HRS DOCUMENTATION RECORD – REVIEW COVER SHEET

Name of Site:	Grain Handling Facility at Freeman
Contact Persons:	
Site Inspection	Ecology and Environment, Inc., July 2014, *Freeman Ground Water Contamination, Freeman, Washington*
Documentation Record	Linda Ader, Ecology & Environment Inc., Seattle, WA Ken Marcy, U.S. Environmental Protection Agency, Seattle, WA

Pathways, Components, or Threats Not Scored

The surface water migration pathway, soil exposure pathway, and air migration pathway were not scored as part of this Hazard Ranking System (HRS) evaluation. These pathways/components were not included because a release to these media does not significantly affect the overall site score and because the ground water migration pathway produces an overall site score well above the minimum required for the site to qualify for inclusion on the National Priorities List. These pathways are of concern to the U.S. Environmental Protection Agency (EPA) and may be evaluated during future investigations.

HRS DOCUMENTATION RECORD

Name of Site: Grain Handling Facility at Freeman

EPA Region 10 Date Prepared: March 2015

CERCLIS No.: WAN001003081

Street Address of Site*: South 14603 Highway 27, Freeman, Washington, 99030

County and State: Spokane, Washington

General Location in the State: Eastern

Topographic Map: Freeman, Washington, 2014 (Ref. 3)

Latitude: 47° 31' 10.30" North Longitude: 117° 11' 39.47" West

(Ref. 4, p. 15 as determined at the Out-of-Use Freeman School District Well)

Scores	
Ground Water Pathway	100.00
Surface Water Pathway	NS
Soil Exposure Pathway	NS
Air Pathway	NS
HRS SITE SCORE	50.00

NS = Not Scored

* *- The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under CERCLA. Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.*

TABLE 3-1 --GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum Value	Value Assigned	
Aquifer Evaluated: Grande Ronde Basalt Formation			
Likelihood of Release to an Aquifer:			
1. Observed Release	550	550.0	
2. Potential to Release:			
2a. Containment	10	NS	
2b. Net Precipitation	10	NS	
2c. Depth to Aquifer	5	NS	
2d. Travel Time	35	NS	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	NS	
3. Likelihood of Release (higher of lines 1 and 2e)	550		550.0
Waste Characteristics:			
4. Toxicity/Mobility	(a)	1000.0	
5. Hazardous Waste Quantity	(a)	100.0	
6. Waste Characteristics	100		18.0
Targets:			
7. Nearest Well	(b)	50.0	
8. Population:			
8a. Level I Concentrations	(b)	9000.0	
8b. Level II Concentrations	(b)	0.0	
8c. Potential Contamination	(b)	NS	
8d. Population (lines 8a + 8b + 8c)	(b)	9000.0	
9. Resources	5	NS	
10. Wellhead Protection Area	20	0.0	
11. Targets (lines 7 + 8d + 9 + 10)	(b)		9050.0
Ground Water Migration Score for an Aquifer:			
12. Aquifer Score [(lines 3 x 6 x 11)/82,500][c]	100		100.00
Ground Water Migration Pathway Score:			
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated)[c]	100		100.00

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

WORKSHEET FOR COMPUTING HRS SITE SCORE

	S pathway	S^2 pathway
Ground Water Migration Pathway Score (S_{gw})	100.00	10000
Surface Water Migration Pathway Score (S_{sw})	NS	NS
Soil Exposure Pathway Score (S_s)	NS	NS
Air Migration Score (S_a)	NS	NS
$S^2_{gw} + S^2_{sw} + S^2_s + S^2_a$		10000
$(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		2500
☞ $(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		50.00

REFERENCES

Reference Number	Description of the Reference
1.	U.S. Environmental Protection Agency, December 14, 1990, Hazard Ranking System, Final Rule, 40 CFR Part 300, 14 pages excerpted. A full copy of the HRS Rule is available in the Regional docket, upon request and at http://www.epa.gov/superfund/sites/npl/hrsres/#HRS.
2.	U.S. Environmental Protection Agency, June 20, 2014, Superfund Chemical Data Matrix (SCDM), Hazard Ranking System, Hazardous Substance Factor Values Appendix BI and Hazardous Substance Benchmarks Appendix BII, 42 pages excerpted. A full copy of the Superfund Chemical Data Matrix is available at http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.
3.	U.S. Geological Survey, 2014, 7.5 minute series topographic map, Freeman, Washington quadrangle, 1 page.
4.	Ecology and Environment, Inc., July 2014, *Site Inspection, Freeman Ground Water Contamination, Freeman, Washington*, prepared for United States Environmental Protection Agency, Contract Number EP-S7-13-07, Technical Direction Document Number 13-07-0005, 392 pages.
5.	Ecology and Environment, Inc., March 2014, *Freeman Ground Water Contamination, Sampling and Quality Assurance Plan, Freeman, Washington*, prepared for U.S. Environmental Protection Agency, Technical Direction Document Number 13-07-0005, 302 pages.
6.	Ecology and Environment, Inc., November 2013 to April 25, 2014, Site Manager's Field Logbook, Freeman Ground Water Contamination, Freeman, Washington, Logbook 1 of 3, 24 pages (Title page, pages 1 through 21, 47, and 48; pages 22 through 46 are blank pages).
7.	Ecology and Environment, Inc., April 21, 2014 through April 23, 2014, Project Geologist's Field Logbook, Freeman Ground Water Contamination, Freeman, Washington, Logbook 2 of 3, 13 pages.
8.	Ecology and Environment, Inc., April 21, 2014 through April 23, 2014, Chemist's Field Logbook, Freeman Ground Water Contamination, Freeman, Washington, Logbook 3 of 3, 8 pages.
9.	Washington State Department of Health, May 27, 1992 to August 19, 2014, View Sample Detail – WSID 26460H – Freeman School Dist #358, Analyte Group – VOC-Volatile Organic Contaminants, 92 pages.
10.	United States Environmental Protection Agency, May 2009, National Primary Drinking Water Regulations, Maximum Contaminant Levels, EPA 816-F-09-004, 6 pages.
11.	Agency for Toxic Substances and Disease Registry, August 2005, *Toxicological Profile for Carbon Tetrachloride*, 361 pages.
12.	GeoEngineers, March 14, 2013, *Feasibility Evaluation, Production Well Evaluation – Carbon Tetrachloride Contamination, Freeman School District, Freeman, Washington*, 104 pages.
13.	Leinart, Phil, Toxics Cleanup Program, Eastern Regional Office, Washington State Department of Ecology, Spokane, Washington, August 16, 2012, *Freeman School Wells, Contaminated Ground Water Status Report*, 9 pages.

REFERENCES

Reference Number	Description of the Reference
14.	Spokane County, Washington, January 2, 2014, Parcel Information Search, Parcel Number 43012.9008, 5 pages.
15.	Spokane County, Washington, January 2, 2014, Parcel Information Search, Parcel Number 43012.9005, 5 pages.
16.	Storey, C.L., C.R. Martin, and D.R. Sukkestad, 1981, Journal of Economic Entomology 74: 2, 188-190, Abstract - *Concentrations of 80:20 Grain Fumigant (CCL4-CS2) in Handling Equipment During Transfers of Fumigated Wheat*, 3 pages.
17.	Misiorowski, Mark R., and Joel D. Eagle, November 30, 2007, Bloomberg BNA Environment Reporter, 38 ER 2582, *A Well of a Problem: The Legacy of Carbon Tetrachloride in U.S. Groundwater*,9 pages.
18.	United States Department of Health and Human Services, 2011, *Report on Carcinogens*, Twelfth Edition, 507 pages.
19.	United States Environmental Protection Agency, June 2010, *Interim Record of Decision, Garvey Elevator Superfund Site, Operable Unit 1, Hastings, Nebraska*, 78 pages.
20.	McDonald, Malcolm G., March, 4, 2014, Assistant General Counsel, Davis Law Office, PLLC, letter to Cyndy Mackey, U. S. Environmental Protection Agency, Office of Regional Counsel regarding Freeman Ground Water Contamination Site, CHS, Inc's Response to 104(e) Request, 15 pages.
21.	United States Environmental Protection Agency, July 2006, *Applicability of Superfund Data Categories to the Removal Program*, EPA 540-F-05-005, 4 pages.
22.	Woodke, Mark, October 12, 2014, START QA Chemist, Ecology and Environment, Inc., Seattle, Washington memorandum to Linda Ader, Project Manager, Ecology and Environment, Inc., Seattle, Washington regarding Freeman Ground Water Contamination, TDD: 14-09-0004, 2014 Site Inspection Calculated Correlation Coefficient for Carbon Tetrachloride, 4 pages.
23.	Hosterman, John, 1969, United States Geological Survey, *Clay Deposits of Spokane County, Washington*, Geological Survey Bulletin 1270, 104 pages.
24.	Whiteman, K.J., et. al., 1994, United States Geological Survey, *The Hydrogeologic Framework and Geochemistry of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho*, U.S. Geological Survey Professional Paper 1413-B, 84 pages.
25.	Hansen, A.J., et. al., 1994, United States Geological Survey, *Ground-Water Flow Simulation of the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho*, Water-Resources Investigations Report 91-4187, 88 pages.
26.	Vaccaro, J.J., 1999, *Summary of the Columbia Plateau Regional Aquifer-System Analysis, Washington, Oregon, and Idaho*, United States Geological Survey Paper 1413-A, 64 pages.
27.	Washington State Department of Ecology, October 28, 2014, Regulated Underground Storage Tanks, Active Facilities, Freeman School District #358, 1 page.
28.	Woodke, Mark, February 4, 2015, START QA Chemist, Ecology and Environment, Inc., Seattle, WA memorandum to Linda Ader, Project Manager, Ecology and Environment, Inc., Seattle, WA regarding TDD: 14-09-0004 Example Fixed Laboratory adjusted CRQL calculations for EPA 2014 Site Inspection, 68 pages.

REFERENCES

Reference Number	Description of the Reference
29.	Washington State Department of Health, October 21, 2014, Division of Environmental Health, Office of Drinking Water, *Individual System View – FREEMAN SCHOOL DIST #358 – Water System ID – 26460H, Operating Permits*, webpage https://fortress.wa.gov/doh/eh/portal/odw/si/SingleSystemViews/OpPermitSingleSys.aspx accessed on October 21, 2014, 1 page.
30.	Russell, Randy, April 29, 2014, Freeman School District Superintendent email to Monica Tonel, USEPA Site Assessment Manager regarding questions relating to the Freeman School District Drinking Water Supply, 2 pages.
31.	Woodke, Mark, October 24, 2014, START QA Chemist, Ecology and Environment, Inc., Seattle, WA memorandum to Linda Ader, Project Manager, Ecology and Environment, Inc., Seattle, WA regarding TDD: 14-09-0004 Example Field Laboratory SQL calculations for EPA 2014 Site Inspection, 67 pages.
32.	Washington State Department of Ecology, December 3, 2012, *National Pollutant Discharge Elimination System, Waste Discharge Permit No. WA045403, Freeman School District No. 358,* 33 pages.
33.	Nichols, D., December 3, 2012, Washington State Department of Ecology, *Final Fact Sheet, NPDES Permit WA004540-3, Freeman School District No. 358*, 49 pages.
34.	Lally, Kirk, February 5, 2013, Freeman School District Facilities Manager telephone conversation with Linda Ader, Ecology and Environment, Inc. regarding sanitary wastewater treatment system and stormwater management, 1 page.
35.	Washington State Department of Ecology, 2013, Integrated Site Information System, webpage https://fortress.wa.gov/ecy/tcpwebreporting/reports.aspx, accessed on March 29, 2013, 4 pages.
36.	Blue Ridge Associates, Inc., August 27, 1995, *Underground Storage Tank Site Assessment/Site Characterization, Removal of Petroleum Contaminated Soil (PSC) & Drilling of One Monitoring Well, Freeman High School, Freeman, Washington*, 48 pages.
37.	Washington State Department of Ecology, October 2007, LUST Initial Investigation Report, Freeman School District #358, UST Site ID Number 5314, 3 pages.
38.	Rob's Demolition, July 1998, Site Assessment Results and Independent Cleanup Action Report, Freeman Store, 30 pages.
39.	Washington State Department of Ecology, August 2011, Initial Investigation/File Review, Freeman Store, UST Site Number 100547, 1 page.
40.	Washington State Department of Ecology, October 28, 2014, Regulated Underground Storage Tanks, Active Facilities, Freeman Store, 1 page.
41.	Zawistoski, Mark, January 28, 2015, Ecology and Environment, Inc., START GIS Specialist, Grain Handling Facility at Freeman, TDD: 14-09-0004, 2014 EPA Freeman Ground Water Contamination Site Inspection, Contaminated Soil Volume memorandum, 2 pages.
42.	United States Department of Agriculture, December 1979, *Insect Control in Farm-Stored Grain*, Farmer' Bulletin Number 2269, 18 pages.
43.	U.S. Environmental Protection Agency, September 1986, Carbon Tetrachloride – Pesticide Fact Sheet 9/86, 2 pages.

44. Agency for Toxic Substances and Disease Registry, Last updated March 3, 2011, *Toxic Substances Portal, Carbon Tetrachloride*, webpage http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=35, accessed February 27, 2015, 2 pages.

GRAIN HANDLING FACILITY AT FREEMAN SUMMARY:

The source scored for this HRS documentation record is subsurface contaminated soil at the Grain Handling Facility at Freeman (Source 1) (Figure 1). Analytical results indicate the presence of the hazardous substances carbon tetrachloride and chloroform in subsurface soil samples from the Grain Handling Facility at Freeman (see Section 2.2.2 of this documentation record, Table 1). An observed release of these hazardous substances to the drinking water aquifer has been confirmed (see Section 4.1.2.1.1 of this documentation record, Tables 5 through 8). In relation to targets in the ground water migration pathway, it has been documented that the Freeman School District's Primary drinking water supply well, located downgradient of the contaminated soil source, is subject to actual contamination (see Section 3.3 of this documentation record) (Figure 2 and Ref. 12, pp. 14 and 36 [Figure 8]).

In 1911, carbon tetrachloride was recommended as a substitute insecticide for carbon disulfide and, by the end of World War I, better equipment and technology increased its use as an insecticide and pesticide (Ref. 17, p. 3). Carbon tetrachloride became the most widely used liquid fumigant to kill insects in grain (Ref. 11, p. 210; Ref. 16, p. 1) until 1986 (Ref. 11, p. 210), when its use for this purpose was cancelled by the EPA (Ref. 18, p. 87). In grain elevator storage, the formulation was generally applied during bin loading with a layering method in which it was pumped or poured over the grain between drafts from 10 to 20 feet deep (Ref. 16, p. 1).
Until 1986, the largest source of carbon tetrachloride releases to the environment was from its use as a grain fumigant (Ref. 11, p. 199). Carbon tetrachloride's use as a fumigant, as well as most other historical uses aside from specific industrial uses, is currently banned due to its harmful effects (Ref. 44, p. 1). A degradation product of carbon tetrachloride is chloroform (Ref. 17, p. 2).

Since January 2001, carbon tetrachloride has been detected in several ground water samples collected from the Freeman School District's primary water supply well (WSID 26460H) (Ref. 9, pp. 5, 7, 11, 15, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 75, 79, 83, and 85). This well is used as the sole source of potable water to the Freeman School District campus and is used to irrigate the district's campus grounds (Ref. 13, p. 1). The United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for carbon tetrachloride is 0.005 milligrams per liter (mg/L) ((i.e., 0.005 mg/L is equivalent to 5 micrograms per liter [μg/L] (calculation: 0.005 mg/L x 1,000 μg per 1 mg = 5 μg/L)) (Ref. 10, pp. 1 and 6). In April 2008, continued monitoring of this well revealed the presence of carbon tetrachloride at a concentration of 7.78 μg/L, exceeding the MCL (Ref. 9, p. 21). Since this date, the MCL has been exceeded on multiple occasions with the most recent recorded exceedance being in May 2014 (Ref. 9, pp. 49, 51, 59, 61, 69, and 83). The Freeman School District's primary water supply system has been issued a "Blue" permit from the Washington State Department of Health that specifies the system is considered adequate for existing uses but is not considered adequate for adding new service connections (Ref. 29, p. 1).

The Marlow well is located on a former residential property acquired by the Freeman School District for the recent campus expansion program (Ref. 13, p. 2). The Marlow house and out-buildings were demolished; however the water well was preserved as a possible supplemental water supply for the school (Ref. 13, p. 2). The Freeman School District wanted another water source so there would be an alternate water supply to meet future demands, and to have an emergency backup water supply should the Primary system go down and be out-of-service (Ref. 6,

pp. 20 and 21). During an investigation to determine if the Marlow well was a suitable supplemental water supply a ground water sample was collected on May 30, 2012; this sample exhibited a carbon tetrachloride concentration of 48.1 μg/L (Ref. 13, p. 2). A 3-inch diameter pipe extends from the Marlow well (referred to throughout the remainder of this document as the Freeman School District out-of-use well) to the Freeman School District water supply system, though at present the well is not functioning and is not connected to the water supply system (Ref. 12, p. 16).

The Grain Handling Facility at Freeman as it exists today contains a total of 14 (fourteen) steel storage structures and grain transfer equipment in the form of an enclosed grain leg (i.e., also termed an elevator in reference documents) and enclosed mechanical augers for transferring raw grain products from tank to tank or to load-out bins (Ref. 20, p. 3).

Grains may be brought into the facility with small insects or bugs that bore into the grain kernel and consume the product (Ref. 20, p. 3). Since 2002, there have been no fumigation practices at the Grain Handling Facility at Freeman (Ref. 20, p. 3). The current facility operator indicated that no documents were located to indicate that carbon tetrachloride was ever used at this facility (Ref. 20, p. 3).

Although no documentation of mechanisms or compounds historically used to control insects and pests were located; it is conceivable that carbon tetrachloride was used as a fumigant at this location since carbon tetrachloride was widely used for pest control purposes beginning in 1911 and continuing until 1986 (Ref. 11, p. 210; Ref. 17, p. 3) and since the facility began operations in 1955 (Ref. 17, p. 3).

In February 2013, a draft feasibility study was completed for the Freeman School District that evaluated alternatives for addressing carbon tetrachloride contamination present in the district's primary drinking water well (termed a Production Well in the report) (Ref. 12, p. 6). For the study, five wells were sampled (Ref. 12, p. 14). These included the Freeman School District's primary drinking water supply well, the out-of-use Freeman School District well (well W26), a former domestic well located in the southeast portion of the Freeman School District campus (Well W20), a private well located southeast of the campus (well W30), and the Freeman Store well (Ref. 12, pp. 14, 15, and 34 [Figure 6]). Two of these wells contained detectable concentrations of volatile organic compounds (VOCs) (Ref. 12, p. 15). These were the Freeman School District's primary drinking water supply well and Well W20 (Ref. 12, p. 15). Carbon tetrachloride was present in these wells at 22.0 μg/L (Freeman School District's primary drinking water well) and 21.2 μg/L (Well W20) (Ref. 12, p. 15). Additionally, chloroform was present in these two wells at 1.28 and 2.04 μg/L, respectively (Ref. 12, p. 15). No other VOCs were detected (Ref. 12, p. 15). The feasibility study explored three basic alternatives:

1. Providing an alternative water supply source via the installation and construction of a new water supply well located outside of the area of the existing carbon tetrachloride plume in ground water (Ref. 12, p. 17);

2. Retrofitting the existing Production Well to isolate the contaminated water zone from deeper uncontaminated water and draw water from that deeper zone (Ref. 12, p. 18); and

3. Water treatment (Ref. 12, p. 17).

Of these alternatives, installing a new water supply well was recommended due to lower costs as compared to the other alternatives (Ref. 12, p. 20). The feasibility study speculated that the source of contamination may be from grain fumigant and/or pesticide use (Ref. 12, p. 15).

The Freeman School District tried to drill a new well west of their water holding tanks, but there was no water at this location (Ref. 6, p. 21). For this reason, the Freeman School District opted for placing a water treatment system on the Primary water supply well (Ref. 6, p. 21). An air stripping system was installed on the Freeman School District Primary Well and placed into operation in late August 2013 or early September 2013 (Ref. 6, p. 2).

In 2014, the EPA conducted a Site Inspection (SI) for the Freeman Ground Water Contamination (Ref. 4, p. 13). At that time, the source of ground water contamination was not known, but it was postulated that the Grain Handling Facility at Freeman was the most likely source (Ref. 13, p. 3). For this reason, the SI focused on subsurface soil sampling from borings at the Grain Handling Facility at Freeman (termed the Cenex Harvest States grain handling facility in the SI report) (Figure 3 and Ref. 4, p. 41). The SI also included sampling of the Freeman School District out-of-use well and other drinking water wells (Figure 4 and Ref. 4, pp. 65 [Figure 3-2], 70, and 73). The SI confirmed that a subsurface contaminated soil source of carbon tetrachloride and chloroform is present on the Grain Handling Facility at Freeman property (Ref. 4, p. 52). Another private well, Well 20 (also known as the Larry Marlow Well) was not sampled during the SI since it was out-of-service and had no electrical supply to operate the well's pump (Ref. 6, p. 3).

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GRAIN HANDLING FACILITY
AT FREEMAN
Freeman, Washington

Figure 1

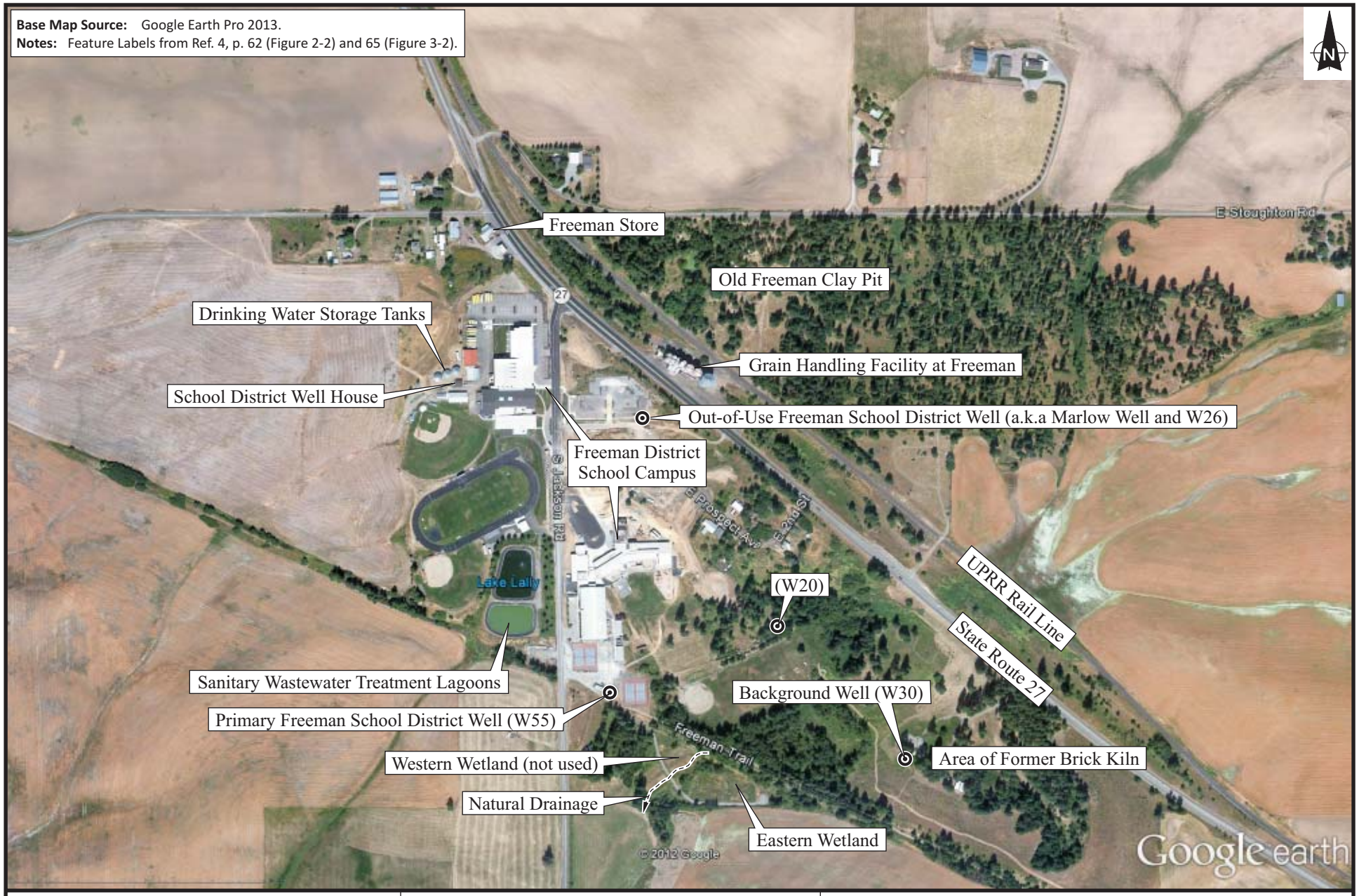
VICINITY MAP

0 .5 1
Approximate Scale in Miles

Date: 10-23-14

Drawn by: AES

10:START IV\13070005\fig 1



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Seattle, Washington

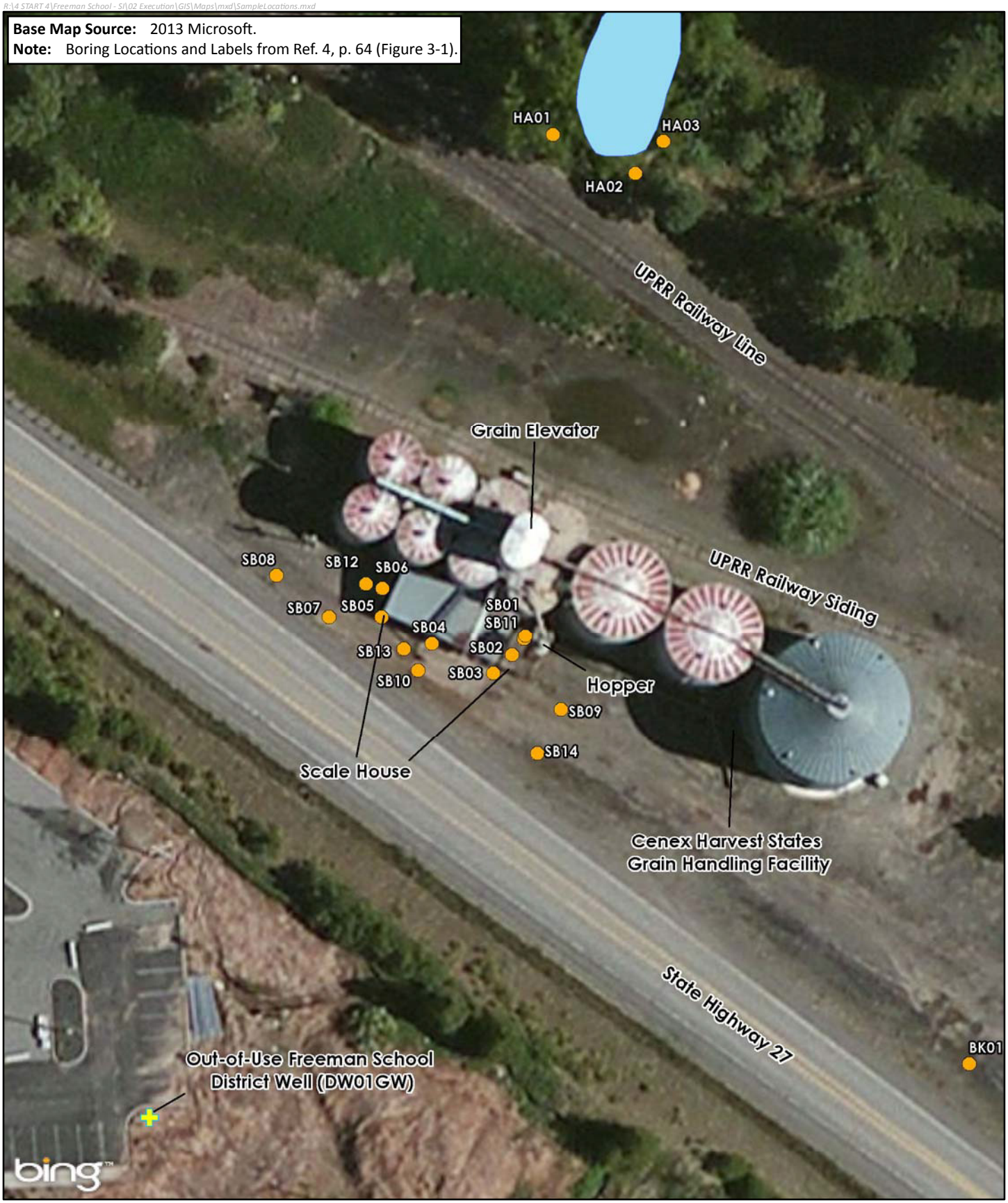
GRAIN HANDLING FACILITY
AT FREEMAN
Freeman, Washington

0 300 600
Approximate Scale in Feet

Figure 2
SETTING MAP

Date:	Drawn by:	
3/5/13	AES	10:START IV\13070005\fig 2

R:\4 START 4\Freeman School - SI\02 Execution\GIS\Maps\mxd\SampleLocations.mxd



Well
Soil Boring
Pond
UPRR - Union Pacific Railroad

FIGURE 3
GRAIN HANDLING FACILITY AT FREEMAN
Freeman, Washington

N
0 10 20 40 Feet

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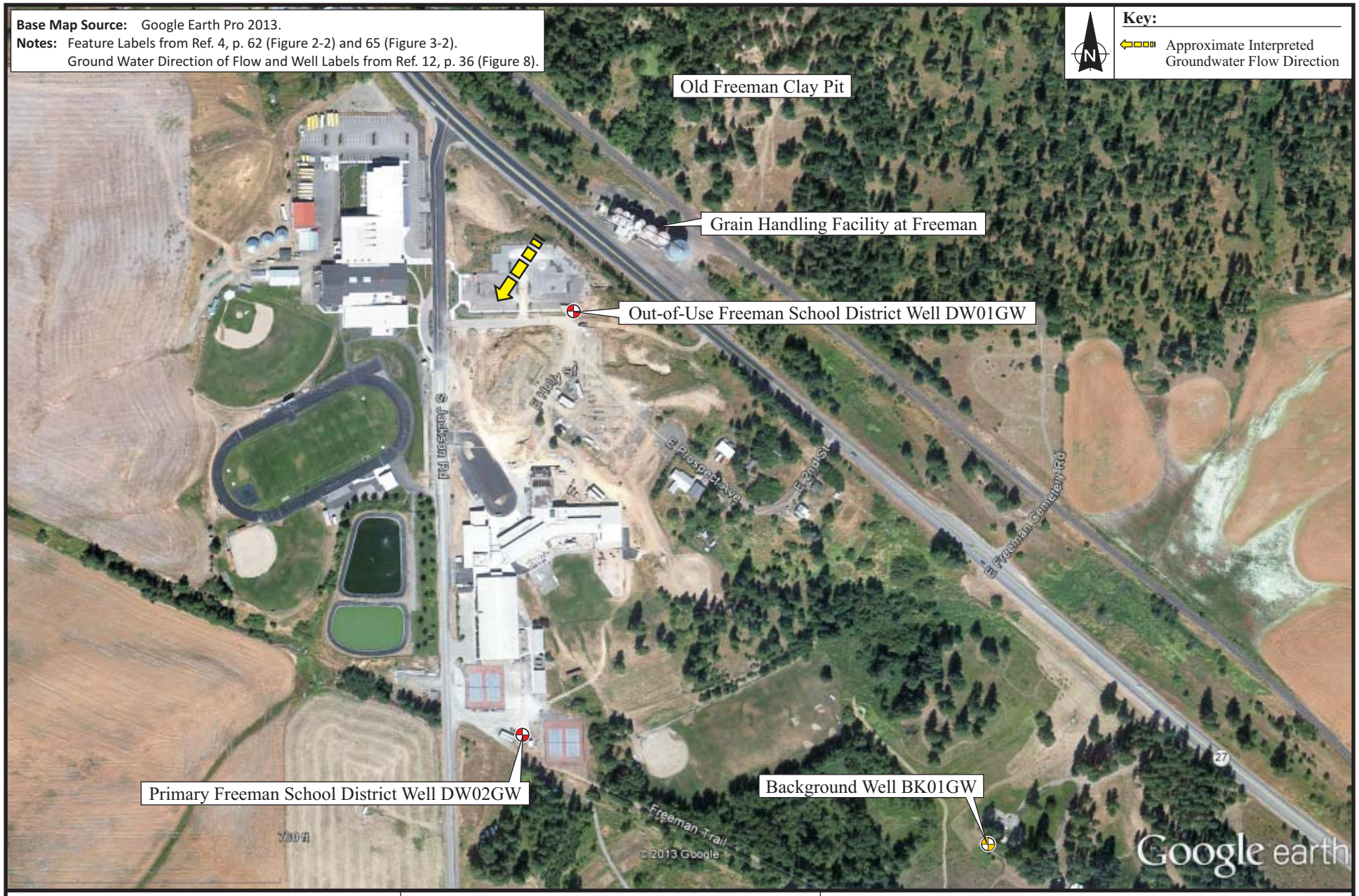

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GRAIN HANDLING FACILITY
AT FREEMAN
Freeman, Washington

0 190 380
Approximate Scale in Feet

Figure 4
WELL SAMPLE LOCATION MAP

Date:	Drawn by:	
3/5/13	AES	10:START IV\13070005\fig 4

SOURCE DESCRIPTION

2.2 SOURCE CHARACTERIZATION

Number of the Source: 1

Name and description of the source: Subsurface Soil at the Grain Handling Facility at Freeman (Contaminated Soil)

In April 2014, subsurface soil samples were collected at the Grain Handling Facility at Freeman as a component of the EPA SI (Ref. 4, p. 41). A Sampling and Quality Assurance Plan (SQAP) was developed prior to conducting sampling work which outlined the numbers and types of samples to be collected and the analytical methods to be applied (Ref. 5, pp. 32 and 33). Sampling techniques employed were in accordance with the SQAP (Ref. 4, p. 29). Deviations from the SQAP were approved by the EPA and were documented in a Sample Plan Alteration Form (Ref. 4, p. 29).

A total of 14 borings (SB01 through SB14) were drilled at the Grain Handling Facility at Freeman using a hydraulic direct-push sampling system and subsurface samples were collected for the purpose of determining whether carbon tetrachloride was present in subsurface soils near this operation (Ref. 4, pp. 30, 41, and 64 [Figure 3-2]). Drilling activities were initiated near the grain elevator and scale house since these features appeared to be the most likely locations for historic pesticide application to grain, and are often associated with the presence of carbon tetrachloride contamination at facilities where this compound was used (Ref. 4, p. 41; Ref. 17, p. 2). Between two and seven grab subsurface soil samples were collected from each boring (Ref. 4, pp. 70, 71, and 72).

In addition, one background boring (BK01) was drilled using the direct-push drill rig on the southeastern portion of the Grain Handling Facility at Freeman property in an area expected to be unaffected by facility operations (Ref. 4, pp. 38, and 64 [Figure 3-2]).

Analytical protocols applied to the SI samples included on-site field laboratory analysis for carbon tetrachloride using Region 10 EMP Field Analytical SOP 303a *Standard Operating Procedures for Analysis of Volatile Organics in Soil and Water Using the Hapsite GC/MS* (Ref. 4, p. 167; Ref. 5, p. 101); and off-site fixed laboratory analysis for volatile organic compounds (VOCs) using USEPA Contract Laboratory Program (CLP) Statement of Work (SOW) for *Multi-Media, Multi-Concentration Organics Analysis* (SOM0l.2) (Ref. 4, pp. 228 and 278). The field GC/MS calibration logbook is provided as Reference 8.

All field laboratory analytical data were validated following *EPA's Stage 2B Data Validation Manual Process (S2BVM)* (Ref. 4, pp. 167, 168, and 169). All fixed laboratory analytical data were validated following EPA' s *Stage 4 Data Validation Electronic/Manual Process (S4VEM)* (Ref. 4, pp. 228 through 231, and 278 through 281).

A correlation analysis between field laboratory results and fixed laboratory results for carbon tetrachloride was performed by E & E (Ref. 22). For the purposes of the correlation analysis, non-detect sample results (i.e., those with a "U" data qualifier) were divided by 2 (Ref. 22). This technique split the difference between using the sample quantitation limit value (which may potentially introduce a high bias) and using zero (which may potentially introduce a low bias) (Ref. 22).

Analytical results indicate the presence of a subsurface soil source of carbon tetrachloride and chloroform contamination at the Grain Handling Facility at Freeman (see Section 2.2.2, Table 1 for specific sample numbers, sample depths, and reference citations). Subsurface soil samples that define the area of contaminated soil were used to develop a volume of contaminated soil. This volume is estimated to be 1,345 cubic yards (see Section 2.4.2.1.3).

Location of the source, with reference to a map:
The contaminated soil source is located at the Grain Handling Facility at Freeman and to the southwest of the grain silos (Ref. 4, p. 64 [Figure 3-2]).

Containment
Release to Ground Water: A ground water containment factor value of 10 (Ref. 1, p. 51598, Table 3-2) is assigned because there is evidence of hazardous substance migration from the source area (see Section 3.0); further, the contaminated soil source is unlined and uncovered (i.e., the source has no maintained engineered cover, or functioning and maintained run-on control system and runoff management system) (Ref. 4, pp. 136 and 137 [Photos 123, 124, 125, and 128]; Ref. 6, pp. 5-6).

Containment Factor Value: 10

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

EPA Site Inspection (Ref. 4):

- **Source Samples:** Thirty-one subsurface soil samples were collected from the Grain Handling Facility at Freeman during the EPA SI (Ref. 4, pp. 70, 71, and 72 [Table 3-1]). Those samples containing hazardous substances are presented below in Table 1.

Table 1 – EPA SITE INSPECTION

Sample ID	Matrix/ Description	Date	Depth (feet below ground surface)	Reference	Hazardous Substance	Hazardous Substance Field Laboratory Result (µg/kg)	Field Laboratory Sample Quantitation Limit[a] (µg/kg)	Reference	Hazardous Substance Fixed Laboratory Result (µg/kg)	Fixed Laboratory Adjusted CRQL[b] (µg/kg)	Reference
SB09SB19.5 14164014 JGFH2	Soil/Sand with Silt	4/22/14	19 – 19.5	Ref. 4, pp. 71, 381, and 382; Ref. 7, p. 8	Carbon Tetrachloride	4.88	3.20	Ref. 4, p. 70; Ref. 31, p. 2	3.8 JQ	7.1	Ref. 4, p. 248; Ref. 28, p. 2
					Chloroform	NA	--	--	7.6	7.1	
SB09SB25 14164015 JGFH4	Soil/Sand with Silt	4/22/14	24.5 – 25	Ref. 4, pp. 71, 381, and 382; Ref. 7, p. 8	Carbon Tetrachloride	3.83	3.37	Ref. 4, p. 70; Ref. 31, p. 2	3.2 JQ	6.9	Ref. 4, p. 250; Ref. 28, p. 2
SB10SB18.5 14164017 JGFH6	Soil/Clay	4/22/14	18 – 18.5	Ref. 4, pp. 71, 383, and 384; Ref. 7, p. 8	Carbon Tetrachloride	5.21	3.03	Ref. 4, p. 70; Ref. 31, p. 2	6.5 JQ	7.8	Ref. 4, p. 254; Ref. 28, p. 2
SB10SB20.5 14164018 JGFH7	Soil/Sand with Silt	4/22/14	20 – 20.5	Ref. 4, pp. 71, 383, and 384; Ref. 7, p. 8	Carbon Tetrachloride	5.06	2.65	Ref. 4, p. 70; Ref. 31, p. 2	4.4 JQ	8.5	Ref. 4, p. 256; Ref. 28, p. 2
SB11SB20 14164031 JGFK0	Soil/Sand with Silt	4/23/14	19 – 20	Ref. 4, pp. 72, 385, and 386; Ref. 7, p. 9	Carbon Tetrachloride	3.21	2.98	Ref. 4, p. 70; Ref. 31, p. 2	1.9 JQ	7.7	Ref. 4, p. 294; Ref. 28, p. 2
SB11SB21.5 14164032 JGFK1	Soil/Sand with Silt	4/23/14	21 – 21.5	Ref. 4, pp. 72, 385, and 386; Ref. 7, p. 9	Carbon Tetrachloride	4.37	3.29	Ref. 4, p. 70; Ref. 31, p. 2	1.7 JQ	8.4	Ref. 4, p. 296; Ref. 28, p. 2
SB11SB28 14164033 JGFK2	Soil/Sand with Silt	4/23/14	27.5 – 28	Ref. 4, pp. 72, 385, and 386; Ref. 7, p. 9	Carbon Tetrachloride	4.42	3.09	Ref. 4, p. 70; Ref. 31, p. 2	0.71 JQ	8.4	Ref. 4, p. 298; Ref. 28, p. 2
SB11SB32 14164034 JGFK3	Soil/Sand with Silt	4/23/14	31.5 – 32	Ref. 4, pp. 72, 385, and 386; Ref. 7, p. 9	Carbon Tetrachloride	3.67	2.99	Ref. 4, p. 70; Ref. 31, p. 2	7.5 U	7.5	Ref. 4, p. 300; Ref. 28, p. 2

Sample ID	Matrix/ Description	Date	Depth (feet below ground surface)	Reference	Hazardous Substance	Hazardous Substance Field Laboratory Result (µg/kg)	Field Laboratory Sample Quantitation Limit[a] (µg/kg)	Reference	Hazardous Substance Fixed Laboratory Result (µg/kg)	Fixed Laboratory Adjusted CRQL[b] (µg/kg)	Reference
SB12SB28.5 14164037 JGFK6	Soil/Sand with Silt	4/24/14	28 - 28.5	Ref. 4, pp. 72, 387, and 388; Ref. 7, p. 11	Carbon Tetrachloride	2.85	2.74	Ref. 4, p. 70; Ref. 31, p. 2	0.19 JQ	7.0	Ref. 4, p. 306; Ref. 28, p. 2
SB13SB20 14164039 JGFK8	Soil/Sand with Silt	4/24/14	19 – 20	Ref. 4, pp. 72, 389, and 390; Ref 7, p. 11	Carbon Tetrachloride	7.98	3.10	Ref. 4, p. 70; Ref. 31, p. 2	4.1 JQ	8.2	Ref. 4, p. 310; Ref. 28, p. 2
SB13SB21.2 14164041 JGFL0	Soil/Sand with Silt and Clay	4/24/14	20.8 – 21.2	Ref. 4, pp. 72, 389, and 390; Ref. 7, p. 12	Carbon Tetrachloride	8.42	2.84	Ref. 4, p. 70; Ref. 31, p. 2	9.7	7.9	Ref. 4, p. 314; Ref. 28, p. 2
SB13SB23 14164042 JGFL1	Soil/Sand with Silt	4/24/14	22 – 23	Ref. 4, pp. 72, 389, and 390; Ref. 7, p. 12	Carbon Tetrachloride	5.92	2.85	Ref. 4, p. 70; Ref. 31, p. 2	7.1 JQ	7.1	Ref. 4, p. 316; Ref. 28, p. 2
SB13SB27.5 14164040 JGFK9	Soil/Silt with Clay	4/24/14	26.5 – 27.5	Ref. 4, pp. 72, 389, and 390; Ref. 7, p. 11	Carbon Tetrachloride	6.42	2.66	Ref. 4, p. 70; Ref. 31, p. 2	4.9 JQ	7.0	Ref. 4, p. 312; Ref. 28, p. 2
SB13SB30 14164043 JGFL2	Soil/Gravel with Clay	4/24/14	29.5 – 30	Ref. 4, pp. 72, 389, and 390; Ref. 7, p. 12	Carbon Tetrachloride	14.98	2.79	Ref. 4, p. 70; Ref. 31, p. 2	15	7.3	Ref. 4, p. 318; Ref. 28, p. 2
SB14SB18 14164046 JGFL5	Soil/Silt with Clay	4/24/14	17.5 – 18	Ref. 4, pp. 72, 391, and 392; Ref. 7, p. 12	Carbon Tetrachloride	5.86	2.99	Ref. 4, p. 70; Ref. 31, p. 2	6.8 JQ	7.8	Ref. 4, p. 320; Ref. 28, p. 3
					Chloroform	NA	--	--	8.5	7.8	
SB14SB21.5 14164047 JGFL6	Soil/Sand with Silt	4/24/14	21 – 21.5	Ref. 4, pp. 72, 391, and 392; Ref. 7, p. 13	Carbon Tetrachloride	9.3	3.37	Ref. 4, p. 70; Ref. 31, p. 3	9.3	8.7	Ref. 4, p. 322; Ref. 28, p. 3
					Chloroform	NA	--	--	11	8.7	

Sample ID	Matrix/ Description	Date	Depth (feet below ground surface)	Reference	Hazardous Substance	Hazardous Substance Field Laboratory Result (µg/kg)	Field Laboratory Sample Quantitation Limit[a] (µg/kg)	Reference	Hazardous Substance Fixed Laboratory Result (µg/kg)	Fixed Laboratory Adjusted CRQL[b] (µg/kg)	Reference
SB14SB23.5 14164048 JGFL7	Soil/Sand with Silt	4/24/14	23 – 23.5	Ref. 4, pp. 72, 391, and 392; Ref. 7, p. 13	Carbon Tetrachloride	10.67	3.97	Ref. 4, p. 70; Ref. 31, p. 3	9.8 JQ	11	Ref. 4, p. 324; Ref. 28, p. 3
					Chloroform	NA	--	--	12	11	

a – The sample quantitation limit used meets the definition provided in Ref. 1, p. 51586 (Ref. 31, p. 1).
b – The adjusted CRQL used meets the definition provided in Ref. 1, p. 51586 (Ref. 28, p. 1).

Key:

-- = no data.
µg/kg = micrograms per kilogram.
CRQL = Contract Required Quantitation Limit.
JQ = The analyte was positively identified and the associated numerical value is an estimated quantity. The result is estimated because the concentration is below the Contract Required Quantitation Limits (Ref. 4, pp. 229, 230, and 280).
NA = Not analyzed.
U = The analyte was analyzed for but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit (Ref. 4, pp. 229 and 280).

- **Background Concentrations:** For illustration purposes, concentrations of organic compounds in background soil samples are presented. Three background subsurface soil samples (BK01SB03, BK01SB04, and BK01SB12) were collected within the property footprint of the Grain Handling Facility at Freeman and three upgradient background subsurface soil samples (HA01SB13.5, HA02SB2.5, and HA03SB09) were collected between the Old Freeman Clay Pit and the Grain Handling Facility at Freeman during the EPA SI (Ref. 4, pp. 38 and 64). Similar to release sample matrix characteristics which were primarily either sand with silt, clay, silt with clay, or gravel with clay; background and upgradient background samples also consisted of silt with clay or sand with silt though one upgradient sample consisted of clay with silt and one consisted of sandy gravel with clay (see Table 2 below for matrix descriptions by sample and corresponding references). Organic results for background and upgradient background subsurface soil samples are presented below in Table 2.

Table 2 – BACKGROUND AND UPGRADIENT BACKGROUND SAMPLES

Sample ID	Matrix/ Description	Date	Depth (feet below ground surface)	Reference	Hazardous Substance	Hazardous Substance Field Laboratory Result (µg/kg)	Field Laboratory Sample Quantitation Limit[a] (µg/kg)	Reference	Hazardous Substance Fixed Laboratory Result (µg/kg)	Fixed Laboratory Adjusted CRQL[b] (µg/kg)	Reference
BK01SB03 14164022 JGFJ1	Soil/Silt with Clay	4/22/14	2.5 – 3	Ref. 4, pp. 70 and 367; Ref. 7, p. 6	Carbon Tetrachloride	2.10 U	2.10	Ref. 4, p. 170; Ref. 31, p. 3	4.7 U	4.7	Ref. 4, p. 264; Ref. 28, p. 3
					Chloroform	NA	--	--	4.7 U	4.7	
BK01SB04 14164023 JGFJ2	Soil/Silt with Clay	4/22/14	3.5 – 4	Ref. 4, pp. 70 and 367; Ref. 7, p. 6	Carbon Tetrachloride	2.15 U	2.15	Ref. 4, p. 170; Ref. 31, p. 3	4.9 U	4.9	Ref. 4, p. 283; Ref. 28, p. 3
					Chloroform	NA	--	--	4.9 U	4.9	
BK01SB12 14164024 JGFJ3	Soil/Silt with Clay	4/22/14	11.5 – 12	Ref. 4, pp. 70 and 367; Ref. 7, p. 6	Carbon Tetrachloride	1.87 U	1.87	Ref. 4, p. 170; Ref. 31, p. 3	4.7 U	4.7	Ref. 4, p. 289; Ref. 28, p. 3
					Chloroform	NA	--	--	4.7 U	4.7	
HA01SB13.5 14164019 JGFH8	Soil/Clay with Silt	4/23/14	13 – 13.5	Ref. 4, pp. 70, 369, and 370; Ref. 6, p. 16	Carbon Tetrachloride	2.14 U	2.14	Ref. 4, p. 170; Ref. 31, p. 3	6.2 U	6.2	Ref. 4, p. 258; Ref. 28, p. 3
					Chloroform	NA	--	--	6.2 U	6.2	
HA02SB2.5 14164020 JGFH9	Soil/ Sandy Gravel with Clay	4/23/14	2 – 2.5	Ref. 4, pp. 70 and 371; Ref. 6, p. 16	Carbon Tetrachloride	2.49 U	2.49	Ref. 4, p. 170; Ref. 31, p. 3	5.5 U	5.5	Ref. 4, p. 260; Ref. 28, p. 3
					Chloroform	NA	--	--	5.5 U	5.5	
HA03SB09 14164021 JGFJ0	Soil/Sand with Silt	4/23/14	8.5 - 9	Ref. 4, pp. 70 and 372: Ref. 6, p. 17	Carbon Tetrachloride	2.37 U	2.37	Ref. 4, p. 170; Ref. 31, p. 3	4.7 U	4.7	Ref. 4, p. 262; Ref. 28, p. 3
					Chloroform	NA	--	--	4.7 U	4.7	

a – The sample quantitation limit used meets the definition provided in Ref. 1, p. 51586 (Ref. 31, p. 1).
b – The adjusted CRQL used meets the definition provided in Ref. 1, p. 51586 (Ref. 28, p. 1).

Sample ID	Matrix/ Description	Date	Depth (feet below ground surface)	Reference	Hazardous Substance	Hazardous Substance Field Laboratory Result (µg/kg)	Field Laboratory Sample Quantitation Limit[a] (µg/kg)	Reference	Hazardous Substance Fixed Laboratory Result (µg/kg)	Fixed Laboratory Adjusted CRQL[b] (µg/kg)	Reference

Key:

--	=	no data.
µg/kg	=	micrograms per kilogram.
CRQL	=	Contract Required Quantitation Limit.
NA	=	Not analyzed.
U	=	The analyte was analyzed for but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection/quantitation limit (Ref. 4, pp. 168, 229, and 280).

List of Hazardous Substances Associated with Source

Carbon tetrachloride and Chloroform.

2.4.2 Hazardous Waste Quantity

2.4.2.1.1 Hazardous Constituent Quantity

The hazardous constituent quantity for Source 1 could not be adequately determined according to the HRS requirements; that is, the total mass of all Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances in the source is not known and cannot be estimated with reasonable confidence (Ref. 1, pp. 51590-51591, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, potentially responsible party [PRP] records, State records, permits, waste concentration data, etc.) available to adequately calculate the total mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 1 with reasonable confidence.

Hazardous Constituent Quantity Value (S): NS

2.4.2.1.2 Hazardous Wastestream Quantity

The hazardous wastestream quantity for Source 1 could not be adequately determined according to the HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants in the source is not known and cannot be estimated with reasonable confidence (Ref. 1, pp. 5159, Section 2.4.2.1.2). There are insufficient historical and current data (manifests, PRP records, State records, permits, etc.) available to adequately calculate the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source 1 with reasonable confidence.

Hazardous Wastestream Quantity (W): NS

2.4.2.1.3 Volume

An estimated volume of the known extent of subsurface soil contaminated with carbon tetrachloride/chloroform on site was determined using both field and fixed laboratory data. A total of six boring locations had contaminated samples (see Section 2.2 and Table 1). These were borings were SB09 through SB14 (see Section 2.2 and Table 1). The interval of contamination in each boring is as follows based on contaminated sample depths (see Table 1 for sample results, sample depths, and the intervals sampled):

- SB09 – 19 to 25 feet bgs (samples SB09SB19.5 and SB09SB25)
- SB10 – 18 to 20.5 feet bgs (samples SB10SB18.5 and SB10SB20.5)
- SB11 – 19 to 32 feet bgs (samples SB11SB20, SB11SB21.5, SB11SB28, and SB11SB32)
- SB12 – 28 to 28.5 feet bgs (sample SB12SB28.5)

- SB13 – 19 to 30 feet bgs (samples SB13SB20, SB13SB21.2, SB13SB23, SB13SB27.5, and SB13SB30)
- SB14 – 17.5 to 23.5 feet bgs (samples SB14SB18, SB14SB21.5, and SB14SB23.5)

Geographic Information System software was used to develop an estimate of the volume of contaminated soil by connecting the contaminated soil intervals in borings SB09 through SB14 to create one single amorphously-shaped layer of contaminated subsurface soil (Ref. 4, p. 45; Ref. 41, p. 1). Use of this approach derives an estimated volume of subsurface soil contamination of 36,320 cubic feet, or 1,345 cubic yards (Ref. 4, p. 45; Ref. 41, p. 1).

The volume measure of the source is conservatively calculated to be 0.538 (i.e., 1,345 cubic yards / 2,500 for contaminated soil) (Ref. 1, p. 51591, Section 2.4.2.1.3).

In borings SB09 to SB13, the deepest sample collected was contaminated indicating that the depth of contamination at these locations was not determined (Ref. 4, p. 44). For this reason, it is considered likely that additional contamination is present at these locations in deeper soils (Ref. 4, p. 44). In boring SB14, the depth of contamination may have been identified since the deepest sample in this boring did not have detections of carbon tetrachloride or chloroform (Ref. 4, p. 44). It appears the lateral extent of contamination was not determined and can be expected to extend beyond the footprint of the area where drilling occurred (Ref. 4, p. 44). Samples from borings SB07 and SB08, located to the southwest of the scale house, did not have contamination, however, the deepest sample collected from these borings was far shallower than the contaminated soil interval demonstrated to be present in borings that were drilled deeper (Ref. 4, p. 44). Hence, the extent of contamination in this direction is not known (Ref. 4, p. 44).

Volume Assigned Value (V): 0.538

2.4.2.1.4 Area

An area measure of 0 is assigned since at least a minimum volume of the source could be adequately determined based on available data for this evaluation (Ref. 1, p. 51591, Section 2.4.2.1.3).

Area Assigned Value (A): 0

Source Hazardous Waste Quantity Factor Value (Ref. 1, p. 51591): 0.538

Table 3 – Summary of Source Descriptions

Source Number	Source Hazardous Waste Quantity Value [a]	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Value for Ground Water [b]
1. Subsurface contaminated soil	0.538	N	10

[a] - See Section 2.4.2 of this document.
[b] - See Section 2.2 of this document; Ref. 1, pp. 51596, Table 3-2.

3.0 GROUND WATER MIGRATION PATHWAY

3.0.1 GENERAL CONSIDERATIONS

Ground Water Migration Pathway Description:

Regional Geology/Aquifer Description:
The Columbia Plateau is bordered by the Cascade Range on the west, by the Okanogan Highlands on the north, and by the Rocky Mountains on the east; its southern boundary is defined more by the extent of the Columbia River Basalt Group (also termed CRBG in certain reference materials) than by any physiographic feature (Ref. 24, p. 10). The majority of Spokane County, including the town of Freeman, is in the Columbia Plateau's physiographic province (Ref. 24, pp. 10 and 11 [Figure 1]). The Columbia Plateau is underlain everywhere by massive basalt flows having an estimated composite thickness of about 14,000 feet at the plateau's low point (Ref. 24, pp. 10 and 11).

The Columbia Plateau aquifer system includes, from youngest to oldest: (1) the overburden, a collective term used in this study for all materials overlying the Columbia River Basalt Group; (2) a minor amount of sediment interlayered with the basalt; and (3) a large thickness of basalt belonging to the Columbia River Basalt Group, which is the most extensive and hydrologically important geologic unit in the aquifer system (Ref. 26, p. 9). This unit consists of five basalt formations of which the Saddle Mountains, Wanapum, and Grande Ronde Basalts are the principal formations of the aquifer system (Ref. 26, p. 9). Prebasalt rocks that underlie the plateau are the lower boundary to the aquifer system (Ref. 26, p. 9). The basaltic lavas make up more than 99 percent of the volume of the aquifer system (Ref. 26, p. 9). These basalts have an average thickness of 3,300 feet and an estimated maximum thickness of about 16,000 feet (Ref. 26, p. 9).

The aquifer system has been divided into three confining units and four aquifer units (Ref. 26, p. 9). The three confining units are the Saddle Mountains-Wanapum interbed, the Wanapum-Grande Ronde interbed, and the prebasalt rocks (Ref. 26, p. 9). The four aquifer units are the overburden aquifer, the Saddle Mountains unit, the Wanapum unit, and the Grande Ronde unit (Ref. 26, p. 9). Two of these formations, the Grande Ronde and Wanapum, have been identified within the Freeman area (Ref. 24, pp. 27 [Figure 10] and 29 [Figure 12]).

The Grande Ronde Basalt underlies most of the Columbia Plateau and pinches out at its margin (Ref. 24, p. 25). It is the most extensive of the Columbia Plateau's major formations, constituting 85 to 88 percent of the total volume of the Columbia River Basalt Group (Ref. 24, p. 25). The Wanapum Basalt overlies the Grande Ronde Basalt and is the second most voluminous and extensive basalt formation in the Columbia River Basalt Group (Ref. 24, p. 25). It composes about 6 percent of the total volume of the basalts (Ref. 24, p. 25).

Water level data from the Columbia Plateau indicate that the vertical flow component is downward over most of the plateau except in discharge areas (Ref. 25, pp. 19 and 20). These discharge areas are generally in topographic lows (Ref. 25, p. 20). The Columbia Plateau has been divided into three informal physiographic subprovinces-the Yakima Fold Belt, the Blue Mountains, and the Palouse (Ref.

25, pp. 10 and 88 [Plate 1b]). The town of Freeman falls in the Palouse subprovince (Ref. 25, p. 88 [Plate 1b]). Within the Palouse subprovince, north of the Snake River, ground water in both the Grande Ronde and Wanapum units flows toward the southwest (Ref. 25, p. 20).

The Columbia River Basalt is an extremely heterogeneous aquifer unit that transmits water most readily through the broken vesicular and scoriaceous interflow zones that commonly constitute 5 to 10 percent of the thickness of an individual basalt flow (Ref. 24, p. 39). The interflow zones are separated by the less transmissive and more massive entablature and colonnade in which the fractures are more or less vertical (Ref. 24, p. 39). Recharge occurs through direct precipitation, vertical infiltration from the overlying unconsolidated sediments, and lateral recharge from upgradient areas to the north and east (Ref. 12, p. 12).

Ground water occurs in basement rocks which underlie the CRBG, in fractured and/or weathered zones (Ref. 12, p. 12). Porosity and permeability are generally low (Ref. 12, p. 12). The yield of water wells penetrating into the basement rock aquifer generally is low, typically on the order of several gallons per minute or less (Ref. 12, p. 12). Recharge to the basement rock aquifer occurs primarily within upgradient areas to the east, with ground water flowing laterally to discharge areas within the Columbia Plateau interior (Ref. 12, p. 12). Recharge also could occur through leakage from the overlying CRBG (Ref. 12, p. 12).

Site Geology/Aquifer Description:
The Freeman area is generally underlain by a minimum of two aquifer systems (Ref. 12, p. 11). These aquifers occur within the CRBG (i.e., Columbia River Basalt Group) and basement rocks (Ref. 12, p. 11). The CRBG formations generally are suitable for extracting ground water of sufficient quantity for water supply and distribution systems (Ref. 12, p. 11). However, the basement rocks can yield sufficient quantities of ground water for domestic supply in certain areas (Ref. 12, p. 11).

In 2013, water level measurement data from the out-of-use School District well and a private domestic well were used to determine the ground water flow direction in the target aquifer (i.e., the CRBG) (Ref. 12, pp. 7, and 13 and 14 [Table 3]). Ground water flow was determined to generally be from the northeast toward the southwest (Ref. 12, pp. 14 and 36 [Figure 8]).

- Aquifer Interconnections/Distance from Source and Aquifer Discontinuities within Target Distance Limit

Description
Available subsurface information suggests that, in general, a surficial loess layer extends from topsoil to the CRBG and ranges in thickness from a few feet to about 100 feet thick (Ref. 12, p. 12). Various low-permeability interbeds are present within the CRBG (Ref. 12, p. 12). At the Freeman School District Production Well (i.e., Primary Drinking Water Supply Well), the loess surficial layer was approximately 50 feet thick and the basalt/interbed sequence was on the order of 145 feet thick (Ref. 12, p. 12). The top of the CRBG generally increases from west to east across the area (Ref. 12, p. 12). East and northeast of the Freeman School District campus, the CRBG pinches out, and basement rocks are encountered at or near the ground surface (Ref. 12, p. 12).

Water well reports were used to develop a cross-section of hydrostratigraphic conditions along a northeast-southwest trending section line across the Freeman School District campus (Ref. 12, p. 12). This cross-section reveals a surficial clay layer overlying the basalt aquifer that pinches out to the northeast at a distance of approximately 0.75 mile from the out-of-use Freeman School District well (also called Well W26 and Virg/Elsie Marlow Well) and Source 1 at the Grain Handling Facility at Freeman (Ref. 12, pp. 13, 32 [Figure 4], and 33 [Figure 5]). This cross-section also demonstrates that a confining layer does not exist between the basalt and the basement rock aquifers in the vicinity (within 2 miles) of the site (Ref. 12, p. 33 [Figure 5]), indicating that these aquifers are in hydraulic communication and thus interconnected. For these reasons, hydrology within a 4-mile radius of Source 1 is considered to consist of a single hydrologic unit (Ref. 1, p. 51595).

SUMMARY OF AQUIFER(S) BEING EVALUATED

Table 4 – Aquifer System

Aquifer No.	Aquifer Name[a]	Is Aquifer Interconnected with Upper Aquifer within 2 miles? (Y/N/NA)[a]	Is Aquifer Continuous within 4-mile TDL? (Y/N)[a]	Is Aquifer Karst? (Y/N)[a]
1	Columbia River Basalt Group	NA	N	N
2	Basement Rock	Y	Y	N

[a] - See Section 3.0.1 of this document.

Key:

N = No.
NA = Not Applicable.
No. = Number.
TDL = Target Distance Limit.
Y = Yes.

3.1 LIKELIHOOD OF RELEASE

3.1.1 OBSERVED RELEASE

Aquifer Being Evaluated: Interconnected Columbia River Basalt Group and Basement Rock

Chemical Analysis

As a component of the EPA SI, two ground water samples were collected from wells on the Freeman School District campus (Ref. 4, p. 50). Sample DW01GW was collected from the district's out-of-use well and sample DW02GW was collected from the district's primary water supply well at a spigot up-line of a water treatment system (Ref. 4, pp. 50 and 65 [Figure 3-2]; Ref. 6, pp. 11 and 12). In addition, one background ground water sample (BK01GW) was collected from a domestic drinking water well (Ref. 4, pp. 38 and 65 [Figure 3-2]; Ref. 6, pp. 18 and 19). The well selected for these purposes is hydrologically cross-gradient to the Grain Handling Facility at Freeman (Ref. 12, p. 36 [Figure 8]), has been demonstrated during past sampling events to be uncontaminated (Ref. 12, pp. 13 and 14 [Table 3], 15 [Table 4], 36 [Figure 8], and 89), and has construction details that are similar to the two sampled Freeman School District wells (i.e., it is cased through the clay layer, does not have a screen, and has a similar total depth) (Ref. 4, p. 38; Ref. 12, pp. 41, 60, and 61). Further, all three wells draw water from the Columbia River Basalt Group aquifer, though the lower reaches of the Primary Freeman School District Well penetrates the Basement Rock aquifer (Ref. 12, pp. 13 and 14 [Table 3]).

A SQAP was developed prior to conducting sampling work which outlined the numbers and types of samples to be collected and the analytical methods to be applied (Ref. 5, pp. 32 and 33). Sampling techniques employed were in accordance with the SQAP (Ref. 4, p. 29). Specific sampling techniques for the types of wells sampled were as follows:

- **Out-of-Use Freeman School District Well -** A centrifugal submersible pump was used for purging and sampling (Ref. 4, p. 30). The pump was placed within 1 foot of the bottom of the well (Ref. 6, p. 11) since this was the most likely depth for encountering the contaminants of concern (Ref. 4, p. 30). Low-flow purging and sample collection techniques were utilized to minimize aquifer disturbance and limit the volume of investigation-derived waste generated (Ref. 4, p. 30; Ref. 6, p. 11). The purging pump rate was set at 0.5 liters per minute (Ref. 6, p. 11), with a goal of limiting the sustained drawdown to a maximum of 4 inches (Ref. 4, p. 30). Water level and water quality measurements were collected every five minutes to monitor water levels and water quality conditions (Ref. 4, p. 30; Ref. 6, p. 11). During purging, no drawdown of the water level was observed (Ref. 4, p. 30; Ref. 6, p. 11). Low-flow sampling commenced once water quality parameters had stabilized to the tolerances outlined below over three consecutive readings spaced at 5-minute intervals:
    - ± 0.1 standard unit for pH;
    - ± 3% for temperature and specific conductance;
    - ± 10% for dissolved oxygen; and

- ± 10% for turbidity or less than 10 nephelometric turbidity units (Ref. 4, p. 30; Ref. 6, p. 11).

Samples were collected directly into sample containers (Ref. 4, p. 30).

- **Primary Freeman School District Well –** The portal positioned up-line of the water treatment system was used for sample collection (Ref. 4, p. 30; Ref. 6, p. 12). Since the water system is in continuous operation during school hours, purging was not required (Ref. 4, pp. 30 and 31). One set of water quality parameter readings (i.e., pH, temperature, specific conductance, dissolved oxygen, and turbidity) was recorded prior to collecting the sample to document water conditions during sampling (Ref. 4, p. 31; Ref. 6, p. 12). The discharge rate from the portal was reduced to 0.4 liters per minute for sample collection (Ref. 4, p. 31; Ref. 6, p. 12). Samples were collected directly into sample containers (Ref. 4, p. 31).
- **Domestic Well (Background Well) –** The water sample was collected from the closest faucet to the wellhead which was an outdoor faucet located near the wellhead (Ref. 4, p. 31). There is no holding tank or water treatment system up-line of this location (Ref. 4, pp. 31 and 87 [Photo 11]. Prior to sampling, the faucet was allowed to discharge at a steady rate for approximately 20 minutes (Ref. 4, p. 31; Ref. 6, pp. 18 and 19). During this time, water quality parameters were monitored, and sampling commenced once water quality conditions had stabilized to the tolerances outlined below over three consecutive readings spaced at 5-minute intervals:
    - ± 0.1 standard unit for pH;
    - ± 3% for temperature and specific conductance;
    - ± 10% for dissolved oxygen; and
    - ± 10% for turbidity or less than 10 nephelometric turbidity units (Ref. 4, p. 31; Ref. 6, p. 19).

  Samples were collected directly into sample containers (Ref. 4, p. 31).

Water sample vials were filled to capacity with no headspace or air bubbles, preserved to a pH ≤ 2 with hydrochloric acid, and cooled to 4°C (±2°C) (Ref. 4, p. 30). Immediately following collection, samples were stored on ice in coolers continuously maintained under the custody of START personnel (Ref. 4, pp. 30, 151, and 152). All ground water samples were submitted to the fixed laboratory for VOCs analysis using EPA CLP SOW SOM01.2 *Multi-Media, Multi-Concentration Organics Analysis* (Ref. 4, p. 172). All fixed laboratory analytical data were validated following EPA' s *Stage 4 Data Validation Electronic/Manual Process (S4VEM)* (Ref. 4, pp. 171 through 175).

Both the Primary Freeman School District well and the out-of-use Freeman School District well contained elevated concentrations of carbon tetrachloride and chloroform (a degradation product of carbon tetrachloride) with respect to background concentrations in samples collected during the EPA SI as demonstrated in the Tables 5 through 8 below. Since January 2001, carbon tetrachloride has been detected in several ground water samples collected from the Primary Freeman School District well (WSID 26460H) during routine monitoring (Ref. 9, pp. 5, 7, 11, 15, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 75, 79, 83, and 85).

Additionally, it should be noted that ground water samples collected during earlier sampling conducted in 1992 from the Primary Freeman School District well did not contain detectable concentrations of carbon tetrachloride, a manmade substance, or chloroform (Ref. 9, pp. 1 and 3; Ref. 44, p. 1).

- Background Concentrations:

Table 5 – Background Ground Water Well Characteristics

Sample ID	Screened Interval (feet bgs)	Well Depth (feet bgs)	Date	References
BK01GW 14164026 JGFJ5	No Screen	180	4/24/2014	Ref. 4, p. 70; Ref. 6, p. 19; Ref. 12, p. 61

Key:

bgs = below ground surface.
ID = Identification.

Table 6 – Background Ground Water Well Results

Sample ID	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL[a] (µg/L)	References
BK01GW 14164026 JGFJ5	Carbon Tetrachloride	0.5 U	0.5	Ref. 4, p. 192; Ref. 28, p. 4
	Chloroform	0.5 U	0.5	Ref. 4, p. 192; Ref. 28, p. 4

a - The adjusted CRQL used meets the definition provided in Ref. 1, p. 51586 (Ref. 28, p. 1).

Key:

µg/L = micrograms per Liter.
CRQL = Contract Required Quantitation Limit.
ID = Identification.
U = The analyte was analyzed for but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit (Ref. 4, p. 173).

- **Contaminated Samples:**

Table 7 – Release Ground Water Well Characteristics

Sample ID	Screened Interval (feet bgs)	Well Depth (feet bgs)	Date	References
DW01GW 14164003 JGFG2	No Screen	140	4/22/2014	Ref. 4, p. 73; Ref. 6, p. 11; Ref. 12, p. 60
DW02GW 14164005 JGFG4	No Screen	215	4/22/2014	Ref. 4, p. 73; Ref. 6, p. 12; Ref. 12, p. 41

Key:

bgs = below ground surface.
ID = Identification.

Table 8 – Release Ground Water Well Results

Sample ID	Hazardous Substance	Concentration (µg/L)	Adjusted CRQL[a] (µg/L)	References
DW01GW 14164003 JGFG2	Carbon Tetrachloride	23	1	Ref. 4, p. 184; Ref. 28, p. 4
	Chloroform	1.9	0.5	Ref. 4, p. 182; Ref. 28, p. 4
DW02GW 14164005 JGFG4	Carbon Tetrachloride	8.8	0.5	Ref. 4, p. 188; Ref. 28, p. 4
	Chloroform	0.52	0.5	Ref. 4, p. 188; Ref. 28, p. 4

a - The adjusted CRQL used meets the definition provided in Ref. 1, p. 51586 (Ref. 28, p. 1).

Key:

µg/L = micrograms per Liter.
CRQL = Contract Required Quantitation Limit.
ID = Identification.

Attribution:

Carbon tetrachloride is a manufactured chemical and does not occur naturally in the environment (Ref. 11, p. 22; Ref. 44, p. 1) and is a clear liquid that evaporates very easily (Ref. 11, p. 21). Most carbon tetrachloride that escapes to the environment is therefore found as a gas (Ref. 11, p. 21). Historically, a mixture containing a 1:4 ratio of carbon disulfide to carbon tetrachloride, commonly known as 80:20 or 80-20 fumigant, has been used to fumigate grain for pest control (Ref. 16, p. 1). A degradation product of carbon tetrachloride is chloroform (Ref. 17, p. 2). In 1956, carbon tetrachloride was registered as a pesticide fumigant (Ref. 43, p. 1). Grain fumigants are pesticides in the form of gases that penetrate throughout the grain bulk to control insects attacking the grain (Ref. 42, p. 14). Fumigants are effective only when the grain structure is sufficiently tight to maintain a gas concentration long enough to be lethal to storage pests (Ref. 42, p. 14). Because fumigant chemicals are highly toxic and hazardous to use, they were classified as restricted pesticides (Ref. 42, p. 14).

In grain elevator storage, the formulation was generally applied during bin loading with a layering method in which it was pumped or poured over the grain between drafts from 10 to 20 feet deep (Ref. 16, p. 1). Historically, carbon tetrachloride has entered the environment due to fumigation or direct application of the 80-20 mixture (Ref. 17, p. 2). Unintended releases of carbon tetrachloride have occurred via spills and leaks from various transporting devices and equipment, such as rail cars, delivery trucks, leaky hoses, and onsite storage tanks, and the improper disposal of excess product by simply pouring it on the ground (Ref. 17, p. 2)

Although no documentation of mechanisms or compounds used to control insects and pests prior to ownership of the Grain Handling Facility at Freeman by the current facility operator were found; it is conceivable that carbon tetrachloride was used at this location since carbon tetrachloride was widely used for pest control purposes beginning in 1911 and continuing until 1986 (Ref. 11, p. 210; Ref. 17, p. 3) and since the facility began operations in 1955 (Ref. 17, p. 3).

The EPA SI confirmed that a subsurface contaminated soil source of carbon tetrachloride and chloroform (Source 1 of this document) is present on the Grain Handling Facility at Freeman property (Ref. 4, p. 52). Carbon tetrachloride was found in soil borings SB11 through SB14 (Table 1 and Figure 3), beyond the perimeter of the grain silos where its use as a registered pesticide would have been legally allowed, indicating a source of this chemical exists outside of the areas where it would have been legally applied. In fact, soil samples from borings closest to the grain silos (SB11 and SB12) had detections of carbon tetrachloride that were lower than the concentrations detected in soil samples further from the silos (SB13 and SB14) (Table 1 and Figure 3); indicating that a more concentrated area of contamination exists in the borings furthest from the grain silos and in areas where these contaminants should not be found if used properly.

More specifically, the table below (an excerpt of Table 1 in Section 2.2.2) provides a summary of carbon tetrachloride concentrations found in borings SB11 and SB12 with the highest concentration detected in these borings of 4.37 µg/kg highlighted in yellow. The table also provides concentrations for SB13 and SB14 with concentrations exceeding 4.37 µg/kg in red font. Those concentrations ranged from 5.86 to

15 µg/kg and demonstrate that every detection in samples collected from SB13 and SB14 are higher than the highest detection in samples from SB11 and SB12.

Further, since the pesticide is a fumigant, it requires a confined space in order to work. For this reason, it would be unlikely that it would have been applied aerially to crops. Carbon tetrachloride is a clear liquid that evaporates very easily (Ref. 11, p. 21). Most carbon tetrachloride that escapes to the environment is therefore found as a gas (Ref. 11, p. 21). Fumigants are effective only when the grain structure is sufficiently tight to maintain a gas concentration long enough to be lethal to storage pests (Ref. 42, p. 14).

Sample ID	Depth (feet below ground surface)	Hazardous Substance	Hazardous Substance Field Laboratory Result (mg/kg)	Field Laboratory Sample Quantitation Limit[a] (mg/kg)	Hazardous Substance Fixed Laboratory Result (mg/kg)	Fixed Laboratory Adjusted CRQL[b] (mg/kg)
SB11SB20 14164031 JGFK0	19 – 20	Carbon Tetrachloride	3.21	2.98		
SB11SB21.5 14164032 JGFK1	21 – 21.5	Carbon Tetrachloride	4.37	3.29		
SB11SB28 14164033 JGFK2	27.5 – 28	Carbon Tetrachloride	4.42	3.09		
SB11SB32 14164034 JGFK3	31.5 – 32	Carbon Tetrachloride	3.67	2.99		
SB12SB28.5 14164037 JGFK6	28 - 28.5	Carbon Tetrachloride	2.85	2.74		
SB13SB20 14164039 JGFK8	19 – 20	Carbon Tetrachloride	7.98	3.10		
SB13SB21.2 14164041 JGFL0	20.8 – 21.2	Carbon Tetrachloride	8.42	2.84	9.7	7.9
SB13SB23 14164042 JGFL1	22 – 23	Carbon Tetrachloride	5.92	2.85		
SB13SB27.5 14164040 JGFK9	26.5 – 27.5	Carbon Tetrachloride	6.42	2.66		

Sample ID	Depth (feet below ground surface)	Hazardous Substance	Hazardous Substance Field Laboratory Result (mg/kg)	Field Laboratory Sample Quantitation Limit[a] (mg/kg)	Hazardous Substance Fixed Laboratory Result (mg/kg)	Fixed Laboratory Adjusted CRQL[b] (mg/kg)
SB13SB30 14164043 JGFL2	29.5 – 30	Carbon Tetrachloride	14.98	2.79	15	7.3
SB14SB18 14164046 JGFL5	17.5 – 18	Carbon Tetrachloride	5.86	2.99		
SB14SB21.5 14164047 JGFL6	21 – 21.5	Carbon Tetrachloride	9.3	3.37	9.3	8.7
SB14SB23.5 14164048 JGFL7	23 – 23.5	Carbon Tetrachloride	10.67	3.97		

This source is hydrogeologically upgradient of the Freeman School District out-of-use well given that ground water generally flows from northeast toward southwest (Figure 2 and Ref. 12, p. 14). It should be noted, that when carbon tetrachloride enters the ground water, this chemical will migrate downward until it encounters a geologic barrier that prevents further vertical movement (Ref. 17, p. 2). At this point, the chemical will continue to break down at a slow rate and may persist in various constituent forms for many years, decades, or longer (Ref. 17, p. 2). The hazardous substances detected at observed release concentrations in ground water are the same as those detected in the Source 1 samples (see Section 2.2, Source 1 and Section 4.1.2.1.1, Observed Release).

Site Setting and Other Possible Non-Site Sources

The town of Freeman has few residences and is dominated by the Freeman School District campus (Ref. 3; Figure 1). The elementary, middle and high schools of the district are situated in three separate buildings on this campus (Ref. 13, p. 1). The Freeman Store is present on the north end of town (Figure 2). A former clay borrow pit known as the Old Freeman Clay Pit is located approximately 0.5 mile northeast of the Grain Handling Facility at Freeman (Ref. 4, pp. 15 and 62 [Figure 2-2]; Ref. 13, p. 8 [Figure 2]). The Old Freeman Clay Pit is situated on property currently owned by Mutual Materials Company (Figure 2; and Ref. 4, p. 15; Ref. 13, p. 8 [Figure 2]; Ref. 15, pp. 1 and 2). Beyond these uses, land near Freeman is primarily used for agricultural production (Ref. 4, p. 15).

In August 2012, the Washington State Department of Ecology (Ecology) completed a report summarizing the history of known carbon tetrachloride ground water contamination in the city of Freeman (Ref. 13). This report also identified businesses and features that were considered potential sources for this contamination (Ref. 13, p. 2). Of these potential sources, only two were located upgradient of the Freeman School District out-of-use well; these being the Grain Handling Facility at

Freeman and the Old Freeman Clay Pit (see Figure 2). The report speculated that the Old Freeman Clay Pit may have been used for dumping or illegal disposal (Ref. 13, p. 3**).** Although no evidence of this use has been located in available documents, three upgradient background borings (HA01, HA02, and HA03) were placed between an area of ponded water at the Old Freeman Clay Pit and the Grain Handling Facility at Freeman during the EPA SI in order to determine whether potential source(s) on the Old Freeman Clay Pit property may be contributing to carbon tetrachloride ground water contamination in the area (Ref. 4, pp. 38 and 64 [Figure 3-2]; Ref. 6, p. 15).

One subsurface soil sample was collected from each boring (Ref. 6, pp. 17, and 18). The samples were collected from 13 to 13.5 feet bgs, 2 to 2.5 feet bgs, and 8.5 to 9 feet bgs (Ref. 6, pp. 17 and 18). As indicated in Section 2.2 of this document, soil matrices at these locations were similar to release sample matrices; sample chain-of-custody was maintained, samples were handled in a similar fashion to release samples (i.e., immediately placed in coolers with ice, aliquots for fixed laboratory analysis were frozen to extend the technical holding times, etc.), samples were collected using a decontaminated stainless steel hand auger, samples were analyzed using the same analytical methods as release samples, and analytical data from these samples were validated using the same protocols as the release samples.

No VOCs, including carbon tetrachloride and chloroform, were detected in these samples (see Table 2 for analytical results and reference citations). A source of carbon tetrachloride or chloroform was not located at the Old Freeman Clay Pit.

Hazardous Substances Released

The hazardous substances found in observed releases by chemical analysis to the drinking water aquifers within the TDL are Carbon Tetrachloride and Chloroform.

Ground Water Observed Release Factor Value: 550

3.2 WASTE CHARACTERISTICS

3.2.1 TOXICITY/MOBILITY

Table 9 below provides Toxicity/Mobility Factor Values for those hazardous substances present in the source at the Grain Handling Facility at Freeman (see Section 2.2).

Table 9 – Toxicity/Mobility Factor Values

Hazardous Substance	Source No.	Toxicity Factor Value	Mobility Factor Value	Does Hazardous Substance Meet Observed Release by Chemical Analysis? (Y/N)	Toxicity/ Mobility (Ref. 1, Table 3-9)[a]	References
Carbon Tetrachloride	1	1,000	1	Y	1,000	Ref. 2, p. BI-2
Chloroform	1	100	1	Y	100	Ref. 2, p. BI-3
a - Hazardous substance mobility factor values are based on a non-karst aquifer. In addition, hazardous substances meeting observed release criteria are assigned a mobility of 1 according to HRS Section 3.2.1.2 (Ref. 1, p. 51601).						

Toxicity/Mobility Factor Value: 1,000
(Ref. 1, p. 51602 [Table 3-9])

3.2.2 HAZARDOUS WASTE QUANTITY

Table 10 – Hazardous Waste Quantity Values

Source No.	Source Type	Source Hazardous Waste Quantity	Source Hazardous Constituent Quantity Complete?
1. Grain Handling Facility at Freeman	Contaminated Soil	0.538 → 1[a]	N
a – The Source Hazardous Waste Quantity Value has been rounded to 1 according to HRS Section 2.4.2.2 (Ref. 1, p. 51591).			

Targets for the Ground Water Migration Pathway are subject to Level I concentrations, hence a Hazardous Waste Quantity Value of 100 is assigned (Ref. 1, p. 51591 [Table 2-6] and 51592).

Hazardous Waste Quantity Factor Value: 100
(Ref. 1, p. 51591 [Table 2-6])

3.2.3 WASTE CHARACTERISTICS FACTOR CATEGORY VALUE

The waste characteristics factor category was obtained by multiplying the toxicity, mobility, and hazardous waste quantity factor values, subject to a maximum product of 1×10^8 according to the HRS Section 3.2.3 (Ref. 1, p. 51602).

Toxicity/Mobility Factor Value: 1,000
Hazardous Waste Quantity Factor Value: 100

Toxicity/Mobility Factor Value X
Hazardous Waste Quantity Factor Value: 100,000

Waste Characteristics Factor Category Value: 18
(Ref. 1, p. 51592 [Table 2-7])

3.3 TARGETS

The Freeman School District operates one drinking water well which is the sole source of potable water to the Freeman School District campus and is used to irrigate the district's campus grounds (Ref. 13, p. 1). The Freeman School District campus includes the district's elementary, middle, and high schools situated in three separate buildings on this campus (Ref. 13, p. 1). Water is pumped from this wellhead approximately 1,800 feet to a pump house located west of the existing Freeman High School (Ref. 12, p. 16). At the well house, water is treated via air stripping to remove carbon tetrachloride, moves through a chlorination system, then is transferred to three, 100,000-gallon aboveground water storage tanks (reservoirs) for temporary storage (Ref. 4, p. 25; Ref. 6, p. 24; Ref. 12, p. 16).

Level I Concentrations

Table 11 – Level I Concentrations

Sample ID	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Benchmark Concentration (µg/L)	Benchmark	References for Benchmark
DW02GW (sampled pre-treatment)	Carbon Tetrachloride	8.8	0.9	Cancer-Risk Screening Concentration	Ref. 1, p. 51603 [Table 3-10]; Ref. 2, p. BII-3

Key:
µg/L = micrograms per Liter.
ID = Identification.

Carbon Tetrachloride Trend Observations

Historic carbon tetrachloride concentration data from the Freeman School District Production Well (i.e., Primary Freeman School District well) suggest that increased ground water recharge during spring tends to exacerbate the contaminant concentrations in ground water captured by this well (Ref. 12, p. 16). The data also suggests that the trend in ground water carbon tetrachloride concentrations at that location generally is increasing (Ref. 12, p. 16). A water treatment system was installed on the water supply system in late August or early September 2013 (Ref. 6, p. 2). Untreated water data supporting these trend observations are provided below in Table 12.

Table 12 - Primary Freeman School District Drinking Water Well Analytical Results

Sample Date	Analyte	Result (µg/L)	Reference
5/7/2014	Carbon Tetrachloride	**6.700 EQ**	Ref. 9, p. 83
4/22/2014	Carbon Tetrachloride	**8.800**	Ref. 4, pp. 73 (Table 3-1) and 81
11/6/2013	Carbon Tetrachloride	**5.500 EQ**	Ref. 9, p. 69

Sample Date	Analyte	Result (µg/L)	Reference
9/18/2013	Carbon Tetrachloride	**3.800 EQ**	Ref. 9, p. 65
7/2/2013	Carbon Tetrachloride	**3.300 EQ**	Ref. 9, p. 63
4/10/2013	Carbon Tetrachloride	**9.300 EQ**	Ref. 9, p. 61
1/25/2013	Carbon Tetrachloride	**22.0**	Ref. 12, p. 91
1/24/2013	Carbon Tetrachloride	**7.600 EQ**	Ref. 9, p. 59
12/12/2012	Carbon Tetrachloride	**8.000 EQ**	Ref. 9, p. 57
9/5/2012	Carbon Tetrachloride	**3.100 EQ**	Ref. 9, p. 55
6/14/2012	Carbon Tetrachloride	**2.100 EQ**	Ref. 9, p. 53
4/19/2012	Carbon Tetrachloride	**7.200 EQ**	Ref. 9, p. 51
3/21/2012	Carbon Tetrachloride	**5.900 EQ**	Ref. 9, p. 49
12/7/2011	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 47
9/21/2011	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 45
6/22/2011	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 43
3/31/2011	Carbon Tetrachloride	**3.900 EQ**	Ref. 9, p. 41
10/27/2010	Carbon Tetrachloride	**3.130 EQ**	Ref. 9, p. 39
8/18/2010	Carbon Tetrachloride	**2.220 EQ**	Ref. 9, p. 37
4/28/2010	Carbon Tetrachloride	**4.290 EQ**	Ref. 9, p. 35
11/4/2009	Carbon Tetrachloride	**3.280 EQ**	Ref. 9, p. 33
6/25/2009	Carbon Tetrachloride	**1.800 EQ**	Ref. 9, p. 31
2/26/2009	Carbon Tetrachloride	**1.660 EQ**	Ref. 9, p. 29
11/13/2008	Carbon Tetrachloride	**3.720 EQ**	Ref. 9, p. 27
9/12/2008	Carbon Tetrachloride	**2.140 EQ**	Ref. 9, p. 25
5/20/2008	Carbon Tetrachloride	**2.340 EQ**	Ref. 9, p. 23
4/3/2008	Carbon Tetrachloride	**7.780 EQ**	Ref. 9, p. 21
4/30/2007	Carbon Tetrachloride	**2.310 EQ**	Ref. 9, p. 19
5/31/2006	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 17
11/16/2004	Carbon Tetrachloride	**1.640 EQ**	Ref. 9, p. 15
8/12/2003	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 13
6/20/2002	Carbon Tetrachloride	**1.400 EQ**	Ref. 9, p. 11
7/11/2001	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 9
3/22/2001	Carbon Tetrachloride	**0.700 EQ**	Ref. 9, p. 7
1/30/2001	Carbon Tetrachloride	**0.700 EQ**	Ref. 9, p. 5
11/13/1992	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 3
5/27/1992	Carbon Tetrachloride	0.500 LT	Ref. 9, p. 1

Notes:
Bold concentrations indicate the analyte was detected.
Shaded concentrations indicate the value exceeds the EPA Safe Drinking Water Act Maximum Contaminant Level of 5 µg/L (Ref. 27, p. 1).

Key:
µg/L = Micrograms per liter.
EQ = Equal to.
LT = Less than.

In fact, despite carbon tetrachloride treatment, post-treatment water has been found to contain residual carbon tetrachloride on three separate occasions as follows:

- March 5, 2014 – Post-treatment water contained 0.2300 μg/L carbon tetrachloride,
- January 8, 2014 – Post-treatment water contained 0.4400 μg/L carbon tetrachloride,
- October 9, 2013 – Post-treatment water contained 0.3100 μg/L carbon tetrachloride (Ref. 9, pp. 67, 75, and 79).

3.3.1 NEAREST WELL

Well ID: Primary Freeman School District Well
Level of Contamination (I, II, or potential): I

Nearest Well Factor Value: 50
(Ref. 1, p. 51603 [Table 3-11])

3.3.2 POPULATION

3.3.2.1 Level of Contamination

3.3.2.2 Level I Concentrations

Level I Population Targets

Table 13 – Population Values

Level I Well	Aquifer No.	Population	References
Primary Freeman School District Well	1 - Columbia River Basalt Group	900	Ref. 12, pp. 13 [Table 3] and 41; Ref. 30, p. 1

Sum of Population Served by Level I Wells: 900
Sum of Population Served by Level I Wells x 10 (Ref. 1, p. 51603, Section 3.3.2.2): 9,000

Level I Concentrations Factor Value: 9,000

3.3.2.3 Level II Concentrations

No Level II Concentrations have been identified.

Level II Concentrations Factor Value: 0

3.3.2.4 Potential Contamination

Targets subject to potential contamination was not scored since the maximum ground water pathway score was met based on the population subject to Level I concentrations. However, it is

worth noting that approximately 469 domestic wells are present within the 4-mile Target Distance Limit (Ref. 4, p. 49).

Potential Contamination Factor Value: NS

3.3.3 RESOURCES

Not scored.

Resources Factor Value: NS

3.3.4 WELLHEAD PROTECTION AREA

There does not appear to be a Wellhead Protection Area within 4 miles of the source.

Wellhead Protection Area Factor Value: 0