Health Consultation

Technical Document Review

Remedial Investigation Update Report
Cadet Manufacturing Company Site
Vancouver, Clark County, Washington

May 5, 2006

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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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Summary and Statement of Issues

The Washington State Department of Health (DOH) conducted this health consultation after receiving a copy of the Cadet Manufacturing Company (Cadet) *Remedial Investigation Update Report* on September 15, 2005.[1] The update report, which summarizes investigation and remediation activities conducted by Cadet from May 2003 through January 2005 at its property and the adjacent Fruit Valley Neighborhood (FVN), provides additional information that allows DOH to continue evaluating whether solvent contaminated groundwater that underlies the Cadet property and the nearby community poses a potential indoor air health threat. DOH conducts health consultations in cooperation with the Agency for Toxics Substances and Disease Registry (ATSDR).

Background

The Cadet Manufacturing Company (Cadet), an electric heater manufacturing facility, is located at 2500 West Fourth Plain Boulevard in Vancouver, Clark County, Washington. A release of chlorinated solvent, predominantly trichloroethylene (TCE) and tetrachloroethylene (PCE) occurred at the Cadet facility sometime in the past resulting in contamination of soil and groundwater below the facility. Solvent contaminated groundwater has migrated from the Cadet property and now underlies a significant portion of the FVN, which is a predominantly residential community located east, north, and southeast of the Cadet property. The contaminated groundwater has migrated eastward to the Burlington Northern Santa Fe (BNSF) railroad tracks, northward beyond La Frambois Road, and southeastward onto Port of Vancouver property.[1] Information collected by Cadet during its remedial investigation work indicates that no one is drinking the contaminated groundwater. However, the groundwater is a potential future drinking water source.

The solvents found in the contaminated groundwater can evaporate and move up through the soil and enter homes and other buildings, potentially affecting indoor air quality. Cadet has conducted indoor air sampling in a number of FVN buildings, predominantly single-family residences, since January 2002. The Washington State Department of Ecology (Ecology) required Cadet to install vapor mitigation systems at six of the tested residences where the highest indoor air levels of TCE and PCE were discovered in 2002 and 2003 that appeared to be associated with solvent contaminated groundwater. The mitigation system installations for these six homes began in August 2003 and were completed in January 2004.

Cadet is treating shallow, solvent contaminated groundwater on its property with an air sparging/soil vapor extraction system. Cadet is also treating shallow and intermediate depth contaminated groundwater below some nearby streets in the FVN with a recirculating groundwater remediation well system. Information provided in the update report suggests that both systems are reducing solvent levels in groundwater. However, the lateral and vertical extent of the contaminated groundwater treatment cannot be determined with the provided information.

DOH has conducted a number of health consultations for the Cadet site beginning in early 2001 because the site poses a possible health risk to the nearby community via the groundwater to indoor air pathway. The site also poses a potential future health risk if the contaminated

groundwater is used as a potable water source. The results of DOH's health consultations, which include recommendations that are intended to protect human health, have been provided to Ecology as health consultation reports since December 2001. This health consultation report summarizes DOH's concerns and recommendations regarding the Cadet remedial investigation (RI) update report.

Discussion

The Cadet RI update report summarizes investigation and remediation efforts conducted from May 2003 to January 2005 as well as a screening level approach for assessing whether the groundwater to indoor air pathway poses a possible health risk to the FVN. Some of the investigation and remediation work conducted by Cadet is not well documented in the RI update report**,** and a number of Cadet's findings/conclusions are unsupported**,** making it impossible to assess whether the site is adequately characterized and that interim remedial measures are as effective as indicated by Cadet. Cadet's screening level approach for delineating areas of the FVN where groundwater poses indoor air health risks is a good first step. However, the data used to develop the approach is questionable and could result in an over or underestimation of the health risks associated with the groundwater to indoor air pathway in the FVN.

Although DOH has a number of concerns about the site characterization, remediation, and proposed approach for assessing the groundwater to indoor air pathway, it acknowledges that Cadet has completed a significant amount of work during the time covered by the RI update report. This work has resulted in a better understanding of the extent of the groundwater contamination beneath the FVN and impact of contaminated groundwater on indoor air. Cadet has also taken measures to reduce solvent levels in a portion of the contaminated groundwater below the Cadet property and a portion of the FVN, as well as reduce solvent levels discovered in indoor air at six residences.

Cadet's approach for assessing the groundwater to indoor air pathway for the FVN (Chapter 16) is similar to an approach used by the U.S. Environmental Protection Agency (EPA) in its vapor intrusion guidance. EPA notes in its guidance, however, that it "is not intended to provide direction on how to fully delineate the extent of impacted buildings or what action should be taken after the pathway is confirmed. It is intended to be a quick screening process to help guide the user in determining if vapor intrusion is or is not a problem on the site."[2]

DOH considers the groundwater to indoor air pathway for this project "confirmed "(i.e., **a** completed exposure pathway) because some FVN homes have elevated levels of TCE and PCE that appear to be associated with the underlying solvent contaminated groundwater. This is consistent with Cadet's findings as noted in Section 16.0 of the RI update report where they state "[p]revious investigations of indoor air, soil gas, and groundwater in the FVN indicate that HVOCs are migrating from sub-surface sources into indoor air."[1]

The focus of Cadet's approach for addressing the groundwater to indoor air pathway is to develop soil gas and groundwater screening levels that delineate the extent of affected buildings in the FVN. Such an approach involves selecting and evaluating representative project information (e.g., building characteristics; soil types in the vadose zone) and data (e.g., indoor

air, groundwater, and soil gas data) that meets data quality objectives. DOH has a number of concerns with information and data that Cadet used to develop its screening level approach. The following bullets summarize some of DOH's concerns with the approach.

- The screening level approach focuses only on TCE although other chemicals exist at the site (e.g., tetrachloroethylene (PCE), 1,2-dichloroethane (1,2-DCA).
- It appears that building feature and well survey information collected by Cadet in January 2003 was not considered when selecting indoor air results.
- It is unknown whether the indoor air data used to develop attenuation coefficients represents the range of conditions across the FVN.
- Some of the indoor air data used to develop attenuation coefficients was collected in residences where active soil vapor vacuum systems are operating, which artificially lowers attenuation coefficients.
- Soil gas samples were collected below the streets, where in some cases active remediation was ongoing during sampling, rather than below or immediately adjacent to buildings as recommended by EPA and by various states.
- No field or laboratory data quality evaluations are provided in the RI update report to support that the indoor air, soil gas, or groundwater data that Cadet uses to develop screening levels is of adequate quality.
- Non-detected contaminants of concern are treated as zero values instead of using half the detection or reporting limits, which is a standard approach.
- Selection of a cancer slope factor for TCE is different than the one required by Ecology (0.4 mg/kgday).$^{-1}$
- Inappropriate outdoor air data was selected for calculating background outdoor air levels of TCE.
- Although the groundwater to indoor air pathway is fraught with uncertainty, no uncertainty discussion is included.

Further discussion about these concerns, as well as additional concerns about the screening level approach, are summarized in the numbered items below.

Once Cadet determines the extent of the potentially affected buildings using appropriate site information and data, additional steps are necessary. For example, a monitoring plan to ensure that building occupants are not being exposed to harmful levels of contaminants via the groundwater to indoor air pathway while investigation and remediation continues and a contingency mitigation plan for responding to situations where indoor air contaminant levels exceed Model Toxics Control Act (MTCA) cleanup levels or remediation levels as a result of the underlying contaminated groundwater. Cadet's approach does not include this type of information.

The following items expand on DOH's concerns about the screening level approach as well as other concerns about the RI update report. All of DOH's comments and recommendations relate directly or indirectly to public health issues and concerns associated with this site. DOH recommends that Ecology require the responsible party to address DOH's comments and recommendations in the revised RI update report.

1. **Section 2.0, Report Organization** – The opening paragraph in this section of the RI update report indicates that the "report is organized to provide an update of activities that occurred through January 2005 at the Cadet Site and FVN." It is not clear why Cadet selected January 2005 as a cutoff point when some critical activities occurred at the site between January 2005 and August 2005, such as the installation of additional recirculating groundwater remediation wells (RGRWs) as well as indoor air and soil gas sampling. It should also be noted that the updated RI report only discusses soil gas data collected through July 2004 although soil gas data was collected through November 2004 (see Appendix A).

   Recommendation – Include all the analytical results for all media including all 2005 and available 2006 results.

2. **Section 2.0, Report Organization** – Appendix A contains a "master analytical table", which the report indicates "may include data that is not yet validated." However, there is no information provided in either the report or the table to identify non-validated data, which could pose a potential problem if the data are used to make health related decisions.

   Recommendation – Clearly identify any non-validated data.

3. **Section 5.0, Geologic and Hydrogeologic Setting** - Three geologic cross sections from the February 2003 RI report were modified slightly and resubmitted with the RI update report to depict subsurface conditions near the Cadet site. However, none of the cross sections depicts subsurface conditions below the Cadet property. Only a small part of one cross section (A – A') crosses the north FVN and that small section is so general that it provides no real information about subsurface conditions that could influence the movement of contaminants volatilizing from groundwater below the Cadet property or the north FVN. No cross section depicts subsurface conditions below the south FVN, which is also underlain by contaminants migrating from the Cadet property. A good understanding of subsurface conditions below the Cadet property and the north and south FVN, particularly in the vadose zone, is necessary for evaluating the vapor intrusion pathway and determining whether it poses a health threat.

   Recommendation –Ecology should provide Cadet with direction about the areas of the site that should be included in additional site cross sections. Decisions about cross section locations should be made using groundwater flow direction, soil types, and other relevant site information.

4. **Section 5.2, Hydrogeology** – Accurate information about hydrogeologic conditions at the Cadet site is necessary to characterize the site. Cadet notes in the updated RI report that the total thickness of the Unconsolidated Sedimentary Aquifer (USA) is approximately 175 feet. However, the cross section presented on Figure 5-2 shows the USA thickness south of Fourth Plain Boulevard as approximately 100 feet thick.

   Recommendation – Correct the RI update report, as appropriate, to accurately reflect the thickness of the USA.

5. **Section 7.0, Cadet Site Remediation System** – The report notes "[t]he influence of the AS/SVE system includes the area beneath the Cadet Site building, and the areas of the property to the north and east of the building." This is a somewhat misleading statement because the air sparging/soil vapor extraction (AS/SVE) system design only addresses the shallower portion of the contaminated groundwater (35 to 60 feet below ground surface (bgs)) at the Cadet property.

   Recommendation – Modify the description of the AS/SVE system influence to reflect the treatment area and depth associated with the AS/SVE system.

6. **Section 7.1, AS/SVE System Operation and Maintenance** – The SVE air stream is treated with granular activated carbon (GAC) before being discharged to prevent the release of volatile contaminants to ambient air. The GAC is periodically replaced. However, there is no information provided in the report to indicate what criteria Cadet uses to determine when GAC replacement is necessary to prevent release of contaminants to ambient air. If not determined appropriately, this could result in inhalation exposures for people working at the Cadet facility or residing in the nearby FVN.

   Recommendation – Add the criteria used for determining GAC breakthrough and replacement.

7. **Section 7.2, AS/SVE System Air Sampling** – Cadet collects AS/SVE system influent and effluent air samples, which it uses to determine the effectiveness of the system. However, neither the data nor the data quality report(s) are included in the RI update report, making it impossible to confirm Cadet's findings that the GAC system has been operating at 99% efficiency. If the GAC is operating less efficiently then stated by Cadet, human health concerns might exist.

   Recommendation – Provide diagram(s) of system sampling points, influent and effluent data, and data quality evaluation report(s).

8. **Section 7.3.2, AS/SVE System Air Sampling** – The report states "[f]ield data indicate that the injected air has been effectively captured by the SVE system and sufficient subsurface vacuum has been maintained to prevent the air from migrating off-site." However, it is unknown what field data indicate these findings.

   Recommendation – Provide or reference field data and field data quality evaluation reports that support Cadet's claim that the SVE system is preventing contaminated soil gas from migrating off the Cadet property so DOH can evaluate whether a human health threat exists.

9. **Section 7.3.3, Changes in Groundwater HVOCs** – Generally, a few monitoring wells (e.g., MW-22S), small diameter direct push wells (e.g., DPW-1), air sparging wells (e.g., AS-50) and vapor extraction (e.g., VE-9) wells are used to measure changes in groundwater contaminant levels since the AS/SVE system began operation in October 2003. RI update report figures 7-2 and 7-3 show changes in TCE concentrations for various wells since the

installation of the AS/SVE system. RI update report figure 7-4 shows pre-remediation groundwater TCE levels and figure 7-5 shows TCE levels in January 2005.

The monitoring wells, and likely the direct push wells, should provide representative groundwater samples, if sampled appropriately. However, the results associated with the AS and VE wells are uncertain. Section 7.4 indicates that the AS/SVE system was shut-off for one to two weeks and then groundwater was sampled from the AS and VE wells to evaluate the effectiveness of the AS/SVE system in reducing solvent levels in groundwater. However, no data is provided to support that shutting off the system for one to two weeks will result in groundwater solvent levels in AS or VE wells that would be representative of groundwater quality if the system were not operating. Collecting groundwater samples from active air sparging and vapor extraction system wells could significantly reduce the level of contaminant found in the well, which would result in an underestimation of the risk associated with the groundwater. In addition, no information is provided in the report to indicate at what depth the groundwater samples were collected at each monitoring well so it is impossible to know what portion of the aquifer is being evaluated and no data quality discussion is provided.

Recommendation – Address the uncertainty associated with using AS and VE wells to measure AS/SVE system effectiveness. Also, add groundwater sample depths and data quality discussion to the revised RI update report.

10. **Section 7.6, Absence of DNAPL** – The report indicates that little or no DNAPL is present beneath the Cadet facility and that significant residual product sources are not in contact with saturated soil. Cadet reached this conclusion based on the absence of DNAPL observed in relatively shallow borings completed at the Cadet property, monitoring wells installed in the FVN, and concentrations of TCE and PCE in groundwater that are below one percent of the aqueous solubility of these two chemicals. However, DNAPL guidance developed by the Interstate Technology and Regulatory Council (ITRC) contradicts Cadet's rationale for concluding that DNAPLs are not present at the Cadet facility:

    "DNAPLs will not be readily apparent in water or soil samples at most sites even if DNAPL is present in the subsurface in significant quantities. Determining if DNAPL is present can be a subjective process because as discussed above, in many cases, an investigator could drill directly through DNAPL ganglia and never see concrete indications of the ganglia in the investigation results. One of the most important considerations in determining whether or not DNAPL is present is whether or not a DNAPL chemical was used, disposed, or manufactured at the site. As discussed above, if a DNAPL chemical can be linked to the site, it is likely that it was released to the environment. The investigator must view all of the available data to determine if there is evidence that indicates the presence of DNAPL.

    One potential indication of the presence of DNAPL in the saturated zone in a monitoring well with a long well screen (at least 10 feet long), is that the concentration of the contaminant is greater than one to ten percent of the compound's effective solubility (Cherry and Feenstra, 1991). The reasoning behind this generalization is that if DNAPL

is present, it will generally be present either as a small lense in a small preferential pathway, as residual phase ganglia, or diffused from a preferential pathway into a fine-grained matrix. If a ten-foot well screen is close to or intersects one of these areas, the area where the DNAPL is present will likely be thin when compared to the full length of the well screen. Therefore, while aqueous phase contamination is dissolving from the DNAPL into groundwater at a concentration close to its solubility limit (please note the DNAPL may be a mixture or used and can have an effective solubility that is different from the solubility of the pure DNAPL chemical), groundwater flow is generally laminar and will not mix quickly with the larger interval of the formation. The contamination will therefore be diluted in the monitoring well during sampling by the larger screened interval of the formation. Therefore, concentrations of a small percentage of solubility may indicate DNAPL. If well screens are short, there will be less dilution and the contaminant concentration will be a higher percentage of solubility before it indicates DNAPL. This technique is subjective and must be used very carefully. It should be considered only a part of the process used to determine if DNAPL is present, not a method that by itself will indicate the presence/absence of DNAPL. The U.S. EPA has indicated that concentrations of DNAPL chemicals in soil greater than one percent by mass or 10,000 mg/kg may indicate the presence of DNAPL (EPA, 1994)."[3]

Recommendation – Revise the discussion about the presence of DNAPLs to reflect the information cited above. Guidance developed by the IRTC, U.S. Environmental Protection Agency (EPA), and others should be cited in the reference section.

11. **Section 8.2, FVN Residential SVV Systems, Maintenance and Monitoring Schedule** – Cadet has developed breakthrough projections for the granular activated carbon (GAC) filters installed at six homes where soil vapor vacuum systems operate to reduce indoor air levels of TCE and PCE. Based on these projections, Cadet changes the GAC filters quarterly where soil vapor vacuum systems operate in homes with basements. GAC change out occurs annually at homes with crawlspaces. However, there are no data to show that the breakthrough projections are reasonable and protective of human health.

    Recommendation –Add sampling results to support that the GAC breakthrough projections.

12. **Section 9.1, Application of Recirculating Groundwater Remediation Wells Technology in the FVN** – The report states "[r]eduction of HVOCs in shallow groundwater beneath the FVN are mitigating HVOCs in indoor air." However, the RI update report provides no explanation about how Cadet arrived at this conclusion.

    Recommendation – Document the evaluation Cadet conducted to support the above statement, and provide all relevant data.

13. **Section 9.0, Recirculating Groundwater Remediation Wells** – Cadet has provided neither a discussion about the purpose and objectives of the recirculating groundwater remediation wells (RGRWs) nor an explanation about the intended or actual RGRW system performance. This lack of information makes it impossible to determine whether the system is working as planned (e.g., are the selected RGRW locations appropriate, are the RGRWs screened

appropriately, are the radii of influence appropriate, are the locations and screened intervals of RGRW monitoring wells (MRs) appropriate).

Recommendation – Include the purpose and objectives of the RGRW system (RGRW 1 through RGRW 7) and a discussion about the intended and actual system performance.

14. **Section 9.6.1, Radius of Influence of RGRW** – All the RGRWs and corresponding RGRW monitoring wells, which are used to measure the radius of influence of the RGRWs, are located in the streets or on Cadet property, so it is unknown how far the RGRWs' zone of influence extends below FVN properties. Soil gas levels, which are being measured below streets, might be affected by the RGRW operation while soil gas levels below homes might not be affected. These are significant data gaps that need to be addressed to ensure the groundwater under homes and other buildings is being remediated as expected and does not pose an indoor air health risk.

    Recommendation – Ecology should require Cadet to install additional RGRW monitoring wells and soil gas probes to better evaluate the effectiveness of the RGRW system below homes and other buildings in the FVN. Ecology should also require Cadet to address possible differences in soil gas levels below homes versus streets.

15. **Section 11, Groundwater Compliance Monitoring** – Table 11-1 provides a summary of the compliance monitoring conducted at the site monitoring wells at various times throughout 2003 and 2004. However, there is no explanation about why some wells were excluded although such information is necessary for evaluating the results and determining whether groundwater monitoring is adequate for evaluating possible health risks.

    Recommendation – Add the rationale for the selection of compliance monitoring wells.

16. **Section 11.2, Groundwater Elevations** – The RI update report provides a summary of activities conducted at the site between May 2003 and January 2005. However, only groundwater depths and groundwater elevation data obtained from 1999 through 2003 are presented in the report. Water levels in new wells installed in 2004 (e.g., MW 25 through MW29) are also important for understanding where samples have been collected relative to the water table and need to be included in the report.

    Recommendation – Add the depths to groundwater and groundwater elevation data for all available monitoring events including those conducted in 2004 and 2005, and any recent monitoring conducted in 2006.

17. **Section 11.3, Groundwater Analytical Results** – The discussion about the groundwater analytical results only focuses on TCE and PCE, which are the chlorinated solvents with the highest concentrations below the Cadet property and the FVN. However, other chlorinated solvents, which are likely breakdown products of TCE and PCE (e.g., cis-1,2 dichloroethene), are also found in groundwater and cannot be ignored when evaluating groundwater analytical results.

Recommendation – Discuss all of the chemicals found in the groundwater data.

18. **Section 12, Evaluation of Potential Preferential Pathways** – Cadet considered whether utility corridors were acting as preferential pathways for contaminant migration via soils and groundwater. However, they did not address whether these corridors are acting as preferential pathways for contaminated soil gas except at one location (RGRW-1). This is a data gap because contaminants could be migrating along utility corridors by either diffusion (i.e., flowing from areas of high concentrations to areas of low concentrations) or advection (e.g., via changes in atmospheric pressure fluctuations) and migrating into indoor air. DOH has raised this issue since 2002 and it remains unaddressed.

    Recommendation – Ecology should require Cadet to evaluate whether utility corridors are acting as preferential pathways for solvent vapors to get into indoor air and include a summary in the revised RI update report. The summary should include a discussion about the uncertainties associated with this pathway, data gaps, and steps to be taken to fill data gaps.

19. **Section 13, FVN Residential Air Monitoring** – Results of indoor air sampling from May through December 2004 are presented in the RI update report but no rationale is provided about why these residences were selected for indoor air sampling. In addition, there are no copies of the analytical result**s** and no field or laboratory data quality summaries so it is impossible to determine whether the quality of the reported data is adequate for making health decisions.

    Recommendation – Summarize the rationale for the selected sampling locations, include copies of analytical data sheets, and add a discussion about field and laboratory data quality so it can be determined whether the data quality is adequate for making health decisions.

20. **Section 13.8.3, 1,2-DCA in Indoor Air** – Cadet reports that 1,2-dichloroethane (1,2-DCA) originates from sources other than the solvent contaminated groundwater that underlies the FVN. The rationale for this conclusion is presented in Section 16.3, which DOH has responded to below. Cadet's other explanations for the 1,2-DCA in indoor air is that the source of 1,2-DCA is gasoline, which is used by FVN automobiles and a nearby service station. It should be noted, however, that 1,2-DCA was added to <u>leaded</u> gasoline to reduce lead levels. Since leaded gasoline has not been available for many years, gasoline is an unlikely source of 1,2-DCA. [4]

    ATSDR notes in its 1,2-DCA toxicological profile that "1,2-Dichloroethane is currently used as a chemical intermediate and as a solvent in closed systems (Dow Chemical Company 1989b). It is also added to leaded gasoline as a lead scavenger; however, this use has declined significantly, as leaded gasoline use has attenuated (Vulcan Materials Company 1989). In the United States, about 98% of the 1,2-dichloroethane produced is used to manufacture vinyl chloride (Anonymous 1998). Smaller amounts of 1,2-dichloroethane are used in the synthesis of vinylidene chloride, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, aziridines, and ethylene diamines and in chlorinated solvents (Anonymous 1998; EPA 1985a)."[4]

    Recommendation – Accurately describe possible sources of 1,2-DCA found in indoor air,

including solvent contaminated groundwater below the site.

21. **Section 14.0, Soil Gas Monitoring** – All of Cadet's soil gas probes (SG-1 to SG-12) are installed below streets in the FVN. The locations of these probes relative to utility lines are unknown. The American Petroleum Institute (API) notes, "[w]hen the soil-gas-monitoring installation is placed too close to utilities, vapors are not being drawn from the vadose zone but instead are being drawn from within the utility."[5] API recommends that "[a] thorough understanding of the location of all utilities and process piping should be developed prior to any soil gas sampling and that sampling locations be placed at a sufficient distance from utility or piping backfill areas to protect the utilities and process piping and to obtain representative samples."[5]

    Recommendation – Address the issue of the proximity of the soil gas sample locations to utility lines and the possible effects on soil gas sample results.

22. **Section 14.3, Soil Gas Sample Results** – The report notes that TCE levels from each soil gas monitoring location are greatest in samples collected immediately above the groundwater table at 20 to 30 feet bgs and that generally TCE levels decreased in the samples collected from the shallower sampling depths of 10 and 15 feet. This is true. However, there is no discussion in the report about why there are some cases where the TCE levels in the intermediate or shallowest soil gas samples exceeded the levels found at the deepest level in the vadose zone (e.g., SG-4 and SG-7 in September and November 2004, SG-6 in September 2004). It seems that this could be occurring because of some sampling problem or change in some subsurface condition.

    Recommendation – Include a discussion about the soil gas anomalies.

23. **Section 14.3, Soil Gas Sample Results** – No copies of the analytical laboratory data sheets for the soil gas samples are included in the RI update report and there is no discussion about field or laboratory soil gas data quality. These items are important for assessing whether the data is of sufficient quality for evaluating the health risks posed by the site.

    Recommendation – Include copies of the soil gas laboratory data sheets and field and laboratory data quality evaluation.

24. **Section 14.3, Soil Gas Sample Results** – The discussion about soil gas sampling results only addresses TCE. However, a number of other chlorinated solvents (e.g., PCE, 1,2-DCA, vinyl chloride) have also been detected in soil gas. Table 14-2 shows these results along with EPA soil gas screening level**s** for the tested chemicals. The report contains no discussion about why these particular EPA soil gas screening levels were chosen so it is impossible to know if these are appropriate for this site.

    Recommendation – Expand the discussion to all the chlorinated solvents detected in soil gas. Add rationale for using the particular EPA soil gas screening levels presented in Table 14-2. Include a discussion about possible chemical breakdown since many of the chemicals found in soil gas are also possible breakdown products of TCE and PCE.

25. **Section 14.3, Soil Gas Sample Results** –Figure 14-3 reportedly contains TCE levels for soil gas from January 2004 to November 2004. However, the August 2004 through November 2004 data (see Table 4-2) is not included in the figure. This is important because some of the data obtained after August 2004 shows soil gas levels rising in the later months of the year.

    Recommendation – Accurately reflect changes in soil gas conditions on the Cadet property and FVN in Figure 14-3.

26. **Section 14.3.1, Comparison of TCE Levels over Time** – Section 9.6.2 discusses the permanganate effectiveness and indicates that groundwater TCE levels in most of the shallow monitoring wells around the RGRWs decreased to very low or non-detected levels after permanganate injection. However, soil gas sampling results indicate that soil gas contaminant levels in most of the soil gas probes along West 28th Street where the RGRWs are installed (SG-1, SG-4, SG-6 and SG-7) although dropping, are still quite elevated. This might suggest that the RGRW system is not as effective as noted by Cadet, solvent vapors are migrating from another area, or some other condition.

    Recommendation – Address why soil gas levels have not dropped to near detection limits in areas where groundwater has been remediated using RGRWs.

27. **Section 15.0, Groundwater Geochemistry Evaluation** – The RI update report notes that geochemical data were collected from some monitoring well locations determined to be the most representative. However, it is unknown what criteria Cadet used to select these particular wells as representative locations so it is impossible to evaluate Cadet's monitoring well choices or interpret the information presented in Section 15.1 to 15.10.

    Recommendation – Provide the criteria used to select monitoring wells for geochemical testing.

28. **Section 15.0, Groundwater Geochemistry Evaluation** – The RI update report notes that background geochemical conditions were measured at MW-2s, MW-21s, MW-19i, and MW-18d. Based on the February 2003 RI report and information presented in the RI update report**;** however, it looks like MW-2s is the only monitoring well in this subset that is located hydraulically upgradient of the Cadet building. The other three wells are likely influenced by the site contamination and would not be considered background.

    Recommendation – Focus background evaluation on areas not influenced by releases from the site so there is a true measure of what is background. This recommendation is consistent with the way Ecology addresses background levels in the Model Toxics Control Act (MTCA) cleanup regulation.

29. **Section 16.1 through 16.6** – Cadet refers to using the 2003 version of the Johnson & Ettinger model and guidance (JEM) throughout Section 16. However, the JEM was revised in February 2004.

Recommendation – Use the current version of JEM model and guidance (February 2004) rather than an outdated version.

30. **Section 16.2, Purpose of the FVN Indoor Air Vapor Attenuation Evaluation** – Cadet correctly notes that "[p]revious investigations of indoor air, soil gas, and groundwater in the FVN indicate that HVOCs are migrating from subsurface sources into indoor air," which means that a completed exposure pathway exists. Vapor mitigation systems were installed at six homes where the highest levels of TCE and PCE were detected. Other protective measures (e.g., patching holes in basement walls) were also taken at these six homes and one additional home to reduce or eliminate exposures. However, there are also other residences were no systems have been installed where it appears that contaminated groundwater is affecting indoor air quality**,** so the pathway remains complete.

    Recommendation – Develop an approach for delineating the buildings potentially affected by the solvent contaminated groundwater.

31. **Section 16.3, Evaluation of Non-Site Related Background Sources of HVOCs** – The approach used by Cadet to evaluate whether indoor air contaminant levels are associated with background sources is flawed because the evaluation is limited to only one chemical – 1,2-DCA**,** and it relies on soil gas data collected in the street where active remediation systems are installed.

    Recommendation – Use data for all the chlorinated solvents tested at the site, not just those that exceed MTCA Method B indoor air levels, to assess potential background contributions. Use soil gas sample results obtained from below buildings, rather than soil gas samples obtained below the streets where active remediation occurs and the influence of utility corridors is unknown, when assessing background sources.

32. **Section 16.3, Evaluation of Non-Site Related Background Sources of HVOCs** – Table 16-1 links some of the residences in the FVN with the nearest street soil gas probe. Proximity of a residence to a soil gas probe is one factor to consider when matching street soil-gas results with indoor air sampling results from residences. However, subsurface conditions are also important factors that need to be considered (e.g., soil type, soil gas concentration below homes vs. soil gas concentration in the street.).

    Recommendation – Use soil gas data collected below buildings in the FVN rather than soil gas data collected in the street when conducting assessments like the background source evaluation in this section and attenuation coefficients in Section 16.4.

33. **Section 16.3, Evaluation of Non-Site Related Background Sources of HVOCs** – Cadet notes that "because 1,2-DCA levels are lower in soil gas than they are in indoor air, 1,2-DCA is most likely from background sources." That is one possibility. However, another possibility is that the 1,2-DCA is from background sources and contaminated soil gas.

    Recommendation – Consider background air, soil gas, and background air and soil gas together as possible sources of indoor air.

34. **Section 16.4.1, Estimating α Using Empirical Data** – Cadet developed site-specific attenuation coefficients (α) for a subset of FVN buildings where indoor air levels of TCE were detected from January and June 2004 along with concurrent groundwater and soil gas samples. The attenuation coefficients were used by Cadet to develop screening levels that are intended to be protective of indoor air.

First, the non-detected TCE values were removed from the data set although this is not a standard approach for handling non-detected values. EPA provides the following guidance when only some chemicals in a medium are above detection limits:

> "[m]ost analytes at a site are not positively detected in each sample collected and analyzed. Instead, for a particular chemical the data set generally will contain some samples with positive results and others with non-detected results. The non-detected results usually are reported as SQLs [sample quantitation limits]. These limits indicate that the chemical was not measured above certain levels, which may vary from sample to sample. The chemical may be present at a concentration just below the reported quantitation limit, or it may not be present in the sample at all (i.e., the concentration in the sample is zero).
>
> In determining the concentrations most representative of potential exposures at the site (see Chapter 6), consider the positively detected results together with the non-detected results (i.e., the SQLs). If there is reason to believe that the chemical is present in a sample at a concentration below the SQL, use one-half of the SQL as a proxy concentration. The SQL value itself can be used if there is reason to believe the concentration is closer to it than to one-half the SQL (See the next subsection for situations where SQLs are not available.) Unless site specific information indicates that a chemical is not likely to be present in a sample, do not substitute the value zero in place of the SQL (i.e., do not assume that a chemical that is not detected at the SQL would not be detected in the sample if the analysis was extremely sensitive). Also, do not simply omit the non-detected results from the risk assessment."[6]

ATSDR provides similar guidance in its public health assessment guidance:

> "By definition, the detection limit is the lowest level of a contaminant that analytical equipment can discern from the "noise" inherent to scientific measurements. When laboratories report that a contaminant was not detected in a sample, that does not mean that the contaminant was not present. Rather, it means the contaminant was not present at levels that can be reliably measured by the analytical method, and the only conclusion that you can draw is that the actual concentration is somewhere between zero and the reported detection limit. In statistical analyses of environmental sampling data, therefore, a common practice is to replace nondetect observations with surrogate concentrations of one-half the detection limit."[7]

Cadet also collected soil gas data in the street rather than below structures as recommended by EPA in its vapor intrusion guidance and in guidance developed by various state

environmental agencies (e.g., New York, New Jersey). There is no data provided in the update report to support that the soil gas levels measured below the streets would be the same as below structures. However, because Cadet's recirculating groundwater remediation wells are operating in the streets, it is expected that soil gas levels measured in the street could result in an underestimation of the levels found below homes. Proximity of the street soil gas probes to utility corridors might also affect soil gas results measured in the streets. In addition, Cadet limited its attenuation coefficients evaluation to only TCE. Given the uncertainty associated with evaluating this pathway, attenuation coefficients should be calculated for all the chemicals of concern to determine if there is significant variability among contaminants of concern.

Lastly, it is unknown whether the buildings selected for attenuation coefficient represent a range of conditions across the FVN. Some of the buildings used for developing attenuation coefficients are buildings where soil vapor vacuum systems (SVVSs) operate. Buildings with soil vapor vacuum systems are not appropriate buildings to use when developing attenuation coefficients because the indoor air quality is being affected by the operation of SVVS.

Recommendation – Develop α values for all the chemicals of concern. Use detected and non-detected results from a representative range of structures in various areas of the FVN (no buildings with SVVSs). Use soil gas data collected directly below buildings rather than from below the street to determine if there is significant variability among chemical for the reasons stated above. Soil gas and indoor air sampling should occur concurrently with groundwater and outdoor air sampling, not just the same week as suggested by Cadet, to help reduce uncertainty. DOH and Ecology should provide criteria for selecting homes that can be used to develop attenuation coefficients.

35. **Section 16.4.1, Estimating α Using Empirical Data –** Cadet reports that they used indoor air field duplicates as individual samples when calculating attenuation coefficients. Field duplicates are intended to determine whether there are problems with field sampling techniques and should not be considered another sample for calculating attenuation coefficients.

    Recommendation – Conservatively use the duplicate sample with the highest concentration when calculating attenuation coefficients.

36. **Section 16.4.1, Estimating α Using Empirical Data -** Cadet reports that as of July 2004 only seven residences had been tested during winter and summer season. Indoor air data from the seven residences were used to determine whether attenuation coefficients changed in response to seasons. Cadet found that only one out of seven homes had increased attenuation coefficients in the winter months (2113 W. 28th Street). That home had some cracks in the basement foundation. Cadet notes at this residence that soil gas TCE levels are increasing from winter to summer while indoor air TCE levels are decreasing from winter to summer. Cadet explains this situation by saying that "[i]f indoor air TCE levels are from subsurface sources, one would expect higher indoor air levels to correspond to higher soil gas levels" and speculates that the source of the TCE might be products used by the resident when building model airplanes. This may be true. However, no information is provided to indicate

what product(s) might contain TCE. It should be noted that Cadet does not take into account that windows and doors may have been open diluting the indoor air samples in the summer months.

Less than an order of magnitude difference exists between the empirical attenuation coefficients for the remaining six residences between winter and summer months suggesting that attenuation coefficients may not vary much seasonally. This may be true for this small sample set. However, there is no information provided in the RI update report to support that the seven residences are an adequate number for making such a determination. In addition, there is no information to support that the seven residences represent a range of conditions in the FVN.

Recommendation – Address the problems with the seasonality evaluation of attenuation coefficients. Conduct an overall evaluation of indoor air data to assess whether there appear to be seasonal changes in indoor air solvent levels at homes where it appears solvent contaminated groundwater is affecting indoor air quality. Clearly identify these residences.

37. **Section 16.4.1, Estimating α Using Empirical Data** – Until the above issues have been addressed, DOH cannot determine whether Cadet's interpretation and conclusions regarding the spatial distribution of attenuation coefficients using soil gas or groundwater data are reasonable.

    Recommendation – DOH reserves the right for further review and comment on this section in the future when the issues are addressed.

38. **Section 16.4.2, Estimating α using the Johnson & Ettinger Model** (JEM) – Cadet used the JEM to predict attenuation coefficients for basement and slab-on-grade structures using soil gas and groundwater data in addition to the empirical attenuation coefficients that it developed in the previous section of the report. It should be noted that it is not appropriate to use the JEM where there are significant openings to the subsurface (J&E model guidance). These openings can act as preferential pathways.[8] The JEM is a tool that can be used to check whether empirical attenuation coefficients are similar to modeled results as long as site-specific data are used in the model. However, Cadet used the screening level version of the model inserting only a few site parameters (e.g., soil gas sampling depth, depth to groundwater, floor space depth below grade) so its use for comparing with empirical results is not appropriate.

    Recommendation – Use the advance versions of the JEM with site-specific parameters if the JEM will be used to assess the empirical results.

39. **Section 16.4.2, Estimating α using the Johnson & Ettinger Model** (JEM) – Cadet reports that the Soil Conservation Service (SCS) soil classification for soils that underlie the eastern portion of the site (vadose zone) is considered sand while soils below the western portion are considered silty sands. However, the soil logs for the soil gas probes installed below the streets indicate that the soils are predominantly silty sand to sandy silts overlain by up to three feet of asphalt and gravel roadway material. This is a significant difference in

classification, which affects permeability values chosen for modeling.

Recommendation – Present a map showing vadose zone soil types, based on site-specific information, across the FVN with supporting grain size curves and permeability values for the various soil types in the revised RI update report.

40. **Section 16.5 Preliminary Risk Evaluation based on Site Specific α** – The groundwater screening formula does not contain a correction factor (1e-03 cubic meters per liter (m^3/l) to convert the groundwater screening level into micrograms per liter (ug/l).

    Recommendation – Revise the groundwater screening formula.

41. **Section 16.5 Preliminary Risk Evaluation based on Site Specific α** – Ecology's TCE guidance document states that "[c]onsistent with EPA Region 10 Office of Environmental Assessment, and until a cancer potency factor is incorporated into the EPA IRIS database, TCE cleanup levels under MTCA should use 0.4 $(mg/kgday)^{-1}$ as the cancer potency factor (slope factor) for ingestion and inhalation of trichloroethylene in risk assessments and in calculating risk-based cleanup levels."[9] DOH concurs with Ecology's recommended CSF of 0.4 $(mg/kgday)^{-1}$. Cadet calculated indoor air levels for TCE only and used two different TCE cancer slope factors(CSFs):(0.4 $(mg/kgday)^{-1}$ and 0.007 $(mg/kgday)^{-1}$) to come up with a**n** indoor air action level (1.25 ug/m^3). However, the TCE indoor air action level was calculated using the wrong CSF and therefore, is too high. No indoor air action levels were calculated for other chemicals of concern.

    Recommendation – Use the Ecology required TCE CSF of 0.4 $(mg/kgday)^{-1}$) when calculating an indoor air action level for TCE. Indoor air action levels should also be developed for other chemicals of concern (e.g., PCE).

42. **Section 16.5.1 Effects of Background Levels** – Cadet evaluated site data to develop an average TCE background outdoor air level that was used to adjust the TCE indoor air action level. No background levels were calculated for other chemicals. Adjusting indoor air action levels to take into account background sources is reasonable. However, Cadet's approach has several problems including using background air results from near homes where soil vapor vacuum systems discharge into the surrounding air space (over half of the results were from soil vapor vacuum system residences) and excluding non-detected results, which likely overestimates outdoor air background levels. Cadet also did not consider background indoor air levels, which tend to be higher for many chemicals, than outdoor air.

    Recommendation – Ecology, in cooperation with DOH, should provide Cadet with guidance on evaluating background indoor and outdoor air levels for the project chemicals of concern, not just TCE.

43. **Section 16.5 Preliminary Risk Evaluation based on Site Specific α** – Cadet uses the TCE indoor air action level and empirical attenuation coefficients to develop soil gas screening values for various areas of the site. Cadet notes that no TCE screening levels were calculated for groundwater because there were no spatial trends in groundwater empirical attenuation

coefficients. In addition, no soil gas screening levels were developed for other chemicals of concern. As noted throughout this health consultation, there are many issues and data gaps including site characterization, soil gas and groundwater empirical attenuation coefficient development, and indoor air action levels that need to be addressed before DOH can determine whether Cadet's risk evaluation, based on site specific attenuation coefficients using soil gas data, is reasonable.

Recommendation – Address all the concerns raised in this health consultation so DOH can evaluate this section of the report.

44. **Section 16.5 Preliminary Risk Evaluation using JEM α** – The JEM modeling work conducted by Cadet should not be used to develop screening levels. The advanced version of the JEM is a tool that can be used to evaluate whether the empirical data seems reasonable using site specific data. See DOH's previous comments on the JEM, above.

    Recommendation – Summarize the use of the JEM to check empirical results in this section, if used.

45. **Uncertainty** – This section currently does not exist in the RI update report. However, there is significant uncertainty associated with evaluating the groundwater to indoor air pathway including, but not limited to, indoor air data, attenuation coefficients, and building characteristics that can reduce the certainty of the groundwater to indoor air pathway evaluation. These uncertainties need to be addressed.

    Recommendation – Add an uncertainty discussion to Section 16 of the RI update report.

46. **Section 16.6, Summary** – The summary should be revised in the RI update report to reflect DOH's recommended changes.

    Recommendation – Same as the comment.

47. **Section 17.0, Other Sources and Background Concentrations of VOCs in Groundwater** – Cadet notes in this section that "[c]hemical analysis of groundwater samples obtained from monitoring wells in the vicinity of the POV [Port of Vancouver] property indicates that groundwater in this area is contaminated with VOCs derived from numerous sources" and summarizes information about reported releases of chemicals, including chlorinated solvents, from a number of possible industrial/commercial sources where only limited environmental investigation has been conducted. It appears that some of these releases could affect indoor air quality or possibly affect drinking water in other neighborhoods in the vicinity of these releases.

    Recommendation – Ecology should evaluate whether any contaminated environmental media (e.g., groundwater, soil gas) associated with the facilities pose a threat to indoor air quality or drinking water.

48. **Section 19.0, Conclusions -** – The conclusions section should be revised to reflect DOH's recommended changes summarized above.

    Recommendation – Same as the comment.

Children's Health Concerns

Children could potentially be exposed to groundwater contaminants associated with the Cadet site via the indoor air pathway and could be exposed in the future if the solvent contaminated groundwater is used as a drinking water source. Children can be uniquely vulnerable to the hazardous effects of environmental contaminants. When compared to adults, pound for pound of body weight, children breathe more air and drink more water. These facts lead to an increased exposure to contaminants. Additionally, the fetus is highly sensitive to many chemicals, particularly with respect to potential impacts on childhood development. For these reasons, DOH considers the specific impacts that contaminated sites, like the Cadet site, might have on children, as well as other sensitive populations, when evaluating health risks.

Conclusions

The Cadet remedial investigation (RI) report provides a summary of investigation and remediation activities conducted by Cadet from May 2003 through January 2005 on its property and the nearby Fruit Valley Neighborhood (FVN) where the groundwater to indoor air pathway poses a possible long-term health threat. DOH identified a number of issues and concerns, described above, that need to be addressed to ensure that the RI is adequate for evaluating health risks and selecting remedies that are protective of human health.

Recommendations

Recommendations regarding the RI update report for the Cadet property and the nearby FVN are summarized in the discussion section above. DOH suggests that Ecology require Cadet to address these recommendations in the revised RI update report.

Public Health Action Plan

1. DOH will review the revised RI Update report to determine whether its recommendations have been followed.

2. DOH will post this health consultation report on its web site to make it available to the public.

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Certification

This Cadet Manufacturing Company site health consultation was prepared by the Washington State Department of Health under a cooperative agreement with the federal 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 Division of Health Assessment and Consultation (DHAC) ATSDR, has reviewed this health consultation and concurs with the findings.

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