Health Consultation

Silver Springs Shores

Ocala, Marion County, Florida

FDEP Site Investigation Section
Site Number 747-1

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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

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Foreword

The Florida Department of Health (Department) evaluates public health risks through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ASTDR) in Atlanta, Georgia. The Department prepared this report using the same procedures used for reports reviewed by ATSDR. This report evaluates the public health risk associated with groundwater collected in the Silver Springs Shores area of Ocala, Florida. The Department evaluates public health issues using the following processes:

Evaluating exposure: The Department scientists review available information about environmental conditions. The Florida Department of Environmental Protection (DEP) provided the data for this assessment.

Evaluating health effects: If evidence is found that exposures are occurring or might occur, the Department scientists next determine whether that exposure could be harmful to human health. The Department focuses on potential health effects for the community as a whole. The Department bases our conclusions and recommendations on current scientific information.

Developing recommendations: The Department lists its conclusions regarding any potential health threat. The Department then offers recommendations for reducing or eliminating human exposure. The role of the Department is primarily advisory. Our assessments will typically recommend actions for other agencies including the Environmental Protection Agency (EPA) and DEP. If a health threat is actual or imminent, the Department 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. The Department starts by soliciting and evaluating information from various government agencies, individuals, or responsible organizations, and those living in nearby communities. The Department shares conclusions with the groups and organizations providing the information and asks for feedback from the public.

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

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Summary

INTRODUCTION

In the Silver Springs Shores area, the Florida Department of Health's (Department) top priority is to ensure the public has the best information to safeguard their health.

The Silver Springs Shores area is within a mile of Maricamp and Oak Roads in Ocala, Marion County, Florida. The area includes two Silver Springs Shores public water supply wells and nearby private residential wells. The public supply wells and some private wells have low levels of 1,4-dioxane.

Overall, the Department finds that 1,4-dioxane in Silver Springs Shores area groundwater is not a public health hazard. The Department concludes that:

CONCLUSION #1

Drinking water that contains low levels of 1,4-dioxane detected in the Silver Springs Shores **public water supply** or breathing low levels of 1,4-dioxane from showering with the water is not likely to cause illness.

BASIS FOR DECISIONS #1

Before February 2017, 1,4-dioxane levels in the water distribution system were slightly more than the state Health Advisory Level (HAL) of 0.35 micrograms per liter (µg/L). Since then, monthly levels have been less than the HAL. The highest 1,4-dioxane levels before February 2017 were below levels likely to cause illness. HALs include safety factors to protect public health.

NEXT STEPS #1

The Department recommends the public water supply continues to meet the HAL.

CONCLUSION #2

Drinking water that contains low levels of 1,4-dioxane from **private wells** in the Silver Springs Shores area or breathing low levels of 1,4-dioxane from showering with the water is not likely to cause illness.

BASIS FOR DECISIONS #2

Although 1,4-dioxane levels in some private wells are slightly more than the state HAL, they are still less than levels likely to cause illness. HALs include safety factors to protect public health.

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 Department toll-free at 877-798-2772 and ask for information about the Silver Springs Shores area.

Background and Statement of Issues

The purpose of this health consultation report is to assess the public health threat from groundwater in the Silver Springs Shores area. The Florida Department of Health (Department) initiated this assessment. For purposes of this report, the Department defines Silver Springs Shores as the area within one mile of the intersection of Maricamp and Oak Roads, Marion County, Florida, 34472 (Figure 1). The extent of groundwater contamination, however, has not been determined and testing is ongoing.

This assessment estimates the health risk for individuals exposed to the highest measured level of contamination. Those without exposure are not at risk.

Area Description

The Silver Springs Shores area is in a mixed residential, commercial, and industrial area 10 miles southeast of Ocala, Florida. It includes two public water supply wells, the water distribution system, and nearby private drinking water wells (Figures 2 and 3).

Demographics

The Department examines demographic and land use data to identify sensitive populations, such as young children, the elderly, and women of childbearing age, to determine whether these sensitive populations are exposed to any potential health risks. Demographics also provide details on population mobility and residential history in a particular area. This information helps the Department evaluate how long residents might have been exposed to contaminants.

Approximately 15,500 people live within three miles of the Silver Springs Shores public water supply wells. Sixty-eight percent (68%) are white, 26% are African-American, and 6% are other. Twenty-five percent (25%) are less than 18 years old. Approximately twenty-one percent (21%) are women of child-bearing age (15-44 years old). Fifty-four percent (54%) have a high school diploma or less and 22% have at least two years of college. Eighty-seven percent (87%) speak only English and 68% have a household income of less than $50,000 a year [EPA 2010].

Land Use

Land use near the public water supply wells is industrial/commercial. Land use within three miles is mostly residential.

Community Health Concerns

The Department is unaware of community health concerns. The Florida Department of Health in Marion County (DOH-Marion) and the DEP did not report any community health concerns.

Discussion

Environmental Data

Consultants for DEP compiled results of monthly testing (November 2016 to April 2017) from the two public supply wells and from point of entry into the water distribution system. DEP analyzed all samples for volatile organic constituents per the Environmental Protection Agency (EPA) Method 8260. They also tested for 1,4-dioxane using EPA Method 522 [Tetra Tech 2017]. Table 2 summarizes contaminant concentrations above screening levels. Levels of 1,4-dioxane in the water distribution system have been below the Florida Health Advisory Level since Feburary 2017.

In November 2016, the Florida Department of Health in Alachua County (DOH-Alachua) located and tested 10 private wells within a mile of the public water supply wells (Figure 2) [DOH 2016]. DOH-Alachua tested 24 more private wells in January 2017 and retested two of these wells in May 2017 (Figure 3). There are more private wells in the area. Table 3 summarizes contaminant concentrations above screening levels.

Pathway Analyses

Chemical contamination in the environment can harm your health but only if you have contact with those contaminants (exposure). Without contact or exposure, there is no harm to health. If there is contact or exposure, how much of the contaminants you contact (concentration), how often you contact them (frequency), for how long you contact them (duration), and the danger level of the contaminant (toxicity) all determine the risk of harm.

Knowing or estimating the frequency people could have contact with contaminants is essential to assessing the public health importance of these contaminants. The method for assessing whether a public health hazard exists is to determine whether there is a completed exposure pathway from a contaminant source to a population and whether exposures to contamination 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 the interface with the human body. A completed exposure pathway consists of five elements:

1. A source of contamination
2. An environmental medium like air, water or soil that can hold or move the contamination
3. A point where people contact a contaminated medium like water at the tap or soil in the yard
4. An exposure route like ingesting (contaminated soil or water) or breathing (contaminated air)
5. A population which could be exposed to contamination like nearby residents

Generally, ATSDR and the Department consider three exposure categories: 1) completed exposure pathways when all five elements of a pathway are present; 2) potential exposure pathways if one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways when a population does not come into contact with contaminated media. Exposure pathways are used to evaluate specific ways in which people were, are, might or will be exposed to environmental contamination.

Completed exposure pathways

The Department evaluated two completed human exposure pathways: 1) drinking water and breathing vapors from showering with Silver Springs Shores public water supply water and 2) drinking water and breathing vapors from showering with water from nearby private wells. DEP is investigating the source of contamination. Groundwater is the medium. Drinking water and showers are the points of exposure. Ingestion and inhalation are the exposure routes. Residents using Silver Springs Shores public water and residents on private wells are the exposed populations (Table 1).

Identifying Contaminants of Concern

The Department compares the maximum concentrations of contaminants found in an area to comparison values that are specific for the medium contaminated (soil, water, air, etc.). The Department screens the environmental data using these comparison values:

- ATSDR Cancer Risk Evaluation Guide (CREG)
- ATSDR Environmental Media Evaluation Guides (EMEGs)
- ATSDR Reference Media Evaluation Guides (RMEGs)
- ATSDR Minimal Risk Level (MRL)
- Florida Health Advisory Level (HAL)
- 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, the Department follows ATSDR's general hierarchy and professional standards.

The Department selects for further evaluation contaminants with maximum concentrations above a comparison value. Comparison values, however, are not thresholds of toxicity. The Department and ATSDR 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.

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

The Department compared the highest measured concentrations in groundwater to ATSDR and EPA screening guidelines and selected 1,4-dioxane as the contaminant of concern. Concentrations of other contaminants are below screening guidelines and are not likely to cause illness.

1,4-Dioxane

The following is a discussion of possible health effects from exposure to 1,4-dioxane. Whether these effects occur or not depend on the levels of 1,4-dioxane and other factors. See the Public

Health Implications section for an assessment of the health risk specific to the Silver Springs Shores area.

1,4-dioxane is a clear liquid that easily dissolves in water. It is used primarily as a solvent in the manufacture of chemicals and as a laboratory reagent. 1,4-dioxane is a trace contaminant of some chemicals used in cosmetics, detergents, and shampoos. However, manufacturers now reduce 1,4-dioxane to low levels before using these chemicals in household products.

Few studies are available about the effects of 1,4-dioxane in humans. Exposure to very high levels of 1,4-dioxane can cause liver and kidney damage and death. People who inhaled 1,4-dioxane vapors for short periods (minutes to hours) reported eye and nose irritation.

Animal studies show that breathing vapors of 1,4-dioxane affects the nasal cavity, liver, and kidneys. Ingesting or having skin contact with 1,4-dioxane also affects the liver and kidneys [EPA 2013].

The U.S. Department of Health and Human Services (DHHS) considers 1,4-dioxane as reasonably anticipated to be a human carcinogen [ATSDR 2007].

There are no studies of children exposed to 1,4-dioxane. However, children might experience health problems similar to adults exposed to high concentrations of 1,4-dioxane. Scientists do not know whether exposure of pregnant women to 1,4-dioxane can harm the unborn child.

Public Health Implications

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. The Department 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 public health assessment also considers health concerns of nearby residents and explores possible associations with area contaminants. 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 area's impact on public health err on the side of protecting public health and may overestimate the risk.

The Department provides specific public health recommendations on the basis of 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 and 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, the Department 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. The Department uses 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 (3-4 grains of rice weigh approximately 100 mg); a kilogram is approximately 2 pounds.

To calculate the daily doses of each contaminant, the Department uses standard factors for dose calculation [ATSDR 2005; EPA 1997]. The Department assumes that people are exposed daily to the maximum concentration measured and makes 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.

Non-carcinogens - For an assessment of the non-cancer health risk, the Department and ATSDR use the following formula to estimate a dose:

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

D = exposure dose (milligrams per kilogram per day or mg/kg/day)
C = contaminant concentration (milligrams per kilogram or mg/kg)
IR = intake rate of contaminated sediment (milligrams per day or mg/day)
EF = exposure factor (unitless)
CF = conversion factor (10^{-6} kilograms per milligram or kg/mg)
BW = body weight (kilograms or kg)

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

EF = exposure factor (unitless)
F = frequency of exposure (days/year)
ED = exposure duration (years)
AT = averaging time (days) (ED x 365 days/year for non-carcinogens; 70 years x 365 days/year for carcinogens)

ATSDR groups health effects by duration of exposure. Acute exposures are those with duration of 14 days or less; intermediate exposures are those with duration of 15 – 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.

The Department compares contaminant air concentrations directly to air comparison values and other doses reported in the toxicological literature for inhalation exposures. Children's doses are generally higher than adults are because their ingestion rates of soil and water, and inhalation of air compared with their low body weights exceed those of adults. For non-cancer illnesses, the Department first estimates the health risk by comparing the exposure dose for children to chemical-specific minimal risk levels (MRLs).

MRLs are health guidelines 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 doses/concentrations are above comparison values, the Department further analyzes exposure variables (for example, duration and frequency), toxicology of the contaminants, past epidemiology studies, and the weight of evidence for health effects. The Department uses chronic MRLs where possible because exposures are usually longer than a year. If chronic MRLs are not available, the Department uses intermediate length MRLs [ATSDR 2005].

Drinking VOCs in Water

Carcinogens - the Department and ATSDR use the following equation to estimate increased cancer risk:

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

Risk = Cancer risk
D = Age specific annual non-cancer dose (mg/kg/day)
SF = Slope factor $(\text{mg/kg/day})^{-1}$
LF = Age-specific number years exposure / lifetime in years

For adults, DOH estimated the increased cancer risk consuming water from the public supply system with the highest measured level of 1,4-dioxane before February 2017 (0.69 ug/L) for 12 years assuming central tendency exposures:

Adult cancer risk = 1.1×10^{-5} mg/kg/day x 0.1 $(\text{mg/kg/day})^{-1}$ x 12 years/78 years
= 1.6×10^{-7}

For children, DOH estimated the increased cancer risk consuming water from the public supply system with the highest measured level of 1,4-dioxane before February 2017 (0.69 ug/L) for 21 years assuming central tendency exposures:

Child cancer risk = 1×10^{-4} mg/kg/day x 0.1 $(\text{mg/kg/day})^{-1}$ x 21 years/78 years
= 3.3×10^{-7}

The cancer risk (central tendency estimate) for a an individual living in the same house from birth to 33 years old (95% residence time) is the sum of the adult and child risks above:

33 year cancer risk = 1.6 x 10^{-7} + 3.3 x 10^{-7} = 4.9 x 10^{-7}

This is a 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 risk may be as low as zero.

These cancer risk calculations are specific for exposures likely in the Silver Springs Shores area. Calculations for state-wide Health Advisory Levels are slightly different. Appendix C explains the differences.

Inhalation of VOCs during Showering

The Department assumed water contaminated with VOCs was used for showering. ATSDR's showering model calculates inhalation during showering and adds this dose to the drinking water dose. There are several steps in estimating the equivalent 24-hour air concentration, which will be discussed below.

ATSDR first used a model developed by Andelman [Andelman 1990] to estimate the peak TCE concentration occurring in the bathroom as a result of showering. The equation is given below.

$$Peak\ Conc.\left(\frac{\mu g}{m^3}\right) = \frac{C_W(\frac{\mu g}{L}) \times k \times F_W(\frac{L}{min}) \times T_s(min)}{V_a\ (m^3)}$$

Where

C_w = Concentration of the volatile compound in water, in µg/L

k = volatilization coefficient, unitless (default is 0.6)

F_w = Flow rate of water through showerhead, in L/min (default is 8 L/min)

T_s = Time of shower, in min (varies with age, found in [EPA 2011])

V_α = Volume of air in shower in m^3 (default is 10 m^3)

For example, a 10-year-old takes a 15-minute shower in water containing 27 µg/L TCE. The peak concentration of TCE in the bathroom is:

$$\text{Peak Conc. } (\mu g/m^3) = \frac{27\ \mu g/L) \times 0.6 \times (8\ L/min) \times 15\ min}{10\ m^3}$$

$$= 194\ \mu g/m^3$$

The peak air concentration will be breathed in during the shower and during any time stayed in the bathroom after the shower. ATSDR used shower stay times listed in [EPA 2004]. The intake of contaminant due to inhalation is given by the following:

$Intake_{Inhalation}$ =Peak Conc. (µg/m^3) × IR_{st} (m^3/min) × (T_s+T_b) (min),

Where

IR_{st} = short term inhalation rate in m^3/min (varies with age, found in [EPA 2011], assumed to reflect "light intensity" activity)

T_s = Time of shower and/or bath, in min (varies with age, found in [EPA 2011])

T_b = Time in bathroom after shower/bath, in min (varies with age, found in [EPA 2011])

The total intake from showering is the sum of inhalation dose.

The shower model results reported do not take into account the additional exposures in a family from breathing indoor air from showers from other family members. They do include continued indoor inhalation exposure to contaminant air levels from each individual's shower during showering and remaining in the house for the rest of the day. The inhalation model assumes children under one year old will bathe and does not calculate a shower dose for this age-group.

To evaluate total exposure, shower model calculations add the shower time to the time that someone stays in the bathroom after a shower.

Drinking Water

The Department assumes a Silver Springs Shores area resident drinks groundwater every day for 33 years. Thirty-three years is the 95% residential occupancy period: 21 years as a child followed by 12 years as an adult at the same residence. The Department calculated exposure risks using the maximum concentration.

Public Supply

The Department estimated drinking water exposure using a maximum concentration of 0.69 µg/L 1,4-dioxane found in the public supply before February 2017 (Table 2).

Non-cancer illnesses

Residents who drink water from the public water supply with the highest 1,4-dioxane levels are unlikely to develop non-cancer illnesses. The estimated annual adult 1,4-dioxane central tendency exposure (CTE) dose (1.1×10^{-5} mg/kg/day) (Table 4) is much less than ATSDR's chronic MRL (0.1 mg/kg/day). The estimated dose for children less than 1 year of age (4.8×10^{-5} mg/kg/day) is also much less than the MRL [EPA 2013]. Nonetheless, the Department recommends the public water supply continues to meet the state required 1,4-dioxane Health Advisory Level of 0.35 µg/L.

Cancer

Residents who drink water from the public water supply with the highest 1,4-dioxane levels are at a "low" increased risk of cancer. The sum of the adult increased cancer risk and the child increased cancer risk is approximately 4.9 in 10,000,000 (0.00000049 or 4.9×10^{-7}) (Table 6).

Private Wells

The Department estimated exposure from drinking the maximum concentration of 1,4-dioxane (0.92 µg/L) found in private drinking water wells (Table 3).

Non-cancer illnesses

Residents who drink groundwater from private wells with the highest 1,4-dioxane levels are unlikely to develop non-cancer illnesses. The estimated annual adult 1,4-dioxane CTE dose (1.4×10^{-5} mg/kg/day) is much less than ATSDR's chronic MRL (0.1 mg/kg/day) (Table 4). The estimated dose for children less than 1 year of age (5.9×10^{-5} mg/kg/day) is also much less than the MRL [EPA 2013].

Cancer
Residents who drink groundwater from private wells with the highest 1,4-dioxane levels are at a "low" increased risk of cancer. The sum of the adult increased cancer risk and the child increased cancer risk is approximately 6.5 in 10,000,000 (0.00000065 or 6.5×10^{-7}) (Table 6).

Inhalation

To calculate inhalation risk, the Department assumes a Silver Springs Shores area resident with a breathing rate of 1.2×10^{-2} m^3/min spends 20 minutes (shower + bathroom time) every day for 33 years. The 95% residential occupancy period is 33 years: 21 years exposure as a child followed by 12 years exposure as an adult at the same residence.

Public Supply

The Department estimated inhalation of vapors from showering using a maximum concentration of 0.69 µg/L 1,4-dioxane found in the public supply before February 2017 (Table 2).

Non-cancer illnesses
Residents who inhale vapors from showering with water with the highest 1,4-dioxane levels are unlikely to develop non-cancer illnesses. The estimated 24-hour air concentration of 1,4-dioxane (1.2×10^{-2} ug/m^3) (Table 5) is much less than EPA RfC (30 ug/m^3). Nonetheless, the Department recommends the public water supply continue to meet the state required 1,4-dioxane Health Advisory Level of 0.35 µg/L.

Cancer
Residents who inhale vapors from showering with water with the highest 1,4-dioxane levels are at a "low" increased risk of cancer. Multiplying the average 24-hour 1,4-dioxane air concentration (1.2×10^{-2} ug/m^3) by an exposure factor of 33 years/78 years and by the EPA unit risk factor ($[5 \times 10^{-6}]^{-1}$) results in an increased estimated cancer risk of 1.5 in 10,000,000 (0.00000015 or 1.5×10^{-7}) (Table 7).

Private Wells

The Department evaluated the health risk based on the highest level of 1,4-dioxane (0.92 µg/L) found in private drinking water wells (Table 3).

Non-cancer illnesses
Residents who inhale vapors from showering with groundwater from the area with the highest 1,4-dioxane levels are unlikely to develop non-cancer illnesses (Table 5). The estimated 24-hour air concentration (1.6×10^{-2} ug/m^3) is much less than the EPA RfC (30 ug/m^3).

Cancer
Residents who inhale vapors from showering with groundwater with the highest 1,4-dioxane levels from private wells are at a "low" increased risk of cancer. Multiplying the average 1,4-dioxane air concentration (1.6×10^{-2} ug/m^3) by an exposure factor of 33 years/78 years and by the EPA unit risk factor ($[5 \times 10^{-6}]^{-1}$) results in an increased estimated cancer risk of 2 in 10,000,000 (0.0000002 or 2×10^{-7}) (Table 7).

Child Health Considerations

In communities faced with air, water, or soil contamination, the many physical differences between children and adults demand special attention. Children could be at greater risk than adults from certain kinds of exposure to contaminants. Children play outdoors and sometime engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of contaminants 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.

Conclusions

Overall, the Department finds that 1,4-dioxane in Silver Springs Shores area groundwater is not a public health hazard. The Department concludes that:

1. Drinking water that contains low levels of 1,4-dioxane detected in the Silver Springs Shores **public water supply** or breathing low levels of 1,4-dioxane from showering with the water is not likely to cause illness. Before February 2017, 1,4-dioxane levels in the water distribution system were slightly more than the state Health Advisory Level (HAL) of 0.35 micrograms per liter (µg/L). Since then, monthly levels have been less than the HAL. The highest 1,4-dioxane levels before February 2017 were below levels likely to cause illness. HALs include safety factors to protect public health.

2. Drinking water that contains low levels of 1,4-dioxane from **private wells** in the Silver Springs Shores area or breathing low levels of 1,4-dioxane from showering with the water is not likely to cause illness. Although 1,4-dioxane levels in some private wells are slightly more than the state HAL, they are still less than levels likely to cause illness. HALs include safety factors to protect public health.

Recommendation

1. The Department recommends the public water supply continues to meet the HAL.

Public Health Action Plan

The Department will:

- Post this report online.
- Consider review of new data by request.

Report Preparation

This report was supported in part by funds provided through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services (DHHS). The findings and conclusions in these reports are those of the author(s) and do not necessarily represent the views of the ATSDR or the DHHS. This document has not been revised or edited to conform to ATSDR standards.

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Appendices

Appendix A

Tables

Table 1. Completed Human Exposure Pathways at the Silver Springs Shores Area

Completed Pathway Name	Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Silver Springs Shores Public Water System	Unknown	Groundwater	Drinking water taps and showers in nearby homes and businesses served by public water system	Ingestion & Inhalation	Silver Springs Shores public water system users	Past, present, and future
Private Wells	Unknown	Groundwater	Drinking water taps and showers in nearby homes served by private wells	Ingestion & Inhalation	Private drinking water well users	Past, present, and future

Table 2: 1,4-Dioxane Levels in Silver Springs Shores Public Water

Contaminant	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
1,4-Dioxane	0.19 – 0.69	0.24	CREG	7/8

CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
µg/L = micrograms per liter
* Screening guidelines used only to select chemicals for further scrutiny, not to the judge the risk of health impact.

Sources of data: [Tetra Tech 2017]; DOH Water Program, unpublished data, 2017.

Table 3: 1,4-Dioxane Levels in Nearby Private Wells

Contaminant	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
1,4-Dioxane	BDL – 0.92	0.24	CREG	6/34

BDL = Below laboratory detection limit
CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
µg/L = micrograms per liter
* Screening guidelines used only to select chemicals for further scrutiny, not to the judge the risk of health impact.

Source of data: DOH Water Program, unpublished data, 2017.

Table 4. Estimated Dose and Increased Non-Cancer Risk from Ingestion of 1,4-Dioxane, Silver Springs Shores Area

Maximum 1,4-Dioxane Concentration in Drinking Water (µg/L)	Estimated Ingestion Dose (mg/kg/day) (CTE)	Chronic Oral MRL (mg/kg/day)	Source of MRL
0.69 (Public System)	1.1×10^{-5}	1×10^{-1}	ATSDR
0.92 (Private Well)	1.4×10^{-5}	1×10^{-1}	ATSDR

µg/L = micrograms per liter
mg/kg/day = milligrams per kilogram per day
ATSDR = Agency for Toxic Substances and Disease Registry
CTE = Central Tendency Exposure
MRL = Minimal risk level

Table 5. Estimated Indoor Air Concentrations of 1,4-Dioxane From Showering and Increased Non-Cancer Risk, Silver Springs Shores Area

Maximum 1,4-Dioxane Concentration in Drinking Water (µg/L)	Estimated 24-Hour Indoor Air Concentration (ug/m^3) (CTE)	RfC (ug/m^3)	Source of RfC
0.69 (Public System)	1.2 x 10^{-2}	30	EPA
0.92 (Private Well)	1.6 x 10^{-2}	30	EPA

µg/L = micrograms per liter
ug/m^3 = micrograms per cubic meter
CTE = Central Tendency Exposure
EPA = Environmental Protection Agency
RfC = Reference Concentration for Chronic Inhalation Exposure

Table 6. Estimated Dose and Increased Cancer Risk from Ingestion of 1,4-Dioxane, Silver Springs Shores Area

Maximum 1,4-Dioxane Concentration in Drinking Water (µg/L)	Estimated Cancer Dose Adult (12 years) (mg/kg/day) (CTE)	Estimated Cancer Dose Child (birth to 21) (mg/kg/day) (CTE)	Oral Cancer Slope Factor $(mg/kg/day)^{-1}$	Source of Oral Cancer Slope Factor	Estimated Increased Cancer Risk Adult + Child (33 years) (CTE)
0.69 (Public System)	1.6×10^{-6}	3.3×10^{-6}	1×10^{-1}	EPA IRIS	4.9×10^{-7} (low)
0.92 (Private Well)	2.2×10^{-6}	4.3×10^{-6}	1×10^{-1}	EPA IRIS	6.5×10^{-7} (low)

µg/L = micrograms per liter
mg/kg/day = milligrams per kilogram per day
CTE = Central Tendency Exposure
EPA = Environmental Protection Agency
IRIS = Integrated Risk Information System

Table 7. Estimated Indoor Air Concentrations of 1,4-Dioxane From Showering and Increased Cancer Risk, Silver Springs Shores Area

Maximum 1,4-Dioxane Concentration in Water (µg/L)	Estimated 24-Hour Indoor Air Concentration (ug/m^3) (CTE)	Unit Risk Factor (ug/m^3)$^{-1}$	Source of Unit Risk Factor	Estimated Increased Cancer Risk (CTE)
0.69 (Public System)	1.2×10^{-2}	5×10^{-6}	EPA IRIS	1.5×10^{-7} (low)
0.92 (Private Well)	1.6×10^{-2}	5×10^{-6}	EPA IRIS	2×10^{-7} (low)

µg/L = micrograms per liter
mg/kg/day = milligrams per kilogram per day
CTE = Central Tendency Exposure
EPA = Environmental Protection Agency
IRIS = Integrated Risk Information System

Appendix B

Figures

Figure 1. Silver Springs Shores Area

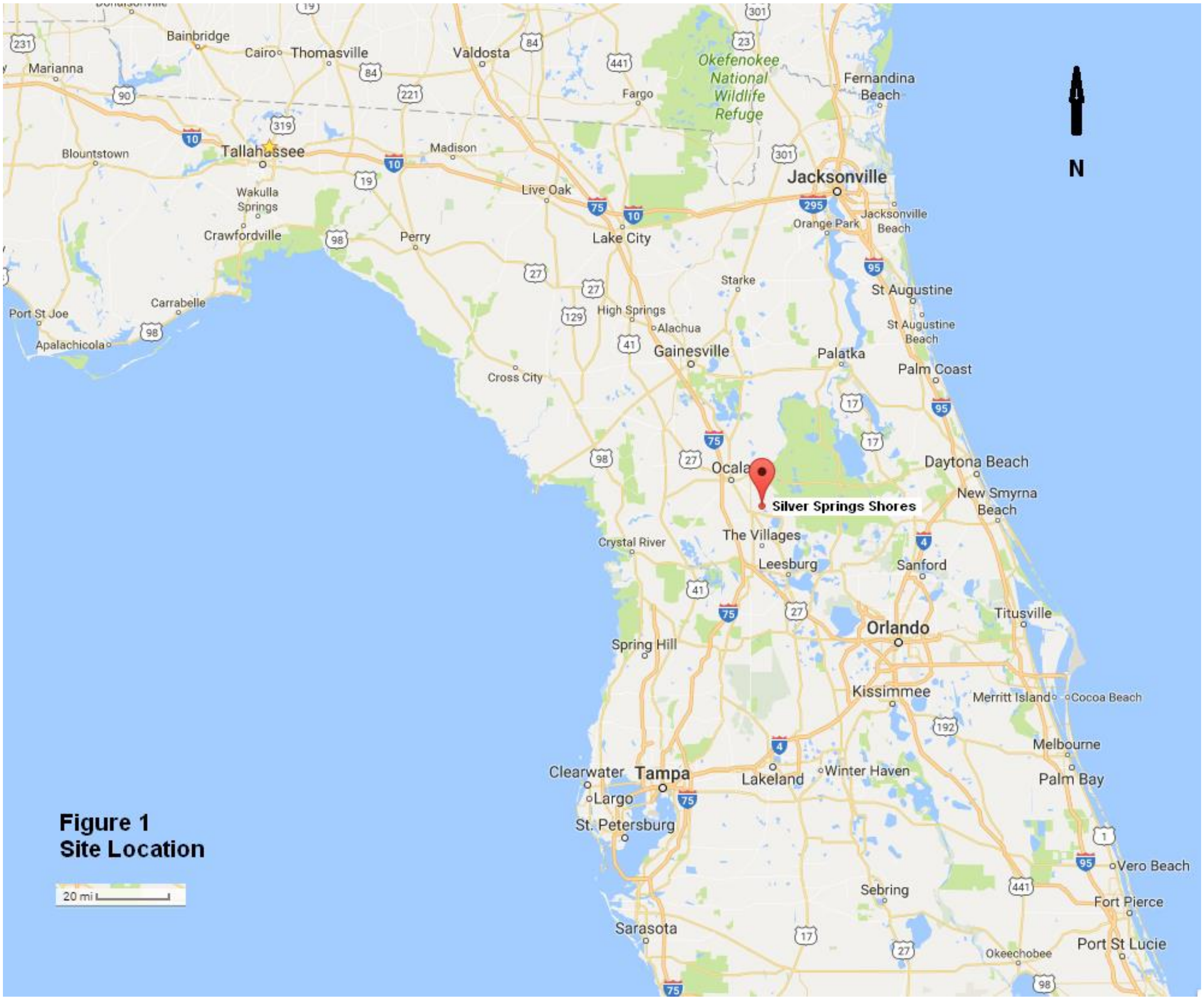


Figure 2. Silver Springs Shores Sample Locations (November 2016)

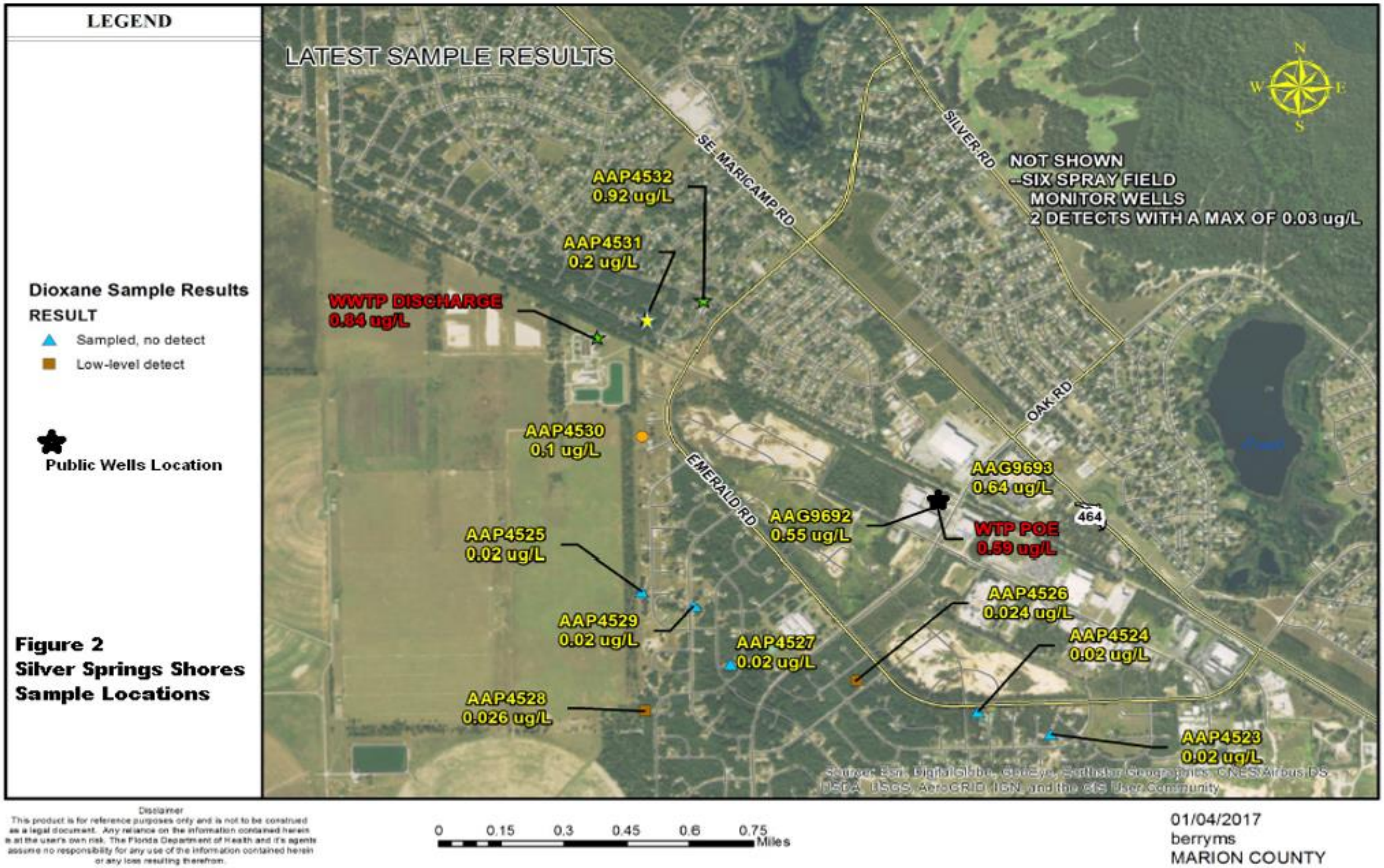
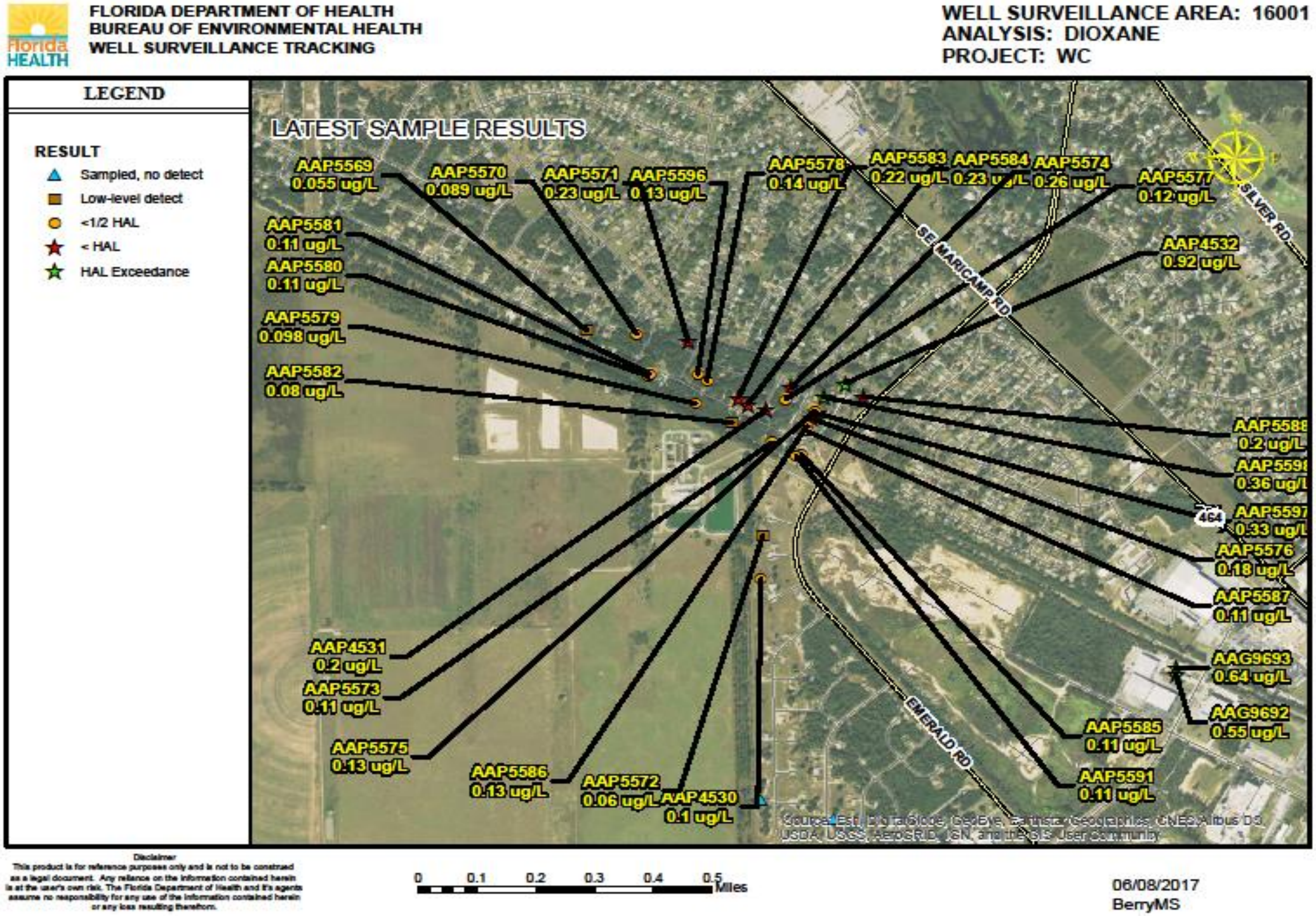


Figure 3. Silver Springs Shores Sample Locations (November 2016 and January 2017)



Appendix C

The method used to calculate the increased cancer risk for drinking water in the Silver Springs Shores area differs slightly from the method used for the state-wide Health Advisory Level (HAL).

In 2013, Florida DOH developed a state-wide HAL of 0.35 µg/L for 1,4-dioxane [DOH 2013]. DOH developed this HAL using standard exposure assumptions and set the HAL to correspond to an increased cancer risk of 1 in a million (10^{-6}). The same calculation and assumptions appear in Figure 1 of the Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C. for Deriving Site-Specific Cleanup Target Levels for Carcinogens in Groundwater, 2005. The HAL is protective rather than a best estimate of risk.

This health consultation report for the Silver Springs Shores (SSS) area uses a more recent risk assessment model developed by the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). Instead of single, point values for some of the exposure assumptions, the ATSDR model uses a range of values for inputs depending on the age group like body weight, intake rate, and exposure duration. The ATSDR model is the best risk estimate for the SSS area.

Both the HAL and the ATSDR model use the same cancer slope factor. The difference in the cancer risk estimate is due to different exposure assumptions.

Although the highest concentration of 1,4-dioxane measured in the SSS water system (0.69 µg/L) slightly exceeds the HAL (0.35 µg/L), this report estimates the increased cancer risk is **less** than 1 in a million. The reason for this apparent contradiction is the differences in exposure assumptions used in the HAL and this report.

Although both the HAL and this report use the same cancer slope factor, they assume different body weights, water consumption, and exposure durations (see table below). These differences result in a slight difference in cancer risk.

	Health Advisory Level (HAL)	DOH Silver Springs Shores Health Consultation Report	Change in cancer risk estimate
Cancer slope factor	1×10^{-1}	1×10^{-1}	none
Body weight	70 kg adult	age specific	little
Water consumption	2 L/day	average (central tendency exposure) & age specific	decrease
Exposure duration	70 years	33 years	decrease

Although this DOH report estimates the increased cancer risk from drinking Silver Springs Shores water is less than 1 in a million, DOH nonetheless recommends the water continue to meet the required HAL. If Chapter 62-777, F.A.C. is revised, any changes in exposure assumptions will lead to a review of the HALs.

Glossary

Absorption
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

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)**.

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

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 getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Central tendency exposure (CTE)
Average 50th percentile of the population distribution

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**).

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

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.

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

Dermal contact
Contact with (touching) the skin (see **route of exposure**).

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time. 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, biota (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 (**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**).

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.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

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**).

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year (compare with **acute exposure** and **chronic exposure**).

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), non-cancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time (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.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

Point of exposure
The place where someone can come into contact with a substance present in the environment (see **exposure pathway**).

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

Receptor population
People who could come into contact with hazardous substances (see **exposure pathway**).

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases.

Reasonable maximum exposure (RME)
High-end or above the 90th percentile of the population distribution

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 (see **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.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs (compare with **groundwater**).

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.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.