Health Consultation

Ephrata Landfill
Ephrata, Washington

December 21, 2010

Prepared by

**The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**

Washington State Department of Health

DOH 334-259 December 2010

Health Consultation: A Note of Explanation

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

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

HEALTH CONSULTATION

EPHRATA LANDFILL

EPHRATA, WASHINGTON

Prepared By:

Washington State Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

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For people with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TTY/TDD call 711).

For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/ .

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You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

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Glossary

Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Cancer Risk	A theoretical risk for developing cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Comparison value	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.
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 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 period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on ATSDR’s *minimal risk level* (MRL).
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.

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**].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
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].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
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.
Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
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 oral **reference dose**].

Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
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.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Plume	A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The RMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
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].
Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].
Time Weighted Approach (TWA)	The exposure concentration of a contaminant during a given period.
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Summary

Introduction:

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the Grant County Health District (GCHD). The purpose of this health consultation is to evaluate the potential human health hazard posed by contaminants in groundwater in private wells near the Ephrata Landfill in Ephrata, Grant County, Washington. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

DOH reached one important conclusion about groundwater in private wells near the Ephrata Landfill in Ephrata, Grant County, Washington.

Conclusion:
DOH concludes that using groundwater from private wells near the Ephrata Landfill for drinking, showering, bathing, and cooking is not expected to harm people's health. However, vinyl chloride exceeded the drinking water maximum contaminant level (MCL). This is concerning and DOH encourages remedial measures to ensure that residents are not drinking water that exceeds MCLs. Also, vinyl chloride levels should be monitored by Grant County.

Basis for decision:
The maximum level of volatile organic compounds (VOCs) of concern in this exposure scenario is below levels known to result in harmful non-cancer health effects. In addition, the exposure scenario presents a low to very low increased theoretical cancer risk based on pre-treatment sampling.

Next steps:

1. DOH recommends Grant County continue monitoring of VOC contaminants in the groundwater, specifically vinyl chloride.

2. DOH will mail this health consultation to the Grant County Health District and to residents near the Ephrata Landfill upon completion of this report.

3. DOH will provide fact sheets to communities and the Grant County Health District within two months of the health consultation being approved.

4. DOH will evaluate future data if VOC concentrations in the water system increase.

For More Information:

Please feel free to contact Lenford O'Garro at 360-236-3376 or 1-877-485-7316 if you have any questions about this health consultation.

Background

The Ephrata Landfill site is located in Ephrata, Grant County, Washington. Based on the 2000 population census, there are about 199 people living within 1 mile of the landfill (see Figure 1). The landfill began operations in about 1942 and operated as an open dump until about 1961. The landfill operated as an unlined cell until 2005. The City of Ephrata owned and managed the landfill until 1974. From 1974 until the present, Grant County has managed the landfill [1].

In August 1975, landfill personnel buried about 2300 drums of industrial waste at the site. In 1979, the U.S. Environmental Protection Agency (EPA) added the landfill to the list of potential hazardous sites. The Washington State Department of Ecology (Ecology) completed a Phase I site investigation in 1987, and groundwater sampling at the site began in 1988.

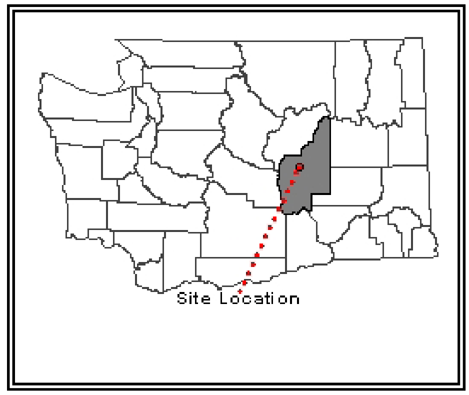
A 1990 assessment report noted the upper three aquifers were contaminated with metals, solvents, and other chemicals. Some of the contaminants detected in groundwater at the site were the same chemicals believed to be in the drums. In 2000, Grant County installed two pilot extraction wells as part of Ecology's Phase I voluntary cleanup. In January 2005, Ecology issued the Final Determinations of Potentially Liable Person (PLP) status to the City of Ephrata and Grant County. In January 2007, an Agreed Order was finalized between the PLP and Ecology [1].

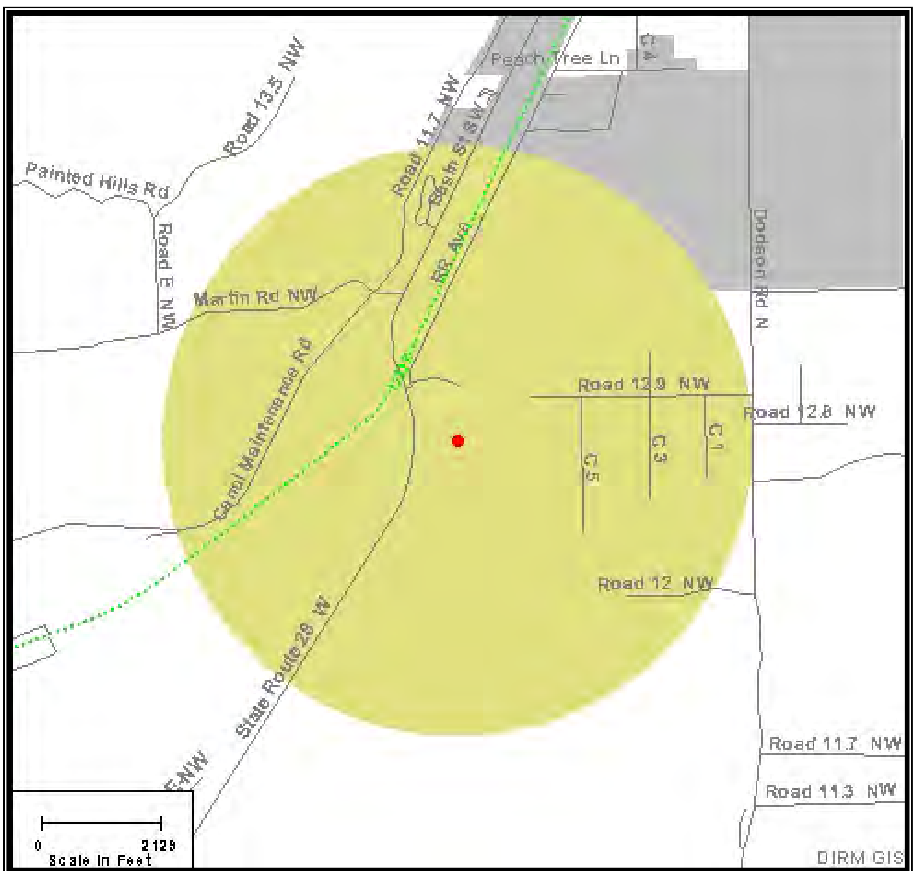
In 2008, contractors removed 2353 drums from the landfill. Forty-six drums were empty and 1038 drums were partially empty. Contaminated water was found at the bottom of the area where the drums were stored. Volatile organic compounds (VOCs) in the water included methylene chloride, acetone, 1,1-dichloroethane, 2-butanone, methyl isobutyl ketone (MIBK), toluene, ethyl-benzene, and xylenes. Over 6000 gallons of water were removed and transported to a disposal facility. The drums were placed in overpacks and sent to be burned. Samples from the drums were sent to a lab for analyses before disposal [1].

In July 2009, Grant County collected water from several private wells in the area surrounding the landfill for site related contaminants. The private well water samples were sent to an analytical laboratory for testing. Table 1 shows the range of concentrations of contaminants detected in private well groundwater near Ephrata Landfill. Additional private wells in the area were tested in September and October 2009. A treatment system consisting of a softener, carbon filter, and ultraviolet treatment (UV) was added to any private well that had VOC contaminants above the federal Maximum Contaminant Level (MCL). Drinking water was collected and tested for VOC pre- and post-treatment analysis (see Appendix B).

Figure 1. Demographic statistics within one mile of the site* - Ephrata Landfill, Grant County.

Total Population	**199**
White	**168**
Black	**0**
American Indian, Eskimo, Aleut	**5**
Asian or Pacific Islander	**2**
Other Race	**17**
Hispanic Origin	**28**
Children Aged 6 and Younger	**23**
Adults Age 65 and Older	**26**
Females Age 15 - 44	**41**
Total Aged over 18	**127**
Total Aged under 18	**71**
Total Housing Units	**69**





*** Calculated using the area proportion technique. Source: 2000 U.S. CENSUS**

Table 1. Range of contaminants detected in private well groundwater near Ephrata Landfill in Ephrata, Washington.

Compounds	Concentration Range (ppb)	Comparison Value (ppb)	EPA Cancer Class	Comparison Value Reference	Contaminant of Concern (COC)
Arsenic	0.2U – 10 4.3*	10	A	MCL	No
Calcium	25500 – 56900				N/A
Chloride	3900 – 74100	250000		MCL	No
Iron	50U - 50	300		MCL	No
Magnesium	10300 – 25900				N/A
Manganese	1.0U – 35	500	D	RMEG	No
Nitrate	10U – 6670	10000	D	MCL	No
Nitrite	10U – 31	1000		MCL	No
Potassium	2920 – 10300				N/A
Sodium	12400 – 57500				N/A
Sulfate	9200 – 66400	250000		MCL	No
Benzene	0.2U – 0.7	0.6	A	CREG	**Yes**
Chloroethane	0.2U – 2.1	800**		MTCA - B	No
1,1-Dichloroethane	0.2U – 5.8	800	C	MTCA - B	No
1,1-Dichloroethene	0.2U – 0.2	90	SU	EMEG	No
1,2-Dichlorobenzene	0.2U – 0.2	3000	D	EMEG	No
1,2-Dichloroethane (EDC)	0.2U – 0.6	0.4	B2	CREG	**Yes**
1,2-Dichloropropane	0.2U – 4.7	900		EMEG	No
cis-1,2-Dichloroethene	0.2U – 2.3	70	D	LTHA	No
Methylene Chloride	0.5U – 0.6	5	B2	CREG	No
Tetrachloroethene (PCE)	0.2U – 0.6	5	C	MCL	No
Trichloroethene (TCE)	0.2U – 0.3	5	UR	MCL	No
Vinyl Chloride	0.2U – 4.1	0.02	A	CREG	**Yes**

ppb Parts per billion
CREG - ATSDR's Cancer Risk Evaluation Guide (child)
RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)
EMEG - ATSDR's Environmental Media Evaluation Guide (child)
U- data qualifier: The analyte was not detected at this level.
A - EPA: Human carcinogen
B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)
C - EPA: Possible human carcinogen (no human, limited animal studies)
D - EPA: Not classifiable as to health carcinogenicity
SU – EPA: Suggestive evidence of carcinogenic potential
* Maximum concentration of arsenic in drinking water well; (10 ppb) arsenic in old well, used only for irrigation and filling spray trucks
** 1,1-Dichloroethane MTCA B value was used as a surrogate.
LTHA - EPA's Lifetime Health Advisory for Drinking Water
MTCA B - Washington State Model Toxics Control Act Method B groundwater cleanup level
MCL - Maximum contaminant level - Federal and state drinking water standard
UR - EPA cancer risk class under review
N/A – Not applicable – See Public Health Implications section
Bold – chemical is a contaminant of concern

Discussion

Contaminants of Concern

Contaminants of concern (COC) in groundwater were determined by employing a screening process. Maximum groundwater contaminant levels were screened against health-based drinking water comparison values. Several types of health-based comparison or screening values were used during this process [see the glossary for descriptions of "comparison value," "cancer risk evaluation guide (CREG)," "environmental media evaluation guide (EMEG)," and "reference dose media evaluation guide (RMEG)"]. Comparison values such as the CREG and EMEG offer a high degree of protection and assurance that people are unlikely to be harmed by contaminants in the environment. For chemicals that cause cancer, the comparison values represent levels that are calculated to increase the theoretical risk of cancer by about one in a million. These types of comparison values often form the basis for cleanup. In general, if a contaminant's maximum concentration is greater than its comparison value, then the contaminant is evaluated further.

Comparisons may also be made with legal standards such as the cleanup levels specified in the Washington State toxic waste cleanup regulation, the Model Toxics Control Act (MTCA). Legal standards may be strictly health-based or they may incorporate non-health considerations such as the cost or the practicality of attainment or natural background levels.

Exposure Pathways

In order for any contaminant to be a health concern, the contaminant must be present at a high enough concentration to cause potential harm, and there must be a completed route of exposure to people. That is, exposure to contaminants in the drinking water where someone is or has swallowed (ingestion exposure), breathed (inhalation exposure), or had contact with their skin (dermal exposure) would be a completed route of exposure. Benzene, 1,2-dichloroethane, and vinyl chloride are COC (see Table 1) and are soluble in water. The most obvious route of exposure from private well contaminated groundwater is ingestion of drinking water. However, benzene, 1,2-dichloroethane, and vinyl chloride are also available for inhalation from indoor air and dermal contact, particularly during showering, bathing, and cooking. Exposure to VOCs of concern through these completed routes and pathways are evaluated below.

Public Health Implications

Calcium, Magnesium, Potassium, Sodium

Calcium, magnesium, potassium, and sodium are essential nutrients and are typically not harmful under most environmental exposure scenarios [2]. Therefore, no public health standards have been established for calcium, magnesium, and potassium in drinking water. The EPA has established a Drinking Water Equivalency Level (DWEL) or guidance level for sodium of 20 milligrams per liter (mg/l). However, the EPA believes this guidance level for sodium needs updating and is probably low [2].

Calcium

The maximum level of calcium detected in private well water was 56.9 ppm. In a worst-case scenario, a person exposed to the maximum level of calcium in private well water and drinking 1.4 liters of water a day, would obtain 79.7 mg/day of calcium. The Dietary Reference Intakes

(DRIs), Adequate intakes (AIs) for calcium range from 210 -1300 mg/day, depending on age and gender [3].

Magnesium

The maximum level of magnesium detected in private well water was 25.9 ppm. In a worst-case scenario, a person exposed to the maximum level of magnesium in private well water and drinking 1.4 liters of water a day, would obtain 36.3 mg/day of magnesium. The Recommended Daily Allowance from the DRIs for magnesium range from 80 - 420 mg/day, depending on age and gender [3].

Potassium

The maximum level of potassium detected in private well water was 10.3 ppm. In a worst-case scenario, a person exposed to the maximum level of potassium in private well water and drinking 1.4 liters of water a day, would obtain 14.4 mg/day of potassium. The DRIs, AIs for potassium range from 400 - 5100 mg/day, depending on age and gender [3].

Sodium

The maximum level of sodium detected in private well water was 57.5 ppm. In a worst-case scenario, a person exposed to the maximum level of sodium in private well water and drinking 1.4 liters of water a day, would obtain 80.5 mg/day of sodium. The DRIs, AIs for sodium range from 120 - 1500 mg/day, depending on age and gender [3].

Calcium, magnesium, potassium, and sodium are essential nutrients. They are well below levels expected to cause health effects and will not be evaluated further.

Chemical Specific Toxicity

Evaluating Non-cancer Hazards

Exposure assumptions for estimating contaminant doses from groundwater exposures are found in Appendix A, Table A1. In order to evaluate the potential for non-cancer adverse health effects that may result from exposure to contaminated media (i.e., soil, air, and water), a dose is estimated for each COC. These doses are calculated for situations (scenarios) in which a person might be exposed to the contaminated media. The estimated dose for each contaminant under each scenario is then compared to MRLs. MRLs are an estimate of the daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during a specified duration of exposure. In the absence of MRLs, DOH uses the EPA's oral reference dose (RfD). RfDs are doses below which non-cancer adverse health effects are not expected to occur. MRLs and/or RfDs are derived from observed effect levels obtained from human population and laboratory animal studies. These observed effect levels can be either the LOAEL or NOAEL. In human or animal studies, the LOAEL is the lowest dose at which an adverse health effect is seen, while the NOAEL is the highest dose that does not result in any adverse health effects.

Because of data uncertainty, the toxic effect level is divided by "uncertainty factors" to produce the lower and more protective MRL. If a dose exceeds the MRL, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. With the exception of an "uncertainty factor" of 10, if the estimated exposure dose is only slightly above the MRL, then that dose will fall well below the observed toxic effect level. The higher the estimated dose is above the MRL, the closer it will be to the actual observed toxic effect level. This comparison is called a hazard quotient (HQ). See Appendix A for the hazard quotient equation.

Estimated exposure doses, exposure assumptions, and hazard quotients are presented in Appendix A for COCs found in groundwater. Based on exposure estimates quantified in Appendix A, residents are not likely to experience adverse non-cancer health effects from exposure to VOCs in groundwater at this site since the exposure dose did not exceed the minimal risk level (MRL) or RfD.

Benzene

Benzene was detected at a maximum concentration of 0.7 ug/L in private well drinking water near the Ephrata Landfill. Exposure to benzene can occur through ingestion of drinking water and inhalation of water vapors during activities such as showering, bathing, and cooking. Benzene can be absorbed through human skin [4].

Benzene is a highly flammable colorless liquid commonly found in the environment. Benzene evaporates into the air very quickly and dissolves slightly in water. Natural sources of benzene include volcanoes and forest fires. Benzene is also found in crude oil, gasoline, and cigarette smoke [4].

Breathing high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death. Breathing very high levels of benzene can result in death [4]. Long-term exposure to high levels of benzene in the air can cause acute myeloid leukemia. Benzene can cause a decrease in red blood cells leading to anemia. Benzene in the body enters the bloodstream and is converted to breakdown products called metabolites. Most of the metabolites of benzene leave the body in the urine within 48 hours after exposure; however, they are the cause of some of the harmful effects of benzene exposure [4].

The EPA established reference dose (RfD) for benzene is 0.004 mg/kg/day based on the benchmark dose (BMD) modeling of absolute lymphocyte data from workers exposed to benzene by inhalation [4]. EPA classifies benzene as a human carcinogen.

Estimated daily exposure doses for an adult and child were calculated. Exposure doses ranged from 1.52×10^{-5} to 4.37×10^{-5} mg/kg/day (see Appendix A, Table A2). The lowest observed adverse effect level (LOAEL) of 0.29 mg/kg/day for benzene is based on health effects of reduced white blood cells and platelets counts in humans chronically exposed [4]. Therefore, DOH does not expect that exposures to benzene in private well drinking water at this site will cause harmful non-cancer health effects to residents.

1,2-Dichloroethane

1,2-Dichloroethane was detected at a maximum concentration of 0.6 ug/L in private well drinking water near the Ephrata Landfill. Exposure to 1,2-dichloroethane can occur through ingestion of drinking water and inhalation of water vapors during activities such as showering, bathing, and cooking. 1,2-dichloroethane can be absorbed through human skin [5].

1,2-Dichloroethane is a clear man-made liquid. The most common use of 1,2-dichloroethane is in the production of vinyl chloride which is used to make a variety of plastic and vinyl products [5]. 1,2-Dichloroethane breaks down very slowly in air and water.

Breathing or drinking high levels can cause nervous system disorders, liver and kidney diseases, and lung effects [5]. Long-term exposure to low levels of 1,2-dichloroethane is known to cause kidney disease in animals. Human studies of 1,2-dichloroethane causing cancer have been considered inadequate. However, animal studies have shown increases in stomach, mammary gland, liver, lung, and endometrium cancers [5].

ATSDR has derived an intermediate Minimal Risk Level (MRL) of 0.2 mg/kg/day for 1,2-dichloroethane based on a LOAEL of 58 mg/kg/day from kidney effects in rats [5]. EPA classifies 1,2-dichloroethane as a probable human carcinogen.

Estimated daily exposure doses for an adult and child were calculated. Exposure doses ranged from 1.13×10^{-5} to 3.47×10^{-5} mg/kg/day (see Appendix A, Table A2). The LOAEL of 58 mg/kg/day for 1,2-dichloroethane is based on increased kidney weight in rats [5]. Therefore, DOH does not expect that exposures to 1,2-dichloroethane in private well drinking water at this site will cause harmful non-cancer health effects to residents.

Vinyl Chloride

Vinyl chloride was detected at a maximum concentration of 4.1 ug/L in private well drinking water near the Ephrata Landfill. Exposure to vinyl chloride can occur through ingestion of drinking water and inhalation of water vapors during activities such as showering, bathing, and cooking. Vinyl chloride absorption through human skin is limited [6].

Vinyl chloride is a colorless man-made gas. Vinyl chloride can be formed when trichloroethane, trichloroethylene, and tetrachloroethylene are broken down. Vinyl chloride is used to make a variety of plastic and vinyl products [6]. Vinyl chloride breaks down in air within a few days and dissolves slightly in water.

Breathing high levels of vinyl chloride can cause drowsiness or dizziness, and breathing very high levels can result in death [6]. The effects of drinking high levels of vinyl chloride are unknown. Dermal exposure to liquid vinyl chloride can cause numbness, redness, and blisters [6].

The EPA established reference dose (RfD) for vinyl chloride is 0.003 mg/kg/day based on pharmacokinetic (PBPK) modeling [6]. EPA classifies vinyl chloride as a human carcinogen.

Estimated daily exposure doses for an adult and child were calculated. Exposure doses ranged from 8.08×10^{-5} to 2.43×10^{-4} mg/kg/day (see Appendix A, Table A2). The PBPK-modeled human no-observed adverse effect level (NOAEL) of 0.09 mg/kg/day is based on liver cell polymorphisms [6]. Therefore, DOH does not expect that exposures to vinyl chloride in private well drinking water at this site will cause harmful non-cancer health effects to residents. However, the EPA established MCL for vinyl chloride is 2.0 ug/L in drinking water and the level found in the private well has exceeded the MCL standard.

Evaluating Cancer Risk

Some chemicals have the ability to cause cancer. Theoretical cancer risk is estimated by calculating a dose similar to that described above and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than are encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world exposures. This process involves much uncertainty.

Current regulatory practice assumes there is no “safe dose” of a carcinogen. Any dose of a carcinogen will result in some additional cancer risk. Theoretical cancer risk estimates are, therefore, not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat because any level of a carcinogenic contaminant carries an associated risk. The validity of the “no safe dose” assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. Recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise [7].

This document describes theoretical cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight, and no significant increase in theoretical cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one cancer case per ten thousand persons similarly exposed over a lifetime. A very low estimate might result in one cancer case per several tens of thousands similarly exposed persons over a lifetime and a slight estimate would require an similarly exposed population of several hundreds of thousands to result in a single case. DOH considers theoretical cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population.

Theoretical Cancer Risk

Theoretical Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term		# of Excess Cancers
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

Cancer is a common illness and its occurrence in a population increases with the age of the population. There are many different forms of cancer resulting from a variety of causes; not all are fatal. Approximately 1 in 3 to 1 in 2 people living in the United States will develop cancer at some point in their lives [8].

In a worst-case scenario, exposure to the current highest levels of VOCs of concern in drinking water would increase a person's lifetime theoretical cancer risk by 3 in 100,000 (3 excess cancers in a population of 100,000 people similarly exposed) (See Appendix A - Table A3). The reader should note that these estimates are for excess cancers that might result, in addition to those normally expected in an unexposed population. This estimated risk is low to very low and within the range of cancer risks (1 in 10,000 to 1 in 1,000,000) considered acceptable by the EPA. A lifetime cancer risk of 1 in 10,000 people exposed is selected as the point of departure for significant risk. A point of departure is an estimated dose (usually expressed in human-equivalent terms) near the lower end of the observed range, without significant extrapolation to lower doses.

Children's Health Considerations

The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity. The following factors contribute to this vulnerability:

- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing bodies or systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may occur.

Children's health was considered in the writing of this health consultation and the exposure scenarios treated children as the most sensitive population being exposed. The doses calculated for the VOCs are not expected to result in adverse health effects for children or adults, based on comparison with the MRL or RfD value. The assessment did find that chronic exposure to VOCs over many years (for example, 30 years) does indicate a low to very low increased theoretical cancer risk.

Conclusions

DOH concludes that using groundwater from private wells near the Ephrata Landfill for drinking, showering, bathing, and cooking is not expected to harm people's health. It is important to note that for many chemicals, most of the information is available on how the individual chemical produces effects. However, it is much more difficult to assess exposure to multiple chemicals. Therefore, there is uncertainty linked to the conclusion about potential health impact from exposure to multiple VOCs. The maximum level of VOCs of concern in this exposure scenario is below levels known to result in harmful non-cancer health effects. In addition, the exposure scenario presents a low to very low increased theoretical cancer risk based on pre-treatment sampling. However, vinyl chloride exceeded the drinking water maximum contaminant level (MCL). This is concerning and DOH encourages remedial measures to ensure that residents are not drinking water that exceeds MCLs. Also, vinyl chloride levels should be monitored by Grant County.

Recommendations

Although users of private well drinking water near the Ephrata Landfill are not expected to experience adverse non-cancer health effects, and their increased theoretical cancer risk is low to very low, DOH recommends Grant County continue to monitor the level of VOC contaminants in the groundwater, specifically vinyl chloride.

Public Health Action Plan

Actions Planned

1. DOH will mail this health consultation to the Grant County Health District and to residents near the Ephrata Landfill upon completion of this report.

2. DOH will provide fact sheets to communities and the Grant County Health District within two months of the health consultation being approved.

3. DOH will evaluate future data if VOC concentrations in the water system increase.

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Appendix A

This section provides calculated exposure doses and assumptions used for exposure to chemicals in private well drinking water at the site. Three different exposure scenarios were developed to model exposures that might occur. These scenarios were devised to represent exposures to a child (0-5 yrs), an older child, and an adult. The following exposure parameters and dose equations were used to estimate exposure doses from direct contact with chemicals in water. As with any scenario, there are uncertainties.

Exposure to VOCs in water via ingestion, inhalation, and dermal absorption

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day))}} = \frac{\text{Cw x CF x IR x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Dose}_{\text{(cancer (mg/kg-day))}} = \frac{\text{Cw x CF x IR x EF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

$$\text{Cancer Risk} = \text{Dose}_{\text{(cancer (mg/kg-day))}} \text{ x CSF}$$

Dermal Route - (Shower)

$$\text{Dermal Absorbed (DA}_{\text{event}}\text{)} = \frac{\text{2 x Kp x Cw x SqR of 6 x tau x t/pi}}{\text{ORAF}}$$

$$\text{Dermal Absorbed Dose (DAD)}_{\text{(non-cancer (mg/kg-day))}} = \frac{\text{DA}_{\text{event}}\text{ x EV x SA x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Dermal Absorbed Dose (DAD)}_{\text{(cancer (mg/kg-day))}} = \frac{\text{DA}_{\text{event}}\text{ x EV x SA x EF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

$$\text{Cancer Risk} = \text{DAD}_{\text{(cancer (mg/kg-day))}} \text{ x CSF}$$

Inhalation Route – (Shower)

$$\text{Concentration in air (Ca)} = \text{S/R x (1 – (EXP (-R x t)))}$$

$$\text{Dose}_{\text{non-cancer (mg/kg-day)}} = \frac{\text{Ca x IHR x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Dose}_{\text{cancer (mg/kg-day)}} = \frac{\text{Ca x IHR x EF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Cancer Risk = Dose $_{\text{cancer (mg/kg-day)}}$ x CSF

Table A1. Exposure assumptions used to estimate VOCs in drinking water, Ephrata Landfill, Ephrata, Washington.

Parameter	Value	Unit	Comments
Concentration (Cw)	Variable	ug/l	Maximum detected value
Conversion Factor (CF)	0.001	ug/mg	Converts contaminant concentration from micrograms(ug) to milligrams (mg)
Ingestion Rate (IR) - adult	1.4	l/day	Exposure Factors Handbook [9]
Ingestion Rate (IR) - older child	1.0		
Ingestion Rate (IR) - child	0.9		
Exposure Frequency (EF)	350	days/year	Two week vacation
Exposure Duration (ED)	30 (5, 10,15)	years	Number of years at one residence (child, older child, adult years)
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) - older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	20000	cm^2	Exposure Factors Handbook [9]
Surface area (SA) - older child	11800		
Surface area (SA) - child	6640		
Averaging Time$_{\text{non-cancer}}$ (AT)	1825	days	5 years
Averaging Time$_{\text{cancer}}$ (AT)	27375	days	75 years
Cancer Slope Factor (CSF)	Variable	mg/kg-day^{-1}	Source: EPA
Event frequency (EV)	1	unitless	events/day
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
pi	3.14	unitless	
Dermally absorbed dose per event (DA_{event})	Variable	mg/cm^2	Source: EPA
Dermally absorbed dose (DAD)	Variable	mg/kg-day	Source: EPA
Square root (SqR)	-	unitless	
Time (t)	0.25	unitless	hour/event
Skin permeability coef. (Kp)	Variable	cm/hr	Chemical specific: Benzene – 0.015, 1,2-Dichloroethane (EDC) – 0.0042, Vinyl Chloride – 0.0056
Lag time (tau)	Variable	hr	Chemical specific: Benzene – 0.29 , 1,2-Dichloroethane (EDC) – 0.38, Vinyl Chloride – 0.24
Inhalation rate (IHR) - adult	0.21	m^3/day	Exposure Factors Handbook [9]
Inhalation rate (IHR) - older child	0.19		
Inhalation rate (IHR) - child	0.11		
Air exchange rate (R)	0.0083	min^{-1}	Model Parameters [10]
Time concentration calculated (t)	15	min	Model Parameters [10]
Concentration in air (Ca)	Variable	mg/m^3	Model Parameters [10]
Shower emission rate (S)	Variable	mg/m^3-min	Model Parameters [10]

Hazard Quotient formula:

$$HQ = \frac{\text{Estimated Dose (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

Private Wells Exposure –Non-cancer

Table A2. Non-cancer hazard calculations resulting from exposure to VOCs in drinking water, Ephrata Landfill, Ephrata, Washington.

Contaminant	Maximum Concentration (ppb)	Scenarios	Estimated Dose (mg/kg/day)			Total Dose (mg/kg/day)	RfD or MRL (mg/kg/day)	Total Dose/ (RfD/ MRL)
			Ingestion	Dermal Contact	Inhalation			
Benzene	0.7	Child	4.03E-5	3.32E-6	1.25E-7	4.37E-5	4.0E-3*	0.01
		Older Child	1.64E-5	2.20E-6	6.69E-8	1.87E-5		0.005
		Adult	1.31E-5	2.08E-6	4.75E-8	1.52E-5		0.004
1,2-Dichloroethane (EDC)	0.6	Child	3.45E-5	9.11E-8	8.65E-8	3.47E-5	2.0E-1**	0.0002
		Older Child	1.40E-5	5.90E-8	5.34E-8	1.41E-5		0.00007
		Adult	1.12E-5	5.72E-8	3.30E-8	1.13E-5		0.00006
Vinyl Chloride	4.1	Child	2.36E-4	6.60E-6	8.08E-7	2.43E-4	3.0E-3*	0.08
		Older Child	9.59E-5	4.307E-6	4.99E-7	1.01E-4		0.03
		Adult	7.64E-5	4.14E-6	3.08E-7	8.08E-5		0.027

* EPA's Oral Reference Dose
** ATSDR Intermediate Minimal Risk Level
ppb – parts per billion
mg/kg/day - milligrams per kilogram body-weight per day

Private Wells Exposure – Cancer

Table A3. Cancer hazard calculations resulting from exposure to VOCs in drinking water, Ephrata Landfill, Ephrata, Washington.

Contaminant	Maximum Concentration (ppb)	EPA Cancer Group	Scenarios	Estimated Dose (mg/kg/day)			Cancer Potency Factor $(mg/kg\text{-}day)^{-1}$	Increased Cancer Risk			Total Cancer Risk
				Ingestion	Dermal Contact	Inhalation		Ingestion	Dermal Contact	Inhalation	
Benzene	0.7	A	Child	2.68E-6	2.21E-7	8.31E-9	0.055	1.48E-7	1.22E-8	4.57E-10	1.61E-7
			Older Child	2.18E-6	2.90E-7	1.03E-8		1.20E-7	1.60E-8	5.64E-10	1.37E-7
			Adult	2.61E-6	4.20E-7	9.51E-9		1.44E-7	2.30E-8	5.23E-10	1.68E-7
Sum of Benzene Cancer Risks											4.66E-7
1,2-Dichloroethane (EDC)	0.6	B2	Child	2.30E-6	6.08E-9	5.77E-9	0.091	2.09E-7	5.53E-10	5.25E-10	2.10E-7
			Older Child	1.87E-6	7.90E-9	7.12E-9		1.70E-7	7.20E-10	6.48E-10	1.71E-7
			Adult	2.24E-6	1.10E-8	6.60E-9		2.04E-7	1.00E-9	6.00E-10	2.06E-7
Sum of 1,2-Dichloroethane (EDC) Cancer Risks											5.87E-7
Vinyl Chloride	4.1	A	Child	1.57E-5	4.40E-7	5.39E-8	0.72	1.13E-5	3.17E-7	3.88E-8	1.17E-5
			Older Child	1.28E-5	5.70E-7	6.65E-8		9.21E-6	4.10E-7	4.79E-8	9.67E-6
			Adult	1.53E-5	8.30E-7	6.16E-8		1.10E-5	6.00E-7	4.44E-8	1.16E-5
Sum of Vinyl Chloride Cancer Risks											3.30E-5

ppb – parts per billion
mg/kg/day - milligrams per kilogram body-weight per day

Lifetime cancer risk: 4.66E-7 + 5.87E-7 + 3.30E-5 = 3.41E-5

Appendix B

Table B1. Volatile organic compounds (VOCs) contaminants detected in private wells post-treatment near Ephrata Landfill in Ephrata, Washington.

Compounds	Concentration Pre-treatment (10/2009) (ppb)	Concentration Post-treatment (10/2009) (ppb)	Concentration Post-treatment (12/2009) (ppb)	Contaminant of Concern after treatment (COC)
Acetone	6	26	5U	No
Benzene	0.9	0.2U	0.2U	No
1,1-Dichloroethane	6.8	0.2U	1.4	No
1,1-Dichloroethene	0.2	0.2U	0.2U	No
1,2-Dichlorobenzene	0.3	0.2U	0.2U	No
1,2-Dichloroethane (EDC)	0.6	0.2U	0.2U	No
1,2-Dichloropropane	5	0.2U	0.3	No
Chlorethane	2.7	0.3	2.3	No
cis-1,2-Dichloroethene	2.9	0.2U	0.2U	No
Methylene Chloride	1	0.5U	0.7	No
Tetrachloroethene (PCE)	0.4	0.2U	0.2U	No
Trichloroethene (TCE)	0.3	0.2U	0.2U	No
Vinyl Chloride	5	0.2U	2.5	**Yes**

U- data qualifier: The analyte was not detected at this level.
Bold – chemical is a contaminant of concern.

It appears the treatment system (carbon filter) is appropriate for removing the VOCs in private wells. The initial post-treatment analysis showed a reduction in the VOCs below the MCL. Acetone was detected in the first post-treatment sample, but not detected in the second post-treatment sampling (acetone is commonly used to clean pipe fittings before gluing them together).

However, a breakthrough in the treatment system has occurred causing an increase in the level of some VOCs, including vinyl chloride. The maximum level of vinyl chloride is below levels known to result in harmful non-cancer health effects. In addition, the exposure presents a low to very low increased theoretical cancer risk. Because vinyl chloride exceeded the drinking water MCL it should be monitored by Grant County.

Certification

The Washington State Department of Health prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

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The ATSDR Division of Health Assessment and Consultation has reviewed this public health consultation and concurs with the findings.

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