsite or offsite in our calculations.

1,1-Dichloroethene (1,1-DCE) non-cancer risk—Future residents using groundwater with the highest 1,1-DCE level measured under the former Hurley's Dry Cleaners site are not likely to suffer non-cancer illnesses (Table 7). The maximum 1,1-DCE 1,1-DCE dose (0.003 milligrams per milligram body weight per day: mg/kg/day) is less than the ATSDR chronic oral MRL of 0.009 mg/kg/day.

1,1-DCE cancer risk—EPA has not classified 1,1-DCE as a carcinogen based on lack of evidence.

***cis*-1,2-Dichloroethene** (*cis*-1,2-DCE) non-cancer risk—The kidney and liver are target organs for *cis*-1,2-DCE toxicity via ingestion and inhalation of the chemical in well water [ATSDR 1996]. Increased kidney weight in male rats is the adverse health effect seen at the lowest exposure level. Although the highest dose (0.03 mg/kg/day) for *cis*-1,2-DCE (Table 8) is 170 times less that the Lowest Observable Adverse Effect Level (LOAEL) (5.1 mg/kg/day), it is too close, and the toxicity too uncertain to rule out the risk of adverse kidney effects for future daily long-term residential use.

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

Tetrachloroethene (PCE) non-cancer risk—The brain is the target organ for PCE toxicity via ingestion and inhalation of the chemical in well water [ATSDR 1997a]. Delayed reaction time, cognitive effects, and color vision loss are the adverse health effects seen at the lowest PCE exposure levels.

Although the highest dose (0.5 mg/kg/day) for PCE (Table 9) is only about one-fifth of the LOAEL (2.6 mg/kg/day), we are unable to rule out the risk of adverse neurotoxic effects for daily long-term future residential use of groundwater.

PCE cancer risk—The estimated increased lifetime cancer risk for residents drinking and showering with private well water containing the highest level of PCE (3,570 µg/L) varies from 5×10^{-5} for an average or central tendency exposure (CTE) water ingestion rate to 1×10^{-4} for a reasonable maximum exposure (RME) (Table 9). This is a "low" increased cancer risk of 1 additional case in 10,000 people to a "very low" increased cancer risk of 5 cases in 100,000 people .

Trichloroethene (TCE) non-cancer risk—The reproductive and immune systems are the targets for TCE toxicity via ingestion and inhalation typical of well water use [ATSDR 1997a]. Increased fetal heart defects in rats (reproductive), decreased thymus weights in female mice and decreased plaque-forming cell response in mice (immune system) are the adverse health effects seen at the lowest TCE exposure level.

Long-term drinking and showering with private well water containing 930 µg/L TCE could cause non-cancer illness. The estimated daily dose varies from 0.1 mg/kg/day for 0 to 1 year olds consuming the upper percentile amount of water per day to 0.01 mg/kg/day for persons older than 6 who ingest an average rate of water per day (Table 10).

All estimated doses for consumers exceed the LOAEL for fetal heart malformations (0.0051 mg/kg/day) identified in rat studies. Therefore, drinking water with the maximum TCE concentration at this site over a lifetime might cause congenital heart defects in babies.

Three of 7 doses estimated for consumers using the upper percentile amount of water per day and 1 of 7 doses estimated for consumers using an average amount of water per day exceed the LOAEL for immunological effects (0.048 mg/kg/day) for decreased thymus weights identified in female mice. Therefore, drinking water with the maximum TCE concentration at this site over a lifetime might damage the thymus and interfere with the immune system.

While none of the doses estimated exceeded the LOAEL for developmental toxicity (0.37 mg/kg/day), 5 of 14 are within a factor of 10. Therefore, we are unable to rule out the risk of developmental toxicity from lifetime use of water with the highest TCE concentration.

TCE cancer risk—The estimated increased lifetime cancer risk for residents drinking and showering with private well water containing the highest level of TCE (930 µg/L) varies from 1×10^{-3} for a average (CTE) ingestion rate to 3×10^{-3} (Table 10) for an upper percentile (RME) water ingestion rate. This is a "moderate" increased cancer risk of 1 to 3 additional cases in 1 thousand.

Mixtures

If people inhale, ingest or contact several chemicals at the same time, health scientists may evaluate their exposure to a mixture of chemicals. Certain chemical mixtures exhibit additive toxicity at doses near the individual toxic thresholds. While groundwater with the highest levels of *cis*-1,2-DCE and TCE both affect non-cancer kidney health,

information available on their joint action is limited. Although one study indicated TCE and PCE might have additive effect on the kidneys, several other studies showed TCE metabolism may inhibit the metabolism of PCE making their joint effects less than additive [ATSDR 2004]. Both PCE and TCE increase the risk of non-Hodgkin's Lymphoma [ATSDR 1997a, 1997b, 2013a].

Site Specific Limitations of Findings

For our assessment of the odors residents reported during installation of the soil vapor extraction equipment, we lack actual measurements of the gases in the home. We based our estimates of exposure on soil gas levels measured near the house in 2013 and OVA screening data from the consultants who were in the house that day. In addition, we lack air data to address former worker's exposures.

For levels of groundwater contaminants, we have only 2 sets of data, from 2007 and 2013, and for the second set of data, we have significantly fewer sample points, with respect to depth and area.

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 might be 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 2005].

Potential Exposure Pathway Chemicals

If new drinking water wells exposed children to contaminated groundwater on and near the site, TCE might pose greater health risks for children than adults.

Based on animal studies, the developing fetal heart may be susceptible to the toxic effects of TCE. In addition, an epidemiologic study showed that maternal age at delivery and TCE 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 TCE. A study with mice showed that a single TCE exposure resulted in increased thymocyte cellularity, a condition associated with altered immune system regulation [ATSDR 2013a]. EPA also notes increased early-life susceptibility due to TCE's mutagenic mode of action for kidney tumors [EPA 2013a].

Community Health Concerns Evaluation

On May 27, 2014, FDEP's contractors drilled four holes for SVES wells through the foundation of the house on the Hurley's Dry Cleaners site. The two tenants were concerned that these holes let strong-smelling odors into the house. They were also concerned these vapors were responsible for the headache, nausea, and stomach upset that sent them to the hospital emergency room that night.

FDOH strongly suspects that vapors from these four holes caused the reported symptoms. Inhalation of PCE vapors and/or other strong *but non-toxic* odors are known to cause headaches and nausea [ATSDR 1997a, ATSDR 1997b, OHA 2012]. Although FDEP's consultant used a photo ionization detector to monitor vapors from soil from these holes, this instrument does not identify individual chemicals or levels. Without a laboratory analysis of an air sample for individual chemicals using gas chromatography/mass spectrometry, FDOH cannot be certain of the health threat.

Public Comments

In mid-April 2015, FDOH sent community updates announcing the availability of the public comment version of this report to 125 property owners southeast of the site where FDEP found site-related groundwater contamination. We received one comment from the owner of a rental property during the public comment period.

The comments said, *"The report isn't as comprehensive as I would expect given the seriousness of the problem. If the clerk of courts is alerted for all future property owners, I expect much more."* She also wanted to know about *past issues, symptoms and long-term exposure concerns.* We sent the commenter a letter saying only the former dry cleaning property had a note attached to the parcel by the clerk of courts. We also sent a copy of the full report with our phone number, asking her to call with questions.

We believe the commenter thought the community update was our report. We think this because this report discusses why FDEP asked us to look into the short-term exposure of the former renters. We also discuss that there are no known current exposure routes, and therefore no long-term exposure concerns except for future private wells. Although we do not expect property owners to install private wells in this area, as city water is available, we discuss off-site groundwater contamination as a precaution and recommend not using it for a source of drinking water.

Conclusions

FDOH found that there are no *current* completed exposure pathways related to this site. If people were to drink contaminated groundwater from on and near the site, the highest levels of PCE and other dry cleaning chemicals in the groundwater would pose a public health hazard.

1. Vapors from dry cleaning chemicals or their breakdown products (from four holes drilled through the foundation of the house on the former Hurley's Dry Cleaners site) may have caused the headache, nausea, and stomach upset reported by the residents. FDOH cannot be certain of the toxicity of these vapors, however, without laboratory identification of individual chemicals and levels. Very strong smells from less toxic chemicals may produce these same symptoms.

2. PCE, TCE, and other VOCs contaminate shallow groundwater under the site. Currently, these compounds also contaminate deeper groundwater (15 feet and greater below the level of the surface) one-quarter mile or more southeast of the site. Away from the site, the VOC levels are much lower than those on the site are. FDOH in Orange County has not identified anyone using contaminated groundwater now or in the past through several surveys looking for private wells. Based on estimates using the highest measured contamination levels, future use of this groundwater as a drinking water source could significantly increase the risk of non-cancer illnesses. These illnesses include congenital heart defects, immune system suppression, kidney damage, nervous system damage, and delayed development. However, due to its chemical smell and the availability of municipal water, future use of this contaminated groundwater is unlikely.

3. On-site residents or workers are not at risk from chemicals in soil. FDEP's contractors did not find dry cleaning chemicals in on-site soils.

4. Levels of PCE measured in on-site soil gas are not likely to have caused past illness via vapor intrusion. We estimated the amount of PCE that might have entered the house through vapor intrusion and found non-cancer illness is unlikely and the increased cancer risk is extremely low. Current monitoring well tests (2013) do not show contaminated shallow groundwater off-site, therefore nearby homes are not at risk for vapor intrusion. FDEP's consultants installed a SVES on the site in May 2014.

Recommendations

1. FDOH recommends testing air in the house on the former Hurley's Dry Cleaners site before anyone lives there again. We recommend collection of air samples with the windows shut and the air conditioner or heater on. We recommend the laboratory analyze for individual compounds using gas chromatography/mass spectrometry.

2. FDOH recommends people not install drinking water wells on the former Hurley's Dry Cleaners site or in areas to the southeast with groundwater contamination.

Public Health Action Plan

Actions Undertaken

The week of May 26, 2014, FDOH spoke on the phone with the FDEP project manager, a former tenant, and the former tenant's doctor about short-term indoor air exposures at the site.

FDOH mailed a community update summarizing this draft health report, and solicited public comments on its findings. FDOH addressed these public comments and additional health concerns in this, the final report.

FDOH in Orange County staff filed a notice with the County Clerk of Courts stating that dry cleaners once operated at this address and contaminated the groundwater under the house. As a result, the owner should test the home's air quality before people live in the house and the owner should not put a drinking water well on the property.

The FDOH worked with the FDOH in Orange County to inform nearby residents of the health risk from installing new private drinking water wells in contaminated groundwater associated with the former Hurley's Dry Cleaners site and included this information in our community update.

Actions Planned

FDOH in Orange County staff have offered to test indoor air at the house on the site of the former dry cleaners before anyone lives there again.

We will distribute this final report to the FDOH in Orange County, the two nearby residents who expressed interest, and FDEP. FDOH will also post the final report at hazwaste.floridahealth.gov.

FDOH will consider review of new data when requested.

Report Preparation

The FDOH prepared this public health assessment for the former Hurley's Dry Cleaners site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). Funds from FDOH's cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services supported this report. ATSDR has not reviewed and cleared this document, FDOH completed the editorial review.

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Appendices

Tables and Figures

Table 1. Contaminants of Concern in Soil on the Former Hurley's Dry Cleaners Site

Contaminants	Concentration Range (mg/kg)	Screening Guideline* (mg/kg)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1-Dichloroethene	<1.0	450	ATSDR chronic child EMEG	0/21
cis-1,2-Dichloroethene	<1.0	100	ATSDR chronic child RMEG	0/21
Trichloroethene	<1.0	15	ATSDR CREG	0/21
Tetrachloroethene	<1.0 – 1.8	330	ATSDR CREG	0/21

CREG = ATSDR Cancer Risk Evaluation Guide for 1 in 1 million excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide, chronic exposures last longer than 365 days, screening levels for children are less than adult screening levels.
RMEG = ATSDR Reference Dose media Evaluation Guide, chronic exposures last longer than 365 days, screening levels for children are less than adult screening levels.
mg/kg = milligrams per kilogram
*Screening guidelines only used to select chemicals for further scrutiny, not to the judge the risk of illness.
Data sources: [URS 2008, TTNUS 2010, HSA 2013, CRA 2013b].

Table 2. Contaminants of Concern in Groundwater at and near the Former Hurley's Dry Cleaners Site

Contaminants	Concentration Range (µg/L)	Screening Guidelines* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1-Dichloroethene	<1.0 - 18.6	7	EPA MCL	2/236
cis-1,2-Dichloroethene	<1.0 - 220	10	EPA LTHA	3/236
Trichloroethene	<1.0 - 930	0.76	ATSDR CREG	42/236
Tetrachloroethene	<1.0 - 3570	5	EPA MCL	15/236

CREG = ATSDR Cancer Risk Evaluation Guide for 1 in 1 million excess cancer risk
LTHA = EPA lifetime health advisory
MCL = EPA Maximum Concentration Level
µg/L = micrograms per liter
*Screening guidelines only used to select chemicals for further scrutiny, not to the judge the risk of illness.
Data sources: [URS 2008, TTNUS 2010, HSA 2013, CRA 2013a]

Table 3. Contaminants of Concern in Soil Gas from the Former Hurley's Dry Cleaners Site

Contaminants	Concentration Range ($\mu g/m^3$)	Screening Guidelines* ($\mu g/m^3$)	Source of Screening Guideline	# Above Screening Guideline/ Total #
1,1-Dichloroethene	<0.37	20	ATSDR Int. EMEG	0/6
cis-1,2-Dichloroethene	<0.31	–	–	–
Trichloroethene	<0.64	0.24	ATSDR CREG	0/6
Tetrachloroethene	18-208	3.8	ATSDR CREG	6/6

CREG = ATSDR Cancer Risk Evaluation Guide for 1 in 1 million excess cancer risk
INT. EMEG =Environmental Media Evaluation Guide for periods of exposure lasting 15–365 days
$\mu g/m^3$ = micrograms per cubic meter
*Screening guidelines only used to select chemicals for further scrutiny, not to the judge the risk of illness.
Data source: [HSA 2013]

Table 4. Completed Human Exposure Pathways at the Former Hurley's Dry Cleaners Site

Completed Pathway Name	Completed Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Indoor air vapors	Solvent disposal at the former Hurley's Dry Cleaners site	Soil gas that entered the house on the site through holes drilled in the foundation	Air inside the on-site house	Inhalation	Two residents	May 27, 2014

Table 5. Potential Human Exposure Pathways at the Former Hurley's Dry Cleaners Site

Potential Pathway Name	Completed Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Vapor and vapor intrusion: on-site workers	Dry cleaning operations and solvent disposal at the former Hurley's Dry Cleaners site	Indoor air and soil gas that may have entered houses through cracks in the foundation	Indoor air	Inhalation	Workers at Hurley's Dry Cleaners	Past (1948–1984)
Past vapor intrusion: residents	Solvent disposal at former Hurley's Dry Cleaners site	Soil gas that may have entered houses through cracks in the foundation	Indoor air	Inhalation	Residents in the on-site house and nearby houses	Past (1984–2014)
Future drinking water wells	Solvent disposal at former Hurley's Dry Cleaners site	Groundwater	Tap water at residences and businesses	Ingestion, dermal absorption, and vapor inhalation	Users of new drinking water wells	Future

Table 6. Eliminated Human Exposure Pathways at the Former Hurley's Dry Cleaners Site

Eliminated Pathway Name	Completed Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Present and future vapor intrusion: residents	Solvent disposal at former Hurley's Dry Cleaners site	Soil gas that may have entered houses through cracks in the foundation	Indoor air of on-site and nearby houses	Inhalation	None	Present and future
Incidental soil ingestion	Solvent disposal at former Hurley's Dry Cleaners site	Soil	On and off-site yards	Ingestion	None	Past, present and future
Past and present drinking water wells	Solvent disposal at former Hurley's Dry Cleaners site	Groundwater	Tap water at residences and businesses	Ingestion, dermal absorption, and inhalation	None	Past and present

Table 7. Estimated Upper Percentile and Mean Doses of 1,1-Dichloroethene for Hypothetical Residential Exposures via Private Wells for the Highest Groundwater Concentration on or near the Former Hurley's Dry Cleaners Site

Age Group (years)	Body Weight (kg)	Maximum Groundwater Concentration (µg/L)	Estimated Ingestion Dose (mg/kg/day)		ATSDR Chr. Oral MRL/EPA RfD (mg/kg/day)
			RME	CTE	
0.5 to <1	9.2	18.6	3×10^{-3}	1×10^{-3}	$9\times10^{-3}/5\times10^{-2}$
1 to <2	11.4		1×10^{-3}	5×10^{-4}	
2 to <6	17.4		1×10^{-3}	4×10^{-4}	
6 to <11	31.8		8×10^{-4}	3×10^{-4}	
11 to <16	56.8		6×10^{-4}	2×10^{-4}	
16 to <21	71.6		6×10^{-4}	2×10^{-4}	
≥21	80		7×10^{-4}	3×10^{-4}	

µg/L = micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
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. This MRL is for chronic exposures, meaning those lasting longer than 1year with a critical effect of fatty liver (uncertainty factor of 1000).
EPA RfD = Reference dose calculated from the point-of-departure in the 10% benchmark dose levels (4.6 mg/kg/day, multiplied by an uncertainty factor of 100) for rat liver toxicity in a chronic drinking water study. A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Table 8. Estimated Upper Percentile and Mean Doses of cis-1,2-Dichloroethene for Hypothetical Residential Exposures via Private Wells for the Highest Groundwater Concentration on or near the Former Hurley's Dry Cleaners Site

Age Group (years)	Body Weight (kg)	Maximum Groundwater Concentration (µg/L)	Estimated Ingestion Dose (mg/kg/day)		EPA RfD (mg/kg/day)
			RME	CTE	
0.5 to <1	9.2	220	3×10^{-2}	1×10^{-2}	2×10^{-3}
1 to <2	11.4		2×10^{-2}	6×10^{-3}	
2 to <6	17.4		1×10^{-2}	5×10^{-3}	
6 to <11	31.8		1×10^{-2}	4×10^{-3}	
11 to <16	56.8		8×10^{-3}	2×10^{-3}	
16 to <21	71.6		8×10^{-3}	2×10^{-3}	
≥21	80		9×10^{-3}	3×10^{-3}	

µg/L = micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
EPA RfD = Reference dose calculated from the point-of-departure in the 10% benchmark dose levels (5.1 mg/kg/day, multiplied by an uncertainty factor of 3000) for increased relative kidney weight in male rats. A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
Shaded doses exceed the EPA RfD.

Table 9. Estimated Upper Percentile and Mean Doses of Tetrachloroethene for Hypothetical Residential Exposures via Private Wells for the Highest Groundwater Concentration on or near the Former Hurley's Dry Cleaners Site

Age Group (years)	Body Weight (kg)	Maximum Ground-water Concentra-tion (µg/L)	Estimated Non-cancer Ingestion Dose (mg/kg/day)		EPA RfD (mg/kg/day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Ingestion Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			U.P.	Mean			RME	CTE	U.P.	Mean
0.5 to <1	9.2	3,570	5×10^{-1}	2×10^{-1}	6×10^{-3}	.0021	7×10^{-3}	3×10^{-3}	1×10^{-5}	6×10^{-6}
1 to <2	11.4		3×10^{-1}	1×10^{-1}			4×10^{-3}	1×10^{-3}	8×10^{-6}	3×10^{-6}
2 to <6	17.4		2×10^{-1}	8×10^{-2}			1×10^{-2}	4×10^{-3}	2×10^{-5}	8×10^{-6}
6 to <11	31.8		2×10^{-1}	6×10^{-2}			1×10^{-2}	4×10^{-3}	2×10^{-5}	8×10^{-6}
11 to <16	56.8		1×10^{-1}	4×10^{-2}			8×10^{-3}	3×10^{-3}	2×10^{-5}	5×10^{-6}
16 to <21	71.6		1×10^{-1}	4×10^{-2}			8×10^{-3}	3×10^{-3}	5×10^{-6}	5×10^{-6}
≥21	80		1×10^{-1}	1×10^{-1}			2×10^{-2}	3×10^{-3}	4×10^{-5}	2×10^{-5}
							Children's summed cancer risk 0.5 year to <21 year.....		**1×10^{-4}**	**4×10^{-5}**
							Adults' summed cancer risk 21 year to 78 year.....		**5×10^{-5}**	**2×10^{-5}**
							Lifetime Cancer Risk, Children + Adults.....		**1×10^{-4}**	**5×10^{-5}**

µg/L = micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
EPA RfD = The RfD is supported by two principal studies, as a midpoint of the range of available values (then rounded to one significant figure). They calculated one study dose from the point-of-departure (LOAEL of 9.7 mg/kg/day, multiplied by an uncertainty factor of 1,000) for neurotoxicity (reaction time, cognitive effects) in occupationally exposed adults. The LOAEL for the other study is 2.6 mg/kg/day for neuro-toxicity, (loss of color vision) in occupationally exposed adults. A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
Shaded doses exceed the EPA RfD.

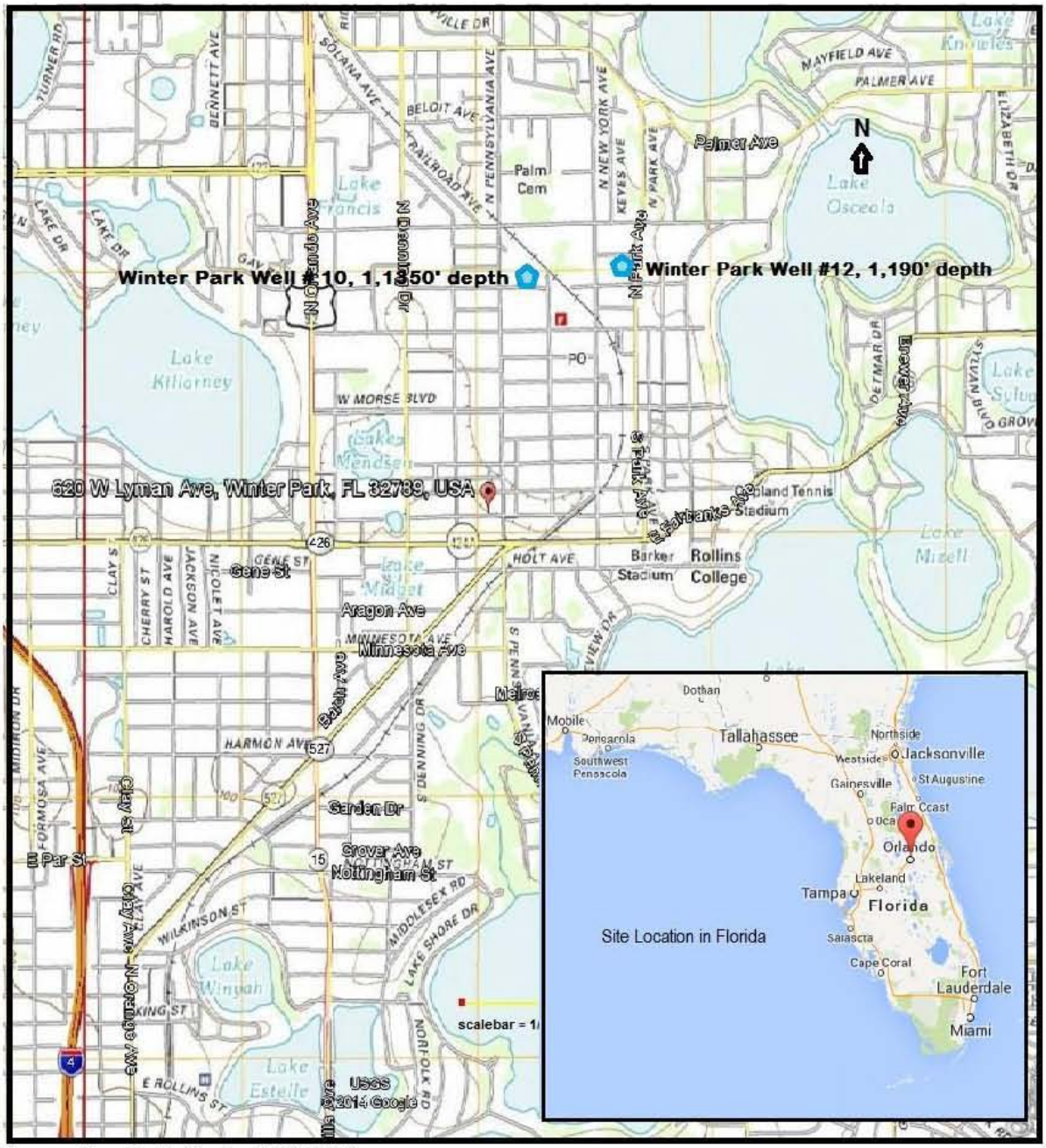
Table 10. Estimated Upper Percentile and Mean Doses of Trichloroethene for Hypothetical Residential Exposures via Private Wells for the Highest Groundwater Concentration on or near the Former Hurley's Dry Cleaners Site

Age Group (years)	Body Weight (kg)	Maximum Ground-water Concentra-tion (µg/L)	Estimated Non-cancer Ingestion Dose (mg/kg/day)		ATSDR MRL & EPA RfD (mg/kg/day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Ingestion Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			U.P.	Mean			RME	CTE	U.P.	Mean
0.5 to <1	9.2	930	1×10^{-1}	6×10^{-2}	5×10^{-4}	0.046	2×10^{-3}	8×10^{-4}	8×10^{-4}	4×10^{-4}
1 to <2	11.4		7×10^{-2}	3×10^{-2}			9×10^{-4}	3×10^{-4}	4×10^{-4}	2×10^{-4}
2 to <6	17.4		5×10^{-2}	2×10^{-2}			3×10^{-3}	1×10^{-3}	4×10^{-4}	1×10^{-4}
6 to <11	31.8		4×10^{-2}	1×10^{-2}			3×10^{-3}	1×10^{-3}	3×10^{-4}	1×10^{-5}
11 to <16	56.8		3×10^{-2}	1×10^{-2}			2×10^{-3}	7×10^{-4}	9×10^{-5}	9×10^{-5}
16 to <21	71.6		3×10^{-2}	1×10^{-2}			2×10^{-3}	6×10^{-4}	2×10^{-3}	3×10^{-5}
≥21	80		4×10^{-2}	1×10^{-2}			6×10^{-3}	2×10^{-3}	3×10^{-4}	1×10^{-4}

Children's summed cancer risk 0.5 year to <21 year.....2×10^{-3} 9×10^{-4}
Adults' summed cancer risk 21 year to 78 year.....3×10^{-4} 1×10^{-4}
Lifetime Cancer Risk, Children + Adults.....3×10^{-4} 1×10^{-3}

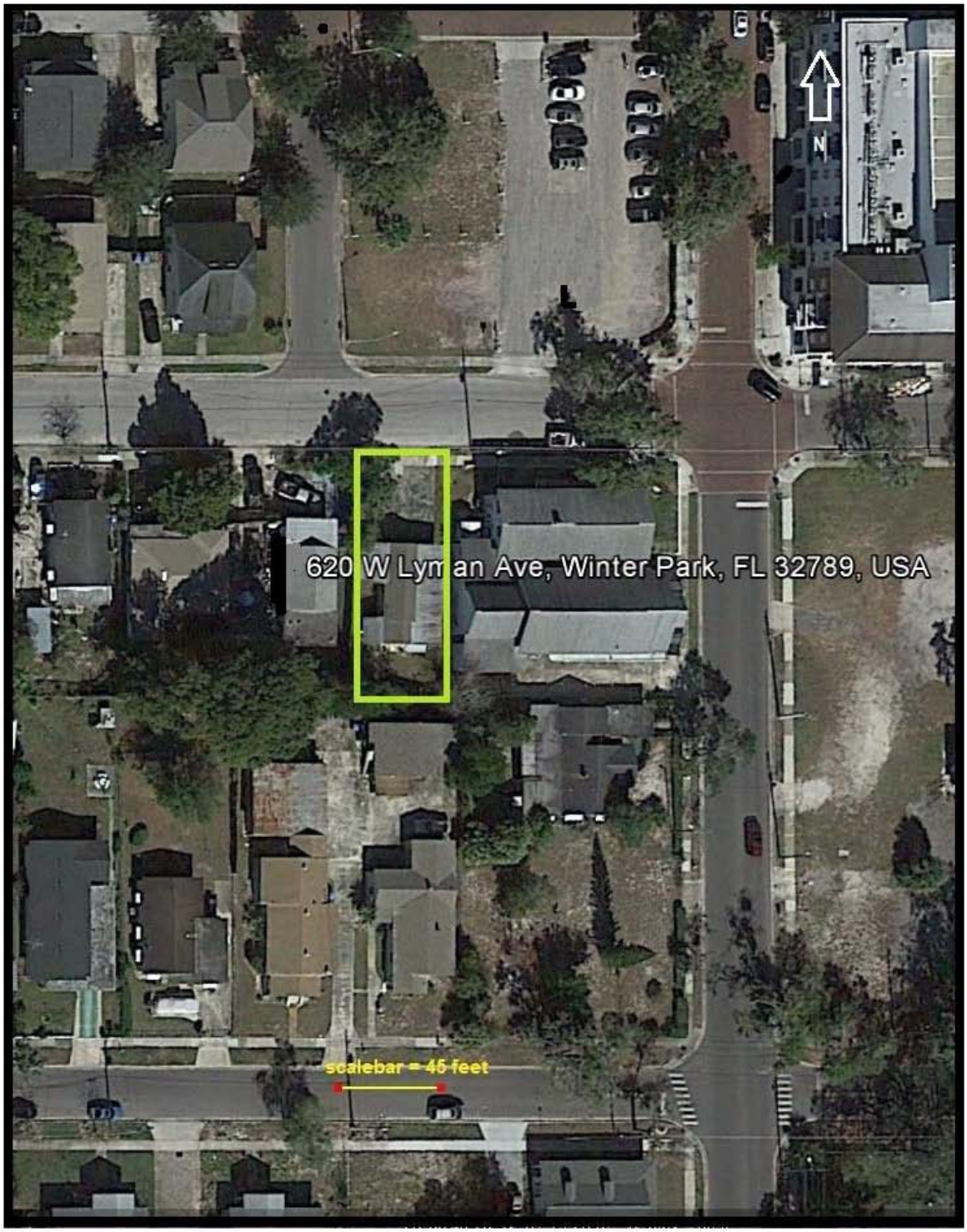
µg/L = micrograms per liter **U.P.** = Upper Percentile **RME** = Reasonable Maximum Exposure **CTE** = Central Tendency Exposure
ATSDR MRL = Agency for Toxic Substances and Disease Registry's Minimal Risk Level. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. This MRL is for chronic exposures, meaning those lasting longer than 1year calculated from three studies, developmental toxicity with an uncertainty factor of 10, and two immunological studies one with an uncertainty factor of 100, and one with and uncertainty factor of 1,000.
EPA RfD = This RfD of 0.0005 mg/kg/day reflects the midpoint among three similar candidate RfDs for the critical effects. The first is 0.0004 mg/kg/day for developmental immunotoxicity (decreased plaque-forming cell (PFC)) and increased delayed-type hypersensitivity) in mice, the second and third are 0.0005 mg/kg/day for both heart malformations in rats and decreased thymus weights in mice—rounded to one significant figure, and is within 25% of each candidate RfD. A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
Shaded doses exceed the ATSDR MRL and EPA RfD

Figure 1. Location of the Former Hurley's Dry Cleaners Site



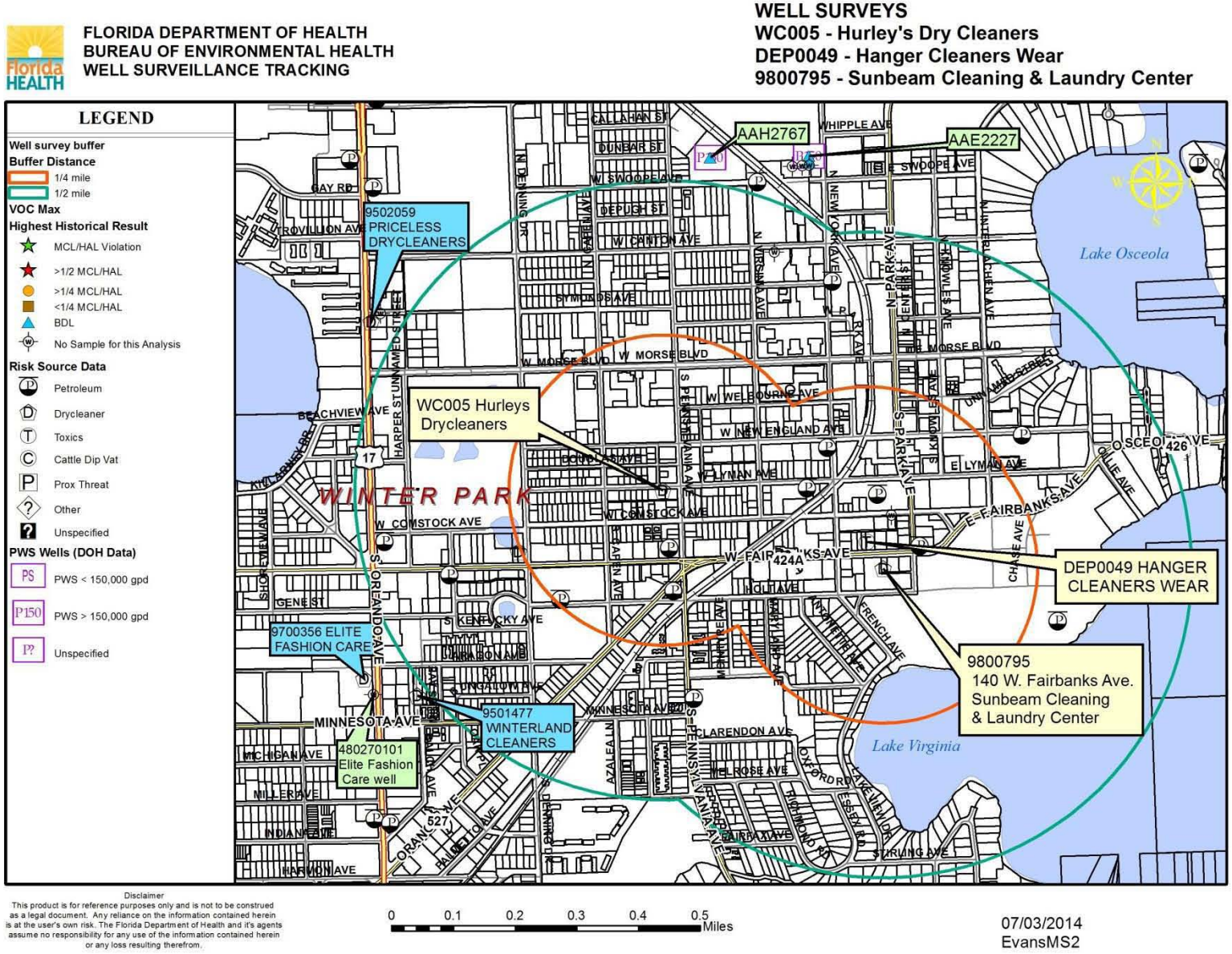
Source: Google Earth, April 19, 2013

Figure 2. Aerial Photograph of the Former Hurley's Dry Cleaners Site



Source: Google Earth January 17, 2014

Figure 3. Former Hurley's Dry Cleaners Well Surveillance



*Winter Park Municipal Wells AAH2767 and AAE2227 (Blue Triangles) are one-half mile north of the site [FDOH 2014]. FDOH in Orange County found no **private wells** for this inventory or for the Hanger Cleaners Wear or Sunbeam Cleaning & Laundry Center well inventories.*

Figure 4. Depths of PCE Groundwater Contamination from the Former Hurley's Dry Cleaners Site in 2007, 2013 tests only show PCE on the Site

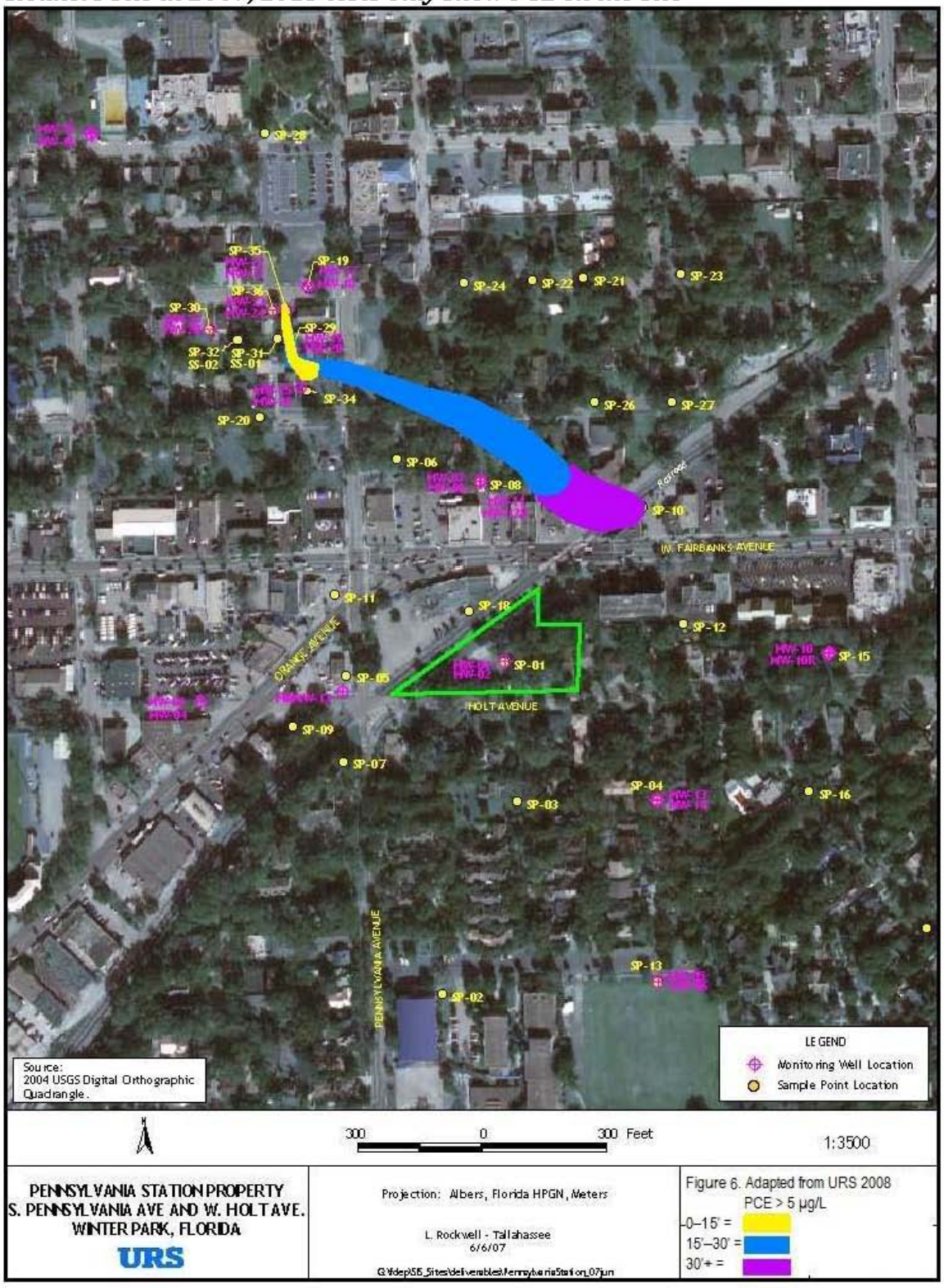


Figure 5. Depths of TCE Groundwater Contamination from the Former Hurley's Dry Cleaners Site in 2007

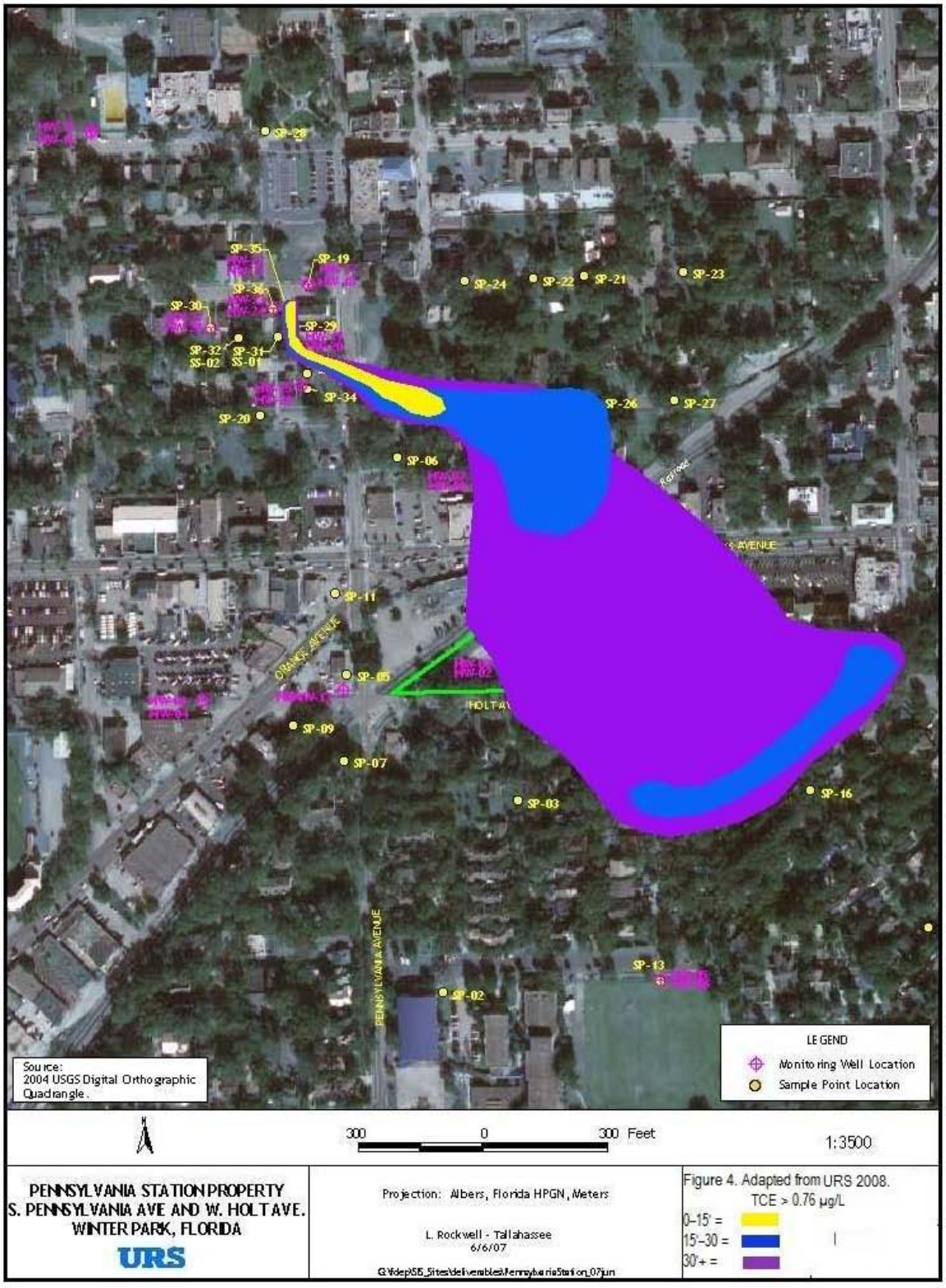


Figure 6. Depths of TCE Groundwater Contamination from the Former Hurley's Dry Cleaners Site in 2013

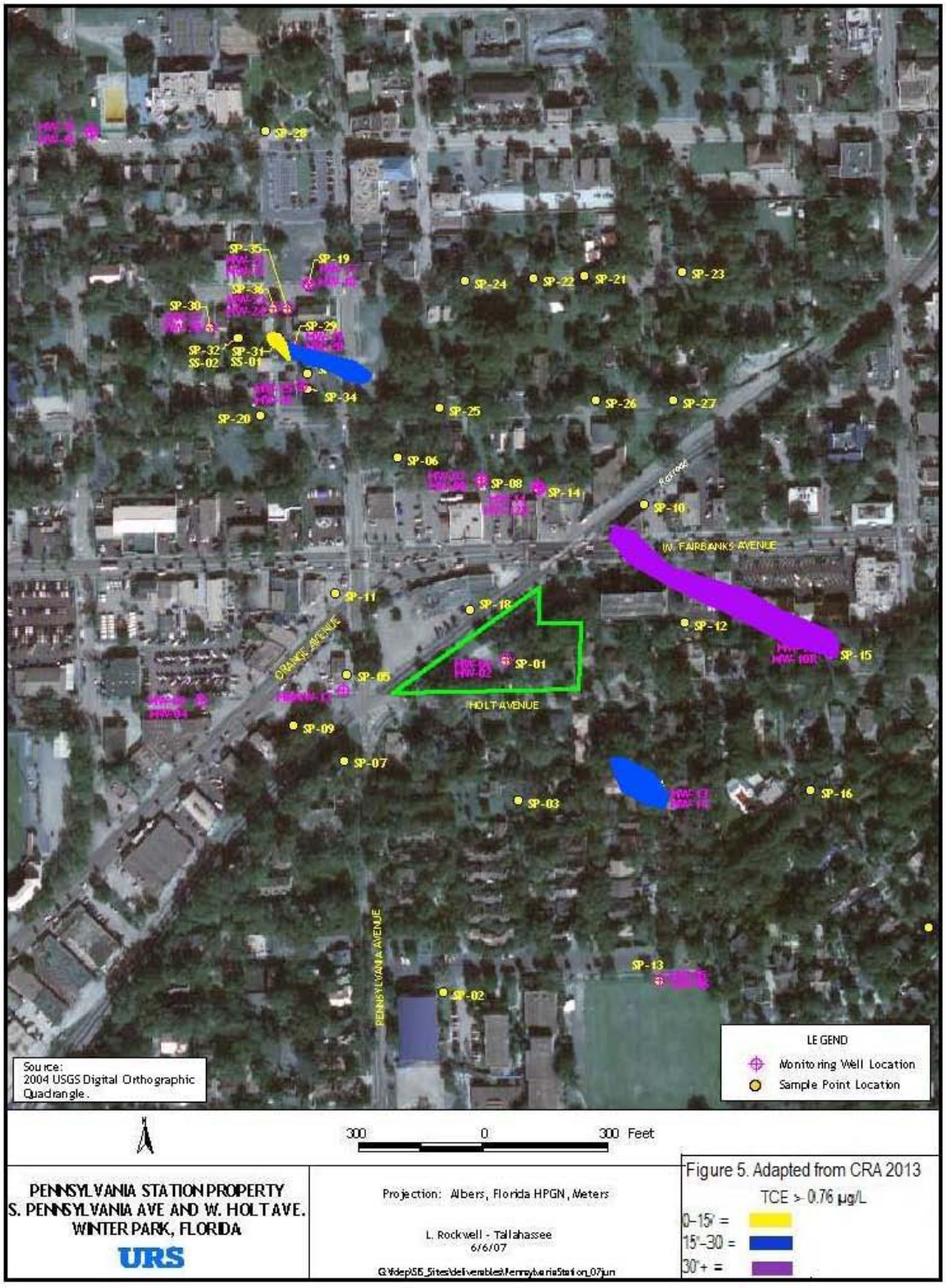
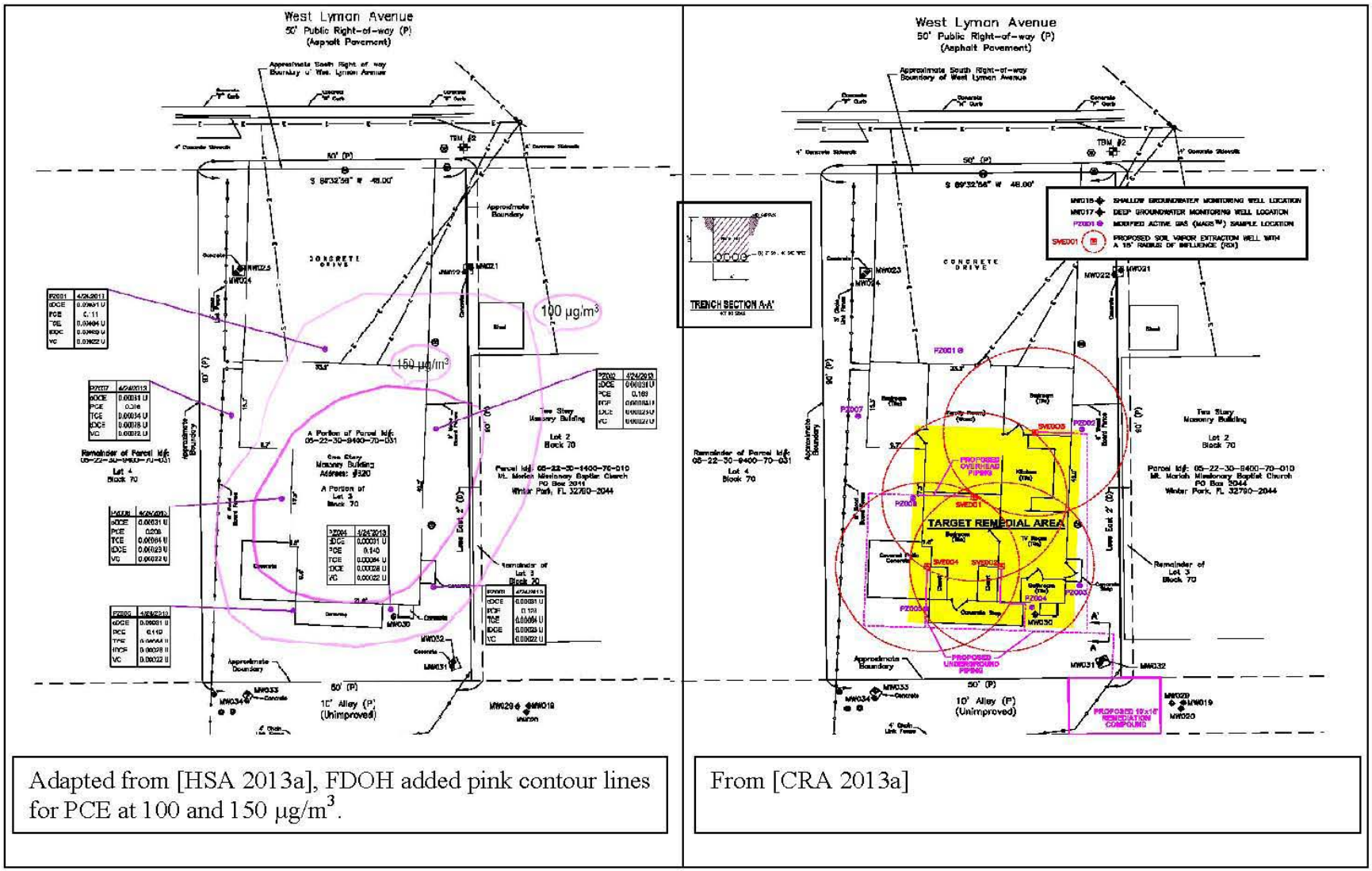


Figure 7. Levels of PCE in Soil Gas under the Former Hurley's Dry Cleaners Site (left diagram) and the Soil Vapor Extraction System (right diagram)



Adapted from [HSA 2013a], FDOH added pink contour lines for PCE at 100 and 150 µg/m^3.

From [CRA 2013a]

General Uncertainties of Risk Assessment

This public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the Hurley's Dry Cleaners Site. Some more important sources of uncertainty in this public health assessment include incomplete environment sampling and analysis, estimates of exposure levels, use of modeled data, and limited toxicological knowledge. These uncertainties may cause us to over- or underestimate risk.

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. These 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. Alternatively, these assumptions may not account for extra exposures for pathways such as airborne dust for which we lack data, or for additive exposures from several sources.

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 interaction 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 environments, 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.

Glossary

Acute
Occurring over a short time [compare with **chronic**].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure**].

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

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

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

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.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

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 [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

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 [compare with **surface water**].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

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 [see **reference dose**].

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

ppm
Parts per million.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

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 meeting
A public forum with community members for communication about a site.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

Risk
The probability that something will cause injury or harm.

Soil Vapor Extraction
Soil vapor extraction is an "in-place" technology for reducing concentrations of volatile constituents in soil above the groundwater table. A vacuum is applied through wells near the source of contamination in the soil. Volatile constituents of the contaminant mass "evaporate" and the vacuum draws the vapors toward the extraction wells. Extracted vapor is then treated as necessary (commonly with a carbon adsorption filter) before being released to the atmosphere. The increased air flow through the subsurface can also stimulate breakdown of some of the contaminants by soil microbes.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

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.

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

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.