

Health Consultation

Hamilton/LaBree Roads Groundwater
Contamination Site

Evaluation of United Rentals Indoor Air Sampling Results (July 2002)
Chehalis, Lewis County, Washington
EPA Facility ID: WASFN1002174

September 7, 2005

Prepared by

**The Washington State Department of Health
Under a 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.

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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/.

Glossary

Acute	Occurring over a short time [compare with chronic].
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.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
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 <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (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.
Chronic	Occurring over a long time (more than 1 year) [compare with acute].
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.
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 <i>comparison value</i> used to select contaminants of potential health concern and is based on ATSDR's <i>minimal risk level</i> (MRL).
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
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.
Indeterminate public health hazard	The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.
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 reference dose].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
Monitoring wells	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful 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.
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 EMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
Remedial Investigation	The CERCLA process of determining the type and extent of hazardous material contamination at a site.
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].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.
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<p>Volatile organic compound (VOC)</p>	<p>Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.</p>

Background and Statement of Issues

The Washington State Department of Health (DOH) conducted an exposure investigation to evaluate whether employees at a business situated above an area of contaminated groundwater (known as the Hamilton/Labree Roads groundwater contamination site, or “site”) were being exposed to harmful levels of chemicals that have the potential to migrate into indoor air. The site is located about three miles south of Chehalis, Washington, near the intersection of Hamilton and Labree Roads in Lewis County. The purpose of this health consultation is to evaluate the results of indoor air samples collected by DOH inside United Rentals, the subject business. The United Rentals property is located south of Hamilton Road, adjacent to a portion (or sub-area) of the site, known as the Hamilton Road Impacted Area (HRIA). DOH is in the process of finalizing a public health assessment for the Hamilton/Labree site that describes this, and other exposure pathways in greater detail.

Environmental testing since 1993 has revealed tetrachloroethylene (PCE) and other volatile organic compounds (VOCs) in drinking water wells, groundwater, surface water, and soil within the Hamilton/Labree Roads site. An aquifer system, which includes a shallow and a deep aquifer, is situated underneath the site. PCE has been measured as high as 3,740 ppb in drinking water and from tens of thousands to well over 100,000 ppb in the shallow groundwater aquifer; reportedly, the highest levels of PCE found in drinking water and groundwater in the state. Other VOCs have been detected in drinking water and shallow groundwater, but at considerably lower levels, and less frequently.^{1,2}

In July 2000, the EPA added the Hamilton/Labree Road groundwater contamination area to its National Priorities List (NPL), and assumed lead agency status. Since then, EPA has conducted additional environmental investigations to determine the extent of contamination and if source removal is appropriate. Until 2002, affected well owners received bottled water, initially provided by the Washington State Department of Ecology (Ecology), and later by the Environmental Protection Agency (EPA). In Fall 2002, a water line was constructed to provide area residences and businesses affected by contaminated groundwater the opportunity to connect to a permanent source of clean, safe water. The water line provides water to 18 homes and businesses affected by PCE-contaminated groundwater in their wells. As each property was hooked up to city water, EPA stopped supplying bottled water (EPA Fact Sheet, Feb. 2003).

Two groundwater contamination source areas have been identified within the Hamilton/Labree site. One is located northeast of the intersection of Hamilton and Labree Road, near the Bulldog Trailer building, and the other is located between Hamilton Road and Interstate-5 (I-5), across from the United Rentals (subject) property. A large quantity of PCE is suspected to have been dumped directly into Berwick Creek in this area. Very high concentrations of PCE remain in the soil and shallow groundwater in the vicinity of the dumping (up to 5,200,000 parts per billion in the soil, and up to 200,000 parts per billion in the groundwater). The EPA is planning to do an early cleanup of this contamination “hot spot” in summer 2004. However, the funding was not available to complete the work. However, funding was not available for a pump and treat system within the timeframe. EPA has now decided to seek funding for a permanent destruction remedy for the source of the plume. EPA expects that a Record of Decision (ROD) will be available in late 2006. EPA and the S.C. Breen Construction Company (a potentially liable party), continue

to monitor and investigate the area in order to better define the extent of groundwater contamination.³

Indoor air Sampling Rationale

Very high concentrations of PCE have been measured in shallow (ten to thirty feet below ground surface) groundwater in the immediate vicinity of the United Rentals property. Concerns about the possible upward migration of PCE from the shallow groundwater and soil to indoor air (i.e., vapor intrusion) at levels of potential health concern inside United Rentals prompted DOH to contact the business to assess the levels (if any) of PCE and PCE degradation products. A second location (a private residence in the same general area as United Rentals) with a history of high PCE concentrations in their drinking water well and in nearby groundwater was also contacted by DOH in an effort to collect indoor air samples there.

DOH contacted United Rentals and the residents to request permission to conduct indoor air sampling. United Rentals agreed to participate, although DOH could not obtain permission to sample at the private residence.

Approximately 12 people are employed at United Rentals, an equipment rental business located at 281 Hamilton Road. Historic PCE levels in the United Rentals water supply well have ranged from 122 ppb to 930 ppb, and from hundreds to thousands of ppb in adjacent monitoring wells. One boring just across the road from United Rentals recorded PCE levels as high as 190,000 ppb in the shallow aquifer prior to the air sampling. Sampling conducted since 2002 has shown consistently high levels of PCE in nearby soil and shallow groundwater.

Air samples were collected from two locations inside United Rentals; the main work area, and behind the front counter (Appendix A). The sampling rationale and methodology is described in detail in a separate Exposure Investigation Workplan prepared by DOH.⁵

Comparison Values

The fact that an air contaminant exceeds a health comparison value does not mean that a public health hazard exists, but rather indicates the need to further evaluate the chemical. Due to the presence of common sources of chemicals in air, such as automobile exhaust, pesticides, tobacco smoke, cleaning products, industrial emissions, personal hygiene products, etc., it is not uncommon for background levels of some chemicals in air to exceed health comparison values.

Indoor air sampling results

PCE and several gasoline-related chemicals were detected in indoor air in both locations tested (the main shop and front counter area) (See Table 1. below). PCE levels in air were low, and were consistent with background levels of this chemical commonly present in urban indoor and ambient air (See Table 2. below).⁶

Of the gasoline-related chemicals, only benzene was detected above health comparison values (Appendix B, Table A1). Benzene and PCE are further discussed relative to their potential public health implications.

Table 1. United Rentals, Chehalis, Washington.
Chemicals exceeding comparison values in indoor air.*
(units are in micrograms per cubic meter)

Chemical	Maximum concentration	Health Comparison Value **	
		Cancer	Non-cancer
PCE	1.8	NA	271
Benzene	100	0.1	30

* The highest chemical concentrations were detected in the main shop area.

** See Appendix B, Table A1 for sources of comparison values.

NA = not available. Used Cal EPA Air Toxics Hotspots Program inhalation unit risk (IUR) to estimate cancer risks (See Table A2).

Table 2. United Rentals, Chehalis, Washington.
Background levels of Benzene and PCE reported in the literature*
(units are in micrograms per cubic meter)

Chemical	Background levels of PCE and benzene reported in the literature			
	Wallace (indoor)	Shah/Singh (indoor median)	UATAMP** (ambient mean ranges)	So. Calif. Air Resources Board studies
PCE	5 - 15	5	0.41 – 0.54	1.74 to 4.41 (outdoor) 2.27 to 6.72 (indoor)
Benzene	10 – 15	10	0.64 – 4.1	-----

* Since no site-specific background sampling was conducted for this investigation, background literature values were used.

**1997 Urban Air Toxics Monitoring Program.

Discussion

Benzene and PCE are further discussed relative to their potential health effects from inhalation exposure to the levels measured inside the United Rentals building.

Benzene

Benzene, a common air contaminant, is produced in the environment by natural processes, such as forest fires and volcanoes, as well as from human activities. Tobacco smoke, automobile service stations, exhaust from motor vehicles, gasoline, and industrial emissions are the major

human sources of benzene in air.^{7, 8, 9} Indoor benzene concentrations in the U.S. are estimated to range from 6 ug/m³ to 10 ug/m³.^{10, 11} People living in urban areas are generally exposed to higher concentrations of benzene than are people living in rural areas. Indoor concentrations of benzene are generally higher than outdoor concentrations (see Table 2).

Benzene is considered by the EPA and the International Agency for Research on Cancer (IARC) to be a human carcinogen.⁸ This classification is based upon evidence presented in numerous occupational epidemiological studies. Significantly increased risks of leukemia, chiefly acute myelogenous leukemia (AML), have been reported in benzene-exposed workers in the chemical industry, shoemaking, and oil refineries.⁸ Chronic exposure (8 hours/day, 5 days/week, 50 weeks/year, for 25 years) to the levels detected in the shop is estimated to result in an increased cancer risk of approximately four to six additional cancers in a population of 100,000 workers exposed for this length of time (Table A2).

Chronic exposure to benzene at levels generally much higher than the levels detected inside United Rentals have resulted in adverse effects on the respiratory system, liver, kidneys, and immune system.⁸ The maximum level detected (100 ug/m³) slightly exceeded ATSDR's intermediate-duration minimal risk level (MRL). The MRL is based on a lowest observed adverse affect level (LOAEL) for neurological effects in mice exposed to benzene levels approximately 20 times higher than the highest level detected in United Rentals.⁸ Although the highest level detected inside United Rentals is below the LOAEL, intermediate or chronic-duration exposure to this level could produce mild neurological effects for sensitive persons. Benzene levels inside United Rentals also exceeded EPA's reference concentration (RfC) by a factor of three. The basis for the RfC is decreased lymphocyte count observed during a 1996 human occupational inhalation study. Although above the RfC, the measured levels of benzene in air were well below the LOAEL upon which the RfC is based.

Since benzene has not been detected in groundwater in the vicinity of United Rentals, the most likely source of the indoor air detections is from gasoline observed by DOH inside the shop, from outside automobile exhaust emissions, or a combination of the two.

Tetrachloroethylene (PCE)

PCE is a manufactured compound widely used for dry-cleaning fabrics and as a metal degreaser. It is also used as an intermediate in the manufacturing of other products. It evaporates easily into the air, and has a sharp, sweet odor at high concentrations.

There is currently no RfC for PCE. The chronic-duration MRL for PCE is based upon neurobehavioral effects observed during a 10-year occupational study.⁸ Other systemic health effects associated with exposure to high levels of PCE in air include hepatotoxic (liver) effects, reversible kidney damage, endocrine effects, reproductive, and developmental effects. Since the levels of PCE detected inside United Rentals were well below the MRL, adverse non-cancer health effects are not expected to occur.

Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that PCE may reasonably be anticipated to be a carcinogen.^{8, 10, 12} The International Agency for Research on Cancer (IARC) has determined that it is probably carcinogenic to humans, based on limited human evidence and sufficient evidence in animals. EPA is currently reassessing PCE toxicity, and has not adopted a final position on the weight-of-evidence classification.^{10, 12}

Although a number of human studies (primarily epidemiology studies of dry-cleaning workers) suggest the possibility of increased cancer incidences from exposure to PCE, particularly esophageal and bladder cancers, it has not been shown to definitively cause cancer in humans. Other cancers suspected of being associated with exposures to high levels of PCE include intestinal, pancreatic, lung, kidney, skin, colon, and lymphatic/hematopoietic cancer. PCE increased the incidence of hepatocellular tumors in laboratory mice after oral and inhalation exposure and mononuclear cell leukemia and kidney tumors in rats after inhalation.^{8, 10, 12}

The California Environmental Protection Agency (Cal EPA) recently derived an inhalation unit risk for PCE that can be used to estimate cancer risk.¹³ Using this value, the estimated increased risk of developing cancer, assuming continuous exposure over a working lifetime to the detected concentrations of PCE in indoor air, is approximately one additional cancer in a population of one million persons exposed for twenty five years, or 1×10^{-6} (Table A2).

Child Health Considerations

ATSDR recognizes that infants and children may be more vulnerable to exposures than adults when faced with contamination of air, water, soil, or food.¹² This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's' developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

Since it is unlikely that children spend appreciable time inside United Rentals, exposures are expected to be minimal. As a result, a detailed discussion about children's exposures and health risks inside this site is not warranted.

Conclusions

1. High levels of tetrachloroethylene (PCE) have consistently been measured in shallow groundwater in the vicinity of the United Rentals property. DOH concerns about the potential migration of PCE present in area groundwater and soil into indoor air in the United Rentals building, where employees could become exposed, prompted indoor air testing by DOH.
2. Test results revealed low levels of PCE in indoor air inside United Rentals. The concentrations were below levels of health concern, and similar to background levels commonly found in ambient and indoor air throughout the U.S. Based on this single sampling event, it is unclear whether the source of the PCE is background-related, or from area groundwater and soil (i.e., vapor intrusion pathway).
3. Several gasoline-related chemicals were also detected in indoor air inside United Rentals. Of these, only benzene was detected at levels exceeding health comparison values, and was further evaluated.

The highest concentration of benzene was in the main shop area. Since benzene has not been detected in area groundwater, the most likely source(s) is from gasoline-containing products and equipment observed in the building, and/or automobile emissions from the adjacent interstate highway.

Long-term exposure to the measured concentrations of benzene is estimated to result in an increased lifetime cancer risk of approximately four to six additional cancers in a population of 100,000 persons exposed over a 25-year working lifetime. In addition, mild neurological effects are possible for sensitive persons if chronically exposed to this level of benzene. The concentrations of the other gasoline-related chemicals were below their respective comparison values, and do not represent a health hazard.

4. Overall, exposure to the detected chemicals poses no immediate or short-term health risks. Pending the results of follow-up sampling to assess longer-term chemical concentrations, the subject business (United Rentals) is categorized as an indeterminate public health hazard.

Recommendations

1. The vapor intrusion pathway should be evaluated in more depth. This consultation was based on a single indoor air sampling event, which is a poor predictor of long-term contaminant levels and potential health effects (i.e., seasonal differences). EPA or the potentially liable party should conduct additional indoor air sampling to further characterize the levels of PCE and PCE degradation products inside United Rentals.

2. Regional background sampling should be considered to assess PCE levels in air unlikely to be impacted by PCE present in the groundwater plume. This baseline information would be useful when assessing PCE sources.
3. United Rentals should provide adequate ventilation inside United Rentals' work areas to minimize the accumulation of gasoline-related chemicals, such as benzene. Gasoline products should be stored properly, covered, and kept as far away from workers as possible when not being used.

Action Plan

1. EPA is aware of the potential vapor intrusion issue, and is planning to address this pathway in greater detail as part of the overall Hamilton/Labree site Remedial Investigation.
2. The United Rentals corporate environmental Manager has been informed of the elevated benzene levels. Copies of this health consultation will be provided to United Rentals, EPA, Lewis County, and the S.C. Breen Construction Co., among others.

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Agency for Toxic Substances and Disease Registry

References

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Appendix A
Photo 1. United Rentals



Photo 2. United Rentals front counter

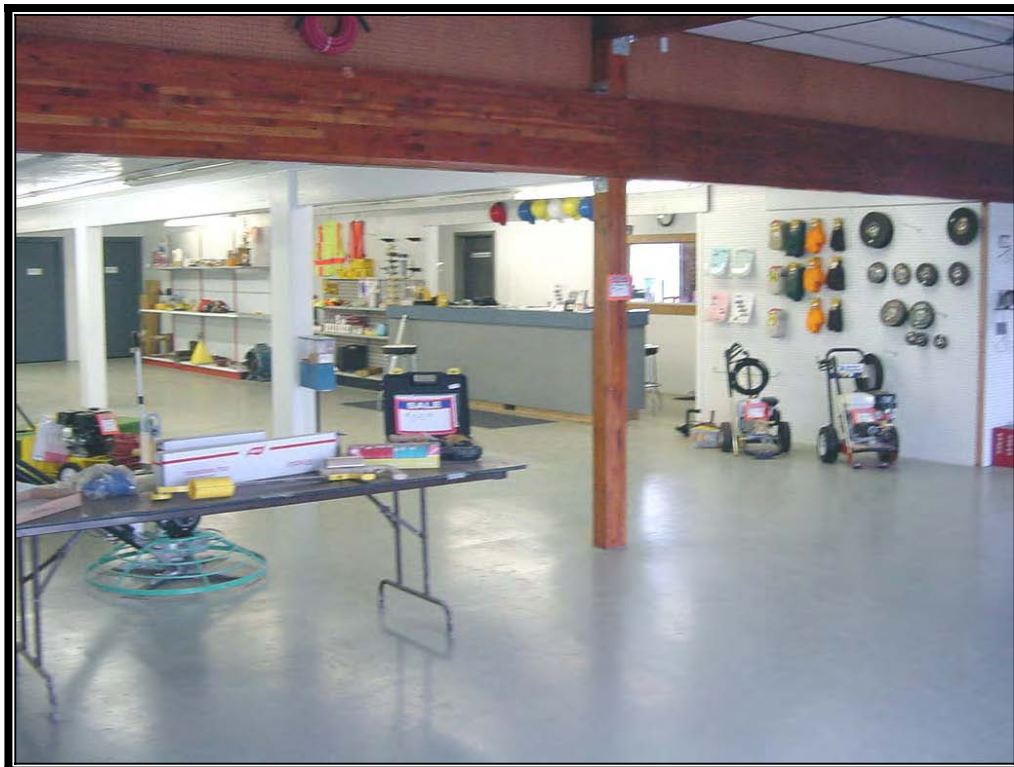


Photo 3. United Rentals air sampling at front counter



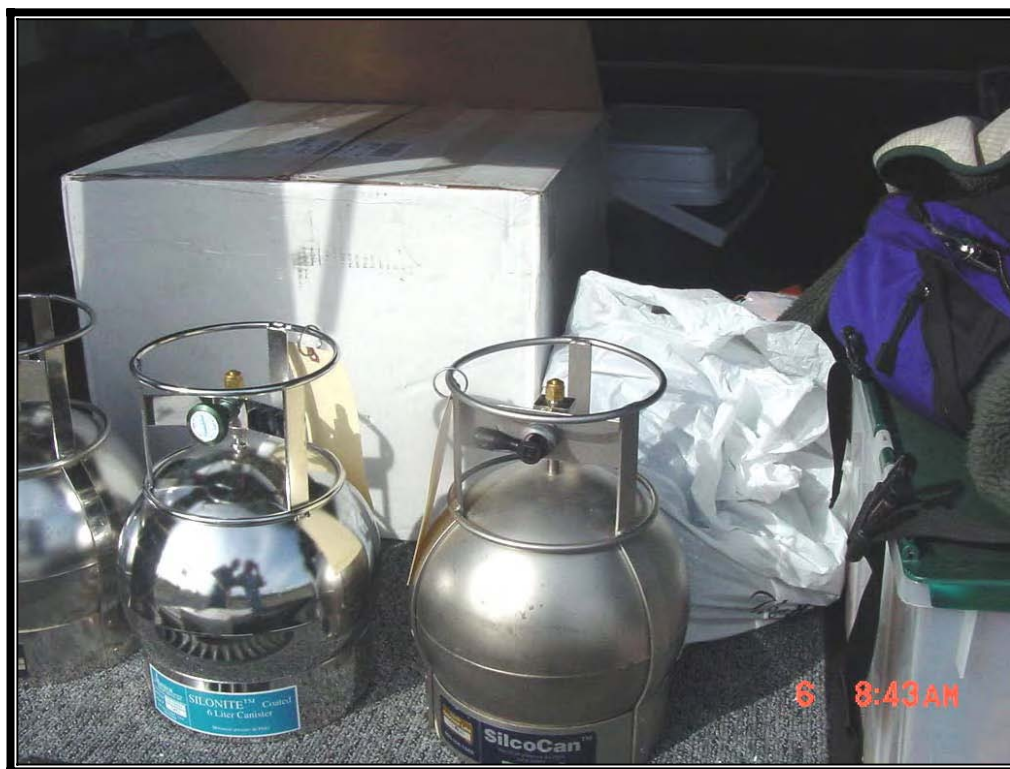
Photo 4. United Rentals shop area



Photo 5. United Rentals air sampling in main workshop area



Photo 6. Air sampling (Summa) canisters



Appendix B Environmental Sampling and Meteorological Data

Table A1. Chemicals detected in indoor air at United Rentals (July 6-7, 2002)
(units are in micrograms of chemical per cubic meter of air)

Chemical	United Rentals			Health Comparison Value (cancer)	** Health Comparison Value (noncancer)
	Front Counter	Shop Area	Shop Area (Field Blank)		
PCE	1.2 (SIM) ND (non-SIM)	1.8 (SIM) 1.8 (J) (non-SIM)	ND	Used Cal EPA Air Toxics Hotspots Program IUR (5.9×10^{-6}) and correction factor to calculate cancer risk.	271 (chronic EMEG)
Benzene	64	100	ND	0.1 (CREG)	30 (RfC)
Toluene	230	320	ND	NA	400 (RfC)
Ethylbenzene	37	52	ND	NA	1,000 (RfC)
m,p-Xylene	140	210	ND	NA	320 (MTCA B)
o-Xylene	48	69	ND	NA	434 (chronic EMEG)

** These health comparison values are established based upon the assumption that exposures occur 24 hours per day, 7 days per week, 365 days per year.

Shaded cell = chemical exceeded a health comparison value and/or background level and was further evaluated

SIM = selective ion method

ND = not detected

NA = not available

J = estimated value

CREG = ATSDR cancer risk evaluation guide

Chronic EMEG = ATSDR chronic-duration environmental media evaluation guide

RfC = EPA Reference concentration. The RfC is based on a 24-hour exposure duration.

MTCA B = Washington State Department of Ecology Model Toxics Control Act method B formula value

Table A2. United Rentals: Increased cancer risk associated with exposure to the concentrations of benzene and tetrachloroethylene detected in indoor air

Chemical	Location	
	Front Counter	Shop area
benzene*	(5E-4 x CF) = 4E-5	(7.8E-4 x CF) = 6.2E-5
tetrachloroethylene (PCE)**	(7E-6 x CF) = 5E-7	(1E-5 x CF) = 8E-7
Total increased cancer risk	4.1E-5	6.3E-5

* Used upper range of EPA's recommended inhalation unit risk (IUR of 7.8×10^{-6}). For the two chemicals listed in Table A2 above, benzene accounted for almost all (97%) of the estimated increased cancer risk.

** Used Cal EPA Air Toxics Hotspots Program IUR (5.9×10^{-6}). Estimated risks from exposure to the detected levels of PCE are similar to risks from background PCE levels reported in the literature (see Table 2).

CF = 0.08 correction factor to account for the less than 24 hour/day exposure assumed for a worker (see Appendix C).

Table A3. United Rentals: Non-carcinogenic risks (hazard quotients) associated with exposure to the concentrations of benzene and tetrachloroethylene detected in indoor air

Chemical	Location	
	Hazard Quotient - Front Counter	Hazard Quotient - Shop area
benzene	(2.1 x CF) = 0.43	(3.3 x CF) = 0.66
tetrachloroethylene (PCE)	(0.004 x CF) = 0.0008	(0.007 x CF) = 0.001
*Total non-cancer risk (HI)	0.431	0.661

*Total non-carcinogenic risk (hazard index, or HI) was less than 1, indicating that non-carcinogenic health effects are unlikely.
CF = 0.2 correction factor (see Appendix C).

Table A4. United Rentals: Meteorological Conditions at Time of Sampling

Date/Time	Location	Temperature Indoor/Outdoor	Barometric Pressure	Wind Speed	Weather Conditions
July 6, 2002 approx. 9:00 AM	United Rentals	23 C / 20 C	30.06 (1017)	North, 6 mph	mostly sunny, high clouds
July 7, 2002 approx. 9:00 AM	United Rentals	22 C / 15 C	30.02 (1016)	Calm	cloudy/overcast light rain

Appendix C

Health Risk Formulas and Exposure Assumptions

The formulas and parameters provided below were used to estimate cancer and noncancer health risks. It should be noted that EPA RfC and IUR values, and ATSDR MRLs assume continuous (i.e., 24-hour) exposure.

Hazard Quotient using RfCs and MRLs

$$HQ = C_a / (\text{RfC or MRL}) \times CF$$

HQ = hazard quotient

C_a = indoor air concentration

RfC = EPA Reference Concentration

MRL = ATSDR Minimal Risk Level

CF = correction factor of 0.2 ($8/24 \times 5/7 \times 50/52$) to account for the less than continuous (i.e., 8 hours/day, 5 days/week, 50 weeks/year) exposure scenario assumed for a worker.

Cancer risk using unit risk factors

$$\text{Cancer risk} = C_a \times \text{IUR} \times CF$$

C_a = indoor air concentration (ug/m^3)

IUR = inhalation unit risk (per ug/m^3)

CF = correction factor of 0.08 ($8/24 \times 5/7 \times 50/52 \times 25/75$) to account for the less than continuous (i.e., 8 hours/day, 5 days/week, 50 weeks/year, 25 years) exposure scenario assumed for a worker.

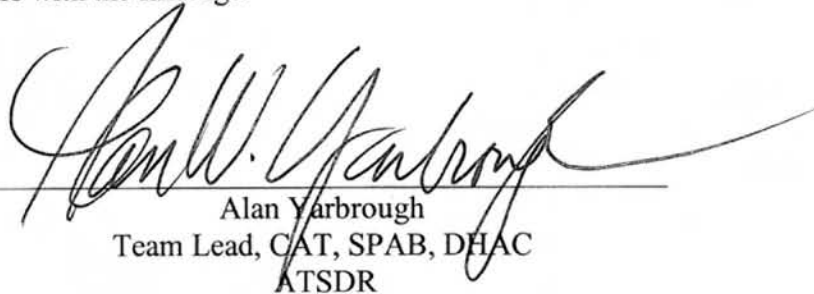
Certification

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



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



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