State of Oregon
Department of
Environmental
Quality

MANAGEMENT APPROVAL FORM
(Preliminary Approval)
Project Name: Evanite Fiber Corp
ECSI #40

Date: ___04/28/15___

REPORT/DOCUMENT TYPE:
(Attached)

Proposed Remedial Action: __X___
Certification of Completion _______
Other: [Describe]________________

Please review the attached staff recommendation regarding an environmental cleanup activity. ORS 465.320 requires public notification of, and a 30 day comment period for, this recommendation. It is important to receive your concurrence/comments as soon as possible to meet publication deadlines. Please provide comments or sign below as approval.

PRELIMINARY APPROVAL: (INDICATES CLEARANCE FOR PUBLIC NOTICE AND COMMENT.)

[signature] 5/1/2015
Michael E. Kucinski, Western Region Cleanup Manager — Date

Return completed form to Seth Sadofsky, Project Manager
Western Region Cleanup Program

Copy: Project Administrative Record File

State of Oregon
Department of
Environmental
Quality

PEER REVIEW COMMENTS & APPROVAL FORM

Evanite Staff Report ECSI #40
(Attached)

Date: April 20, 2015 Action: Staff Report

Please review and comment on the attached document. It is the Staff Report. Please Comments provided in March of 2015 have been addressed. Please sign below as approval.

Route to the following technical team members:

Name	Signature	Date
Greg Aitken, Hydrogeologist	Signature	4/21/2015
Susan Turnblom, Risk Assessor/Toxicologist	Signature	4/20/15
Bob Schwarz, Engineer	Signature	4/24/15
Bruce Scherzinger, Lead Worker	Signature	4/28/15

Return completed form to: Seth Sadofsky, Project Manager
Western Region Environmental Cleanup

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STAFF REPORT

RECOMMENDED REMEDIAL ACTION

For

Evanite Fiber Corporation
ECSI 40
CORVALLIS, OREGON

Prepared By

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
Western Region

April 2015

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1. INTRODUCTION

1.1 INTRODUCTION

This document presents the recommended remedial action for the Evanite site at 1115 SE Crystal Lake Drive in Corvallis, Oregon which was developed in accordance with Oregon Revised Statutes (ORS) 465.200 et. seq. and Oregon Administrative Rules (OAR) Chapter 340, Division 122, Sections 010 through 115.

The recommended remedial action is based on the administrative record for this site. A summary of the Administrative Record Index is presented in Section 8. This report summarizes the more detailed information contained in the Remedial Investigation, Risk Assessment, Focused Feasibility Study, Focused Feasibility Study Addendum, and several pilot studies and monitoring reports completed under Oregon Department of Environmental Quality (DEQ) Consent Order No. WMCSR-WR-00-19.

1.2 SCOPE AND ROLE OF THE RECOMMENDED REMEDIAL ACTION

The recommended remedial action addresses the presence of trichloroethylene (also known as trichloroethene or TCE) in contaminated soil and groundwater at the Evanite site. The recommended remedial action consists of the following elements:

- Hydraulic containment
- Contaminant removal using soil vapor extraction and groundwater extraction, including treatment of both the water and vapor
- Contaminant removal using in-situ treatment through enhanced reductive dechlorination
- Engineering controls to control vapor intrusion risk in areas with shallow contamination and to prevent exposure to shallow soils
- Institutional controls to prohibit residential use in areas with shallow soil contamination and to address groundwater use in areas for which controls are needed
- Monitoring

2. SITE HISTORY AND DESCRIPTION

2.1 SITE LOCATION AND LANDUSE

The Evanite site is located on 25 acres at 1115 SE Crystal Lake Drive in Corvallis, Oregon, Township 12 South, Range 5 West, Section 2, Benton County (Figure 1). The site latitude is [44°33’13”N], longitude is [123°15’38.5”W]. The site is used for industrial purposes; surrounding uses are residential to the south, commercial to the west, recreational facilities and the Marys River to the north and the Willamette River to the east. Residential areas are across the street from the Site’s property line to the south. The approximate ground elevation of the site is 220 feet above mean sea level.

The current Hollingsworth and Vose Fiber facility includes the Submicro Building (warehouse) the Glass Plant 1, Glass Plant 2 (also referred to as the Battery Separator Plant [BSP]), Hardboard Buildings, and the Technology and Engineering (T&E) Center (Figure 2), which contains as administrative offices. There are also several smaller structures that house maintenance and repair shops, paved parking and storage areas, raw water storage (intake pond) and the millrace culvert (which conveys off-site surface water from upstream through the facility to the Marys River) (Figures 2 and 3). A security fence encloses the site along the south and west perimeters. The Willamette River flows along the northeast perimeter. Most of the site is about 20 feet above river level. Most of the land on the site is fairly flat but the river bank has a steep slope.

2.2 PHYSICAL SETTING

2.2.1 Climate

Corvallis receives approximately 43 inches of precipitation annually. The majority of the precipitation falls between November and March, with monthly totals ranging from 0.47 inches in July to 7.7 inches in December. The average annual temperature is approximately 53°F.

2.2.2 Geology

An understanding of the subsurface geology at the Evanite site was developed from a review of previous reports, State of Oregon well logs, logs of exploratory soil borings and monitoring wells for the site, and drilling performed in 2002. Surficial geologic deposits beneath the site consist of the Older Alluvium mapped by Frank (1974), which is separated into three units. From the ground surface down, these consist of the Willamette Silt, Linn Gravel and Calapooia (Blue) Clay. At the ground surface to depths of about 20 feet, silt and clay (Willamette Silt, Allison, 1953) form a semi-confining layer. These overlie about 20 feet of sandy gravel and silty (cemented) sandy gravel (Linn Gravel, Allison, 1953). This gravel is the only recognized aquifer in the area. At depths between 30 and 45 feet below land surface, the Linn Gravel sits unconformably on uniform clayey silt to clay deposit (Calapooia Clay). This aquitard is found throughout the valley as the lower unit in the Older Alluvium (CH2M HILL, 1987) and is reported to be up to 100 feet thick in the Willamette Valley. The basal contact of the Calapooia Clay with the underlying Tertiary marine strata is inferred to be an unconformity.

2.2.3 Hydrogeology

The Linn Gravel aquifer ranges between 10 and 25 feet thick under most of the site. The thickest portions underlie the central part of the site, near Submicro/Glass Plant #2. The aquifer thins to the north between MW-2 and MW-6; this appears to be caused by a depression in the top of the coarser-grained sediments that was filled in with finer grained silty sand and sandy silt. Along the northeast site perimeter which borders the Willamette River, the aquifer is fully truncated by erosion of the Willamette River, and most likely to the north by the Marys River. Residual islands of aquifer material (cemented gravels) can be found in the middle of the river just off the bank between MW-6 and MW-15.

The basal unit of the aquifer, just above the aquitard, is predominantly clean sand or gravel in the central part of the site. The basal aquifer becomes clayey and silty in the northeast, east, and south parts of site. The top of the Calapooia Clay aquitard represents a geologic surface that likely resulted from the scouring by fluvial action associated with deposition of the Linn Gravel.

2.2.4 Surface Water and Stormwater Features

The Evanite site lies near the south bank of the Marys River near its confluence with the Willamette River. About one mile west of the site, the Marys River curls to the south, essentially surrounding the site and neighboring community on three sides. During heavy runoff periods, a millrace ditch brings water from the upper Marys River onto and across the plant site.

The Willamette River is the major drainage of the Willamette Valley. The Willamette River basin above Corvallis has a drainage area of 4,400 square miles. Data from the U.S. Geological Survey stream gauge at Albany has measured the average discharge at 15,000 cubic feet per second (cfs), but ranges from about 5,500 cfs in July and August to as high as 32,000 cfs in the winter, from November to March.

The Marys River has a drainage area of 300 square miles. Stream flow data from the U.S. Geological Survey gauge at Philomath averages 460 cfs, with peak flows of 1,000 to 1,200 cfs in December through February and low flows of 19 to 34 cfs from July through September.

The morphology of surface water features (e.g., meandering outside erosional bend) and depth of the stream bed can directly influence the interaction between groundwater and surface water and whether the dynamics of streamflow promote sedimentation.

The Willamette River near the facility flows from southeast to the north, with the outer part of a meander forming the northeast side of the Evanite property. Along this stretch, the river erodes and forms a steep bank (i.e., southwest bank of the river) from a terrace elevation of between 210 and 220 feet above msl. Due to the erosional nature of the river along the Evanite bank of the Willamette River, little if any sedimentation occurs. In fact, only a small section of river bank (northeast of MW-6) at the confluence of the Marys River provides the physical environment for sedimentation. River sediments at this point appear to be thinly wedged against riverbank outcrops of Willamette Silt and aquifer gravels.

Streambed elevations of the Willamette River, measured by the Oregon State Highway Division (OSHD, 1988) during construction of the Highway 34 overpass, are close to 180 feet msl just north of the site.

From visual observation during low river stage, the river bottom just offshore consists of cemented gravels, which are most likely un-eroded Linn Gravel. The Marys River likely contributes to the erosion of the streambed near the site where it flows into the Willamette along the north side of the property.

The millrace cuts roughly a north-south trace across the property. Streambed elevations along a profile begin at 205 feet msl just south of the railroad tracks, and fall to approximately 200 feet msl at its mouth at the Marys River. Construction plans for the millrace culvert installed in 1985 show an invert elevation of 202 feet msl where it rejoins the millrace on the north (downstream) side of Crystal Lake Drive.

2.3 PLANT OPERATIONS

The Evanite site is an active industrial facility that manufactures glass fiber. Battery separator material and hardboard were historically manufactured at the site. Glass fiber battery separator material was manufactured until 1992 in what is now Glass Plant 2. Between 1975 and 1996, Evanite manufactured polyethylene-silica separator material in the Submicro Building. Production of the polyethylene-silica separator material required the use of TCE to extract oil from the separator and create a micro-porous matrix. The Submicro operation was sold in 1996 and the equipment removed from the building. Hardboard operations terminated at the facility in fall 2003. The Submicro building is used as a warehouse and for storage. The Hardboard building was also used for this purpose until it was demolished in 2014. The site has been variable know as Evans Products Company, Evanite, Evanite Battery Separator, Evanite Hardboard, Evanite Glass Fiber, and Hollingsworth and Vose Fiber over the last ~30 years. Hollingsworth and Vose purchased Evanite in the mid 1990s, but the site was known as Evanite until late 2012.

2.3.1 Physical Plant

The current Hollingsworth and Vose Fiber facility includes the Submicro Building (warehouse), the Glass Plant 1 (off figures in this document to the Southeast), Glass Plant 2 (also referred to as the Battery Separator Plant), Hardboard Building, and the Technology and Engineering (T&E) Center, which houses administrative office (see Figure 2). There are also several smaller structures that house maintenance and repair shops, paved parking and storage areas, raw water storage (intake pond) and the millrace culvert (which conveys off-site surface water from upstream through the facility to the Marys River) (Figures 2 and 3). A security fence encloses the site along the south and west perimeters. The Willamette River flows along the northeast perimeter.

2.3.2 Chemical Use and Waste Generation and Management

During operations at the Submicro Building (1975-1996), virgin TCE, miscella (oil and TCE), and recovered TCE were stored in separate 10,000-gallon, above ground storage tanks located outside the operations area. These tanks were set within a concrete secondary containment structure. TCE was loaded from trucks and pumped into the tanks. Review of old invoices suggests between 14,000 and 20,000 gallons were purchased during each year of operations. Other chemicals used on site include past use of formaldehyde resins for hardboard manufacture, petroleum products, use of small amounts of other chemicals such as ammonium hydroxide. Currently, relatively few chemicals are used on site.

3. RESULTS OF INVESTIGATIONS

3.1 NATURE AND EXTENT OF CONTAMINATION

In 1978, Evanite estimated that 1,400 gallons of TCE had leaked from the treatment system carbon vessels onto an unpaved surface along the east side of the Submicro Building. In addition, Evanite discovered an annular opening in the wall of the Submicro wastewater sump in 1985 that likely resulted in a TCE release of unknown quantity. TCE was subsequently discovered in subsurface soil in August 1985 when a deep trench for the new millrace culvert was excavated just east of the Submicro Building. In mid-1986, TCE was also detected in groundwater samples collected from domestic irrigation wells located along the north side of Vera Avenue.

Evanite was advised to submit a RCRA Part B post-closure permit application to close the site of the 1978 TCE spill as a landfill and implement a corrective action program to remove TCE from soil and groundwater. The final permit application was submitted on June 9, 1988 and Evanite received a joint DEQ/EPA permit effective April 30, 1990.

The Evanite Facility then engaged in a continuous remedial action with EPA and DEQ approval starting April 30, 1990. In 2001, under an agreement between Evanite, DEQ, and EPA, DEQ's cleanup program took over the lead role in supervising the remediation of the Site and Evanite entered into a consent order with DEQ.

3.1.1 Groundwater

Site contaminant conditions prior to startup of remediation in 1991 are illustrated by the groundwater plume depicted in Figure 4. TCE was present at near saturation concentrations in the source zone with greater than 100,000 micrograms per liter (μg/L) of TCE plume covering approximately ten acres. The original 100-μg/L TCE plume contour outline extended over approximately 25 acres.

TCE concentrations in groundwater above 100 μg/L now cover only 4.5 acres (Figure 5; Table 1). This is the result of 23 years of continuous groundwater extraction and treatment, soil vapor extraction (SVE) in the near-surface Willamette Silt, and more recently, deeper SVE in the dewatered sections of the upper aquifer.

From the standpoint of applicable receptors, the site has been divided into five areas (Figure 6). The upgradient and Neighborhood Surface Water area plumes have been almost fully remediated. The size of the groundwater plume has been limited as a result of ongoing groundwater pumping and treatment. Eventually remediation is expected to progress to the point where groundwater containment is no longer needed. Additional groundwater and surface water monitoring will be required to evaluate the effects of reducing this hydraulic containment.

3.1.2 Soil

Soil contamination is present in the area of the site known as the DNAPL Source Zone. (DNAPL, or dense non-aqueous phase liquid, refers to a layer of a liquid chemical that settles along the bottom of an aquifer because it is heavier than water and has a low potential for dissolving in water.) As shown in Figure 6, the DNAPL Source Zone extends beneath portions of the Submicro building and Glass Plant 2. Outside of this area, some TCE contamination may have migrated as mobile DNAPL at the base of the aquifer, but significant soil contamination has never been detected. In the area of soil contamination, shallow soils are very low conductivity silts, and recent investigation suggests that areas of high concentrations may remain and concentration may be very heterogeneous. This soil is currently covered by the Submicro building and the cap put in place during the early stages of cleanup (This is referred to in past documents as the "RCRA Cap"). These caps have prevented direct contact with contaminated soil. Soil contamination is summarized in Table 2.

3.1.3 Sediment and surface water

Investigations into sediment contamination have not shown TCE in solid sediment samples in the Marys or Willamette Rivers. However, pore water investigations, initiated in 2010 and conducted annually since then, have shown some TCE and associated chemicals in pore water within sediments in the discharge area of the site (Table 3). Surface water sampling has shown that TCE is not present in surface water.

3.1.4 Air

TCE vapors are present on site as a result of off-gassing from contaminated soils, as well as emissions from the treatment systems. Most recent sampling shows TCE in air throughout the site. However, these concentrations are below residential screening levels at the property boundary. Within the site, concentrations are below occupational screening levels in all areas except inside the submicro building. TCE concentrations inside the submicro building are somewhat higher (see Table 4).

3.2 RISK ASSESSEMENT

The standards for a protective cleanup are defined in the Oregon Revised Statute (ORS) and Oregon Administrative Rule (OAR). ORS 465.315 states in part:

> ***Standards for degree of cleanup required; Hazard Index; risk protocol; hot spots of contamination; exemption.*** *…*

(A) The acceptable risk level for exposures. For protection of humans, the acceptable risk level for exposure to individual carcinogens shall be a lifetime excess cancer risk of one per one million people exposed, and the acceptable risk level for exposure to non-carcinogens shall be the exposure that results in a Hazard Index number equal to or less than one. "Hazard Index number" means a number equal to the sum of the non-carcinogenic risks (hazard quotient) attributable to systemic toxicants with similar toxic endpoints. For protection of ecological receptors, if a release of hazardous substances causes or is reasonably likely to cause significant adverse impacts to the health or viability of a species listed as threatened or endangered pursuant to 16 U.S.C. 1531 et seq. or ORS 496.172, or a population of plants or animals in the locality of the facility, the acceptable risk level shall be the point before such significant adverse impacts occur.

Additional details are also provided in ORS 465-315 and OAR 340-122-0084.

The results of the risk assessment for human health and potential ecological receptors at the Evanite site are summarized below. More detail is available in the Human Health Risk Assessment, Technical Assessment Services, 2005; Scoping Level Ecological Risk Assessment Report; McKenna Environmental, 2002; Screening Level Ecological Risk Assessment Report; McKenna Environmental, 2002; and additional Risk Summary tables prepared by DEQ (Tables 5 and 6). Expected residual risk for the recommended remedial action alternative is summarized in Section 7.2 of this document.

3.2.1 Conceptual Site Model

The conceptual site model (CSM) presented in the focused feasibility study (FFS; Kennec 2007) has been significantly modified since 2007 and is updated in the FFS Addendum (PNG 2015). Source depletion was accelerated by focusing groundwater extraction to the DNAPL source zone near the Submicro building to increase the thickness of the unsaturated zone and allow more effective application of SVE to dewatered portions of the aquifer zone. A Catalytic Oxidizer (CatOx) was purchased to treat off-gas, and several physical pilot tests were implemented between 2009 and present. It is important to note that much of the site, including the neighborhood to the south where the TCE plume was present as a dissolved phase, has been remediated to acceptable levels and no rebound in TCE concentrations has been observed.

Site geology and hydrogeology remain unchanged in the conceptual model; new wells in the source zone supplement our understanding of heterogeneity in the upper silts and underlying aquifer. Whereas the deeper portions of the plume had been flushed through extraction from wells DMW-3, DMW-16, and DMW-17 for many years with concentrations decreased by two to three orders of magnitude, data from more recently installed wells (MW-23, 24 and 25) located between them indicated little if any remediation had occurred. The flushing provided by pump and treat had only minimal influence at lateral distances of 50 feet and vertical distances of five feet from the extraction wells.

3.2.2 Exposure Areas and Pathway Analysis

The five exposure areas (or receptor zone areas) at Evanite with current water quality data are presented in Figure 6. Pore water and surface water data are shown on Figure 7. The boundaries between these areas were selected based on the source of the TCE contamination (e.g., DNAPL vs. dissolved phase plume) and current setting (e.g., residential vs. occupational).

The Neighborhood Area south of the Evanite facility is currently characterized with monitoring wells. Exposure to subsurface contaminants is possible in this area through volatilization to both indoor and outdoor air. Residents in this area have not been using well water for drinking or other domestic uses since 1986, because Evanite agreed to pay for their use of water supplied by the city. However, future domestic use of well water is possible, and is therefore retained as a pathway in the risk assessment.

The Upgradient Area is characterized by six wells (see Figure 6) along a south-to-north arc, as shown in Figure 6. These wells are located on the Evanite upgradient boundary (i.e., upgradient of the DNAPL source zone). This area represents a boundary of the Evanite groundwater plume and is not significantly contaminated. Very low concentrations of TCE in this area may be from upgradient sources.

The Source Zone Area is represented by the four original DNAPL extraction wells and seventeen wells (see Figure 6) added in recent years to support pilot tests performed to evaluate a long-term remedy. Potentially complete exposure pathways include vapor intrusion to indoor air and outdoor air in an occupational setting; potential future vapor intrusion to indoor and outdoor settings for residents and urban residents; groundwater encountered by construction and excavation workers. Indoor and outdoor air which may be contaminated through vapor intrusion and/or through fugitive emissions from the various treatment systems are also potentially complete pathways in this area. Contaminated soil is also present beneath the Submicro building and the area between the Submicro building and the Glass Plant. Potential future risk assessment includes contact with these soils.

The Hardboard Area is located north and east of the Source Zone Area and is distinct from the source zone because current data suggests there is no DNAPL in this area. Exposure pathways in this zone are vapor intrusion from groundwater to indoor air and outdoor air in an occupational setting. Future groundwater use is possible, and was therefore retained in the risk assessment.

The Downgradient Area includes the large grass-covered area north of site buildings and extends to the banks of the Marys and Willamette Rivers. This is the groundwater discharge zone where the groundwater plume historically discharged and mixed with the significantly larger volumes of surface water. Wells DMW-4, MW-6, MW-13, MW-15, and the downgradient pore water sampling locations characterize this area. The Downgradient Area is the only area with likely and applicable ecological exposure pathways. DEQ’s current ecological guidance was used to define the contaminant screening levels for this area. Future building in this area is relatively unlikely due to the steep bank and proximity to the river. Therefore groundwater use is also unlikely.

3.2.3 Human Health Risk Screening

Initially the contaminant concentrations for each environmental medium were compared with conservative risk-based screening level values to determine which contaminants posed potential risk to human health. If detected concentrations of chemicals in a particular medium did not exceed the screening levels, then that chemical was eliminated as a chemical of potential concern and was not evaluated further for that medium. Concentrations and pathways that exceeded the screening levels were carried through for detailed evaluation in the baseline risk assessment.

A brief summary of the results for each environmental medium is provided below:

- **Air –** Ambient air samples have been collected six times between 2005 and 2013. Outdoor air samples have sometimes exceeded occupational RBCs for TCE. The most recent sampling shows that TCE does not currently pose unacceptable risk to occupational receptors anywhere outdoors at the site. Samples closer to residential areas indicate that contamination from Evanite does not pose unacceptable risk to residents. Air in the treatment shed exceeds occupational RBCs for TCE and vinyl chloride (VC). Samples collected inside the Submicro building exceed occupational RBCs for TCE and exceed residential limits for VC. Indoor air samples from other buildings do not exceed RBCs. TCE and VC in the Submicro building, the treatment shed, and outdoors were retained for further evaluation in the risk assessment.

- **Sediment –** No sediment contamination has been detected at the site and sediment is not retained for risk evaluation.

- **Soil –** Soil in the DNAPL source zone is contaminated with high levels of TCE. This TCE is retained in risk screening as it may cause risks to future site users who come into contact with shallow soils, may cause vapor intrusion to overlying structures, and may continue to leach into groundwater.

- **Surface Water –** Aquatic receptors would potentially be at risk if the source zone were not contained. Therefore, screening levels for surface water and pore water in the discharge zone are cleanup targets for the downgradient area.

- **Groundwater –** TCE is present at high concentrations in groundwater in the source zone. Risks are currently managed, but risks to potential future receptors are evaluated. Baseline risk assessment includes risk to future users of groundwater from TCE and VC, vapor intrusion risks for future residents and workers from TCE, volatilization to outdoor air risks for future residents and workers from TCE, and risks to trench workers from TCE.

The chemicals and media that were screened in and evaluated in detail are presented in Table 5 from the 2005 Risk Assessment. An updated summary of risks using current and recent data and broken down by exposure unit is provided in Table 6. The remaining media and chemicals did not exceed acceptable risk levels for humans and were not evaluated further in the human health risk assessment.

3.2.4 Human Health Risk Assessment

The risk assessment report (TAS and Tuppan, 2005) describes in detail the procedures used to evaluate the potential risks associated with the chemicals and media retained for evaluation following the screening step.

Chemicals of Potential Concern.

Chemicals of potential concern for the site include TCE and decay products of TCE (VC, cis 1-, 2-dichloroethylene (DCE), Trans 1-, 2-DCE, and 1, 1 DCE). The site has been extensively investigated and no other contaminants have been found aside from some minor petroleum impacts which are being dealt with separately under LUST rules.

Pathway Analysis.

Pathways relevant to the Human Health Risk Assessment vary according to the different Exposure areas. This is presented in Tables 6a, 6b, and 6c, with some explanation below. The tables present risk from TCE (6a) and its decay products cis 1-, 2-DCE (6b), and VC (6c).

In the Source Zone current risk screening is limited to occupational workers, while potential future risk is assessed for residents, urban residents (urban residential assumes rentals with shorter exposure duration such as apartments), Direct contact to soil, vapor intrusion to buildings from soil, and volatilization to outdoor air are all relevant pathways for these receptors. Direct contact to soil pathways are also relevant for potential future construction and excavation workers. For groundwater in the source zone, tap water use, volatilization to outdoor air, and vapor intrusion to buildings are all potentially applicable pathways for occupational workers and potential future residents. Exposure to groundwater in excavations is also a potentially complete pathway for excavation workers. Air in the current buildings is an applicable pathway for occupational workers, and outdoor air is a complete pathway for potential future residents.

In the Hardboard Area there is no known soil contamination. Risk screening is limited to groundwater and air pathways. For groundwater, tap water use, volatilization to outdoor air, and vapor intrusion to buildings are all potentially applicable pathways for occupational workers and potential future residents and urban residents. Exposure to groundwater in excavations is also a potentially applicable pathway for excavation workers. For air, current outdoor air is a complete exposure pathway for occupational receptors, and potential future residents. In the downgradient area there is no known soil contamination. Risk screening is limited to groundwater and air pathways. For groundwater, tap water use is unlikely this close to the riverfront, but volatilization to outdoor air, and vapor intrusion to buildings are all potentially applicable pathways for occupational workers and potential future residents and urban residents. For air, current outdoor air is a complete exposure pathway for occupational receptors, and potential future residents. Discharge to the Willamette River, and subsequent consumption of organisms that have been exposed to TCE in surface water is also a complete pathway.

In the neighborhood area residential tap water use, volatilization to outdoor air, and vapor intrusion to buildings are complete exposure pathways. Exposure to contaminated air from the site is also a complete exposure pathway.

3.2.5 Ecological Risk Assessment

The ecological risk assessment was completed in accordance with Oregon Department of Environmental Quality, Guidance for Ecological Risk Assessment. A Scoping Level Ecological Risk Assessment was submitted by McKenna Environmental on February 19, 2002 and a Screening Level Ecological Risk Assessment was submitted by McKenna Environmental on December 23, 2002. Since 2010, regular monitoring has included an evaluation of contaminants in pore water based on a comparison to ORNL Tier II screening levels for freshwater benthic invertebrates. Surface water from the Willamette River is also monitored and compared to Ambient Water Quality Criteria for surface water bodies in Oregon and this data is used as a screening level for contaminants reaching the Willamette River.

Chemicals of Potential Concern.

Chemicals of potential concern for ecological receptors are TCE and decay products VC, cis 1-,2-DCE, trans 1-,2-DCE, and 1,1 DCE.

Pathway Analysis.

Contaminated groundwater could discharge to the Willamette River in the absence of the hydraulic containment resulting from ongoing groundwater pumping and treatment in the source zone. If this were to happen there is potential for ecological exposure to chemicals in pore water. To determine if there is risk under current conditions, an annual sampling program of pore water in the discharge zone between groundwater and the Willamette and Marys Rivers was set up in 2010. Since then, TCE has been found one time in one sample above screening levels. Furthermore, contaminant concentrations in monitoring wells in the Downgradient Area have generally been below ecological screening levels. Based on this data, we conclude that risk to ecological receptors does not exceed acceptable levels under current conditions. Ecological risk in pore water discharging to surface water and in surface water itself is a potential future risk and will be considered in remedial planning.

Contaminated soil is unlikely to be a conduit for ecological risk because contaminated soil is limited to the industrial part of the site, which is covered by buildings and parking lots.

3.3 BENEFICIAL USE AND HOT SPOT DETERMINATION

The criteria used to evaluate remedial alternatives for groundwater and surface water depend on whether a “hot spot” is present or not, as determined by a loss of “current or reasonably likely future” beneficial use of the water resource.

OAR 3401-122-115(9) defines beneficial uses of water as:

> any current or reasonably likely future beneficial use of groundwater or surface water by humans or ecological receptors.

OAR 340-122-115(32) defines hot spot of contamination as:

> (a) For groundwater or surface water, hazardous substances having a significant adverse effect on beneficial uses of water or waters to which the hazardous substances would be reasonably likely to migrate

and for which treatment is reasonably likely to restore or protect such beneficial uses within a reasonable time, as determined in the feasibility study; and

(b) For media other than groundwater or surface water, (e.g., contaminated soil, debris, sediments, and sludges; drummed wastes; "pools" of dense, non-aqueous phase liquids submerged beneath groundwater or in fractured bedrock; and non-aqueous phase liquids floating on groundwater), if hazardous substances present a risk to human health or the environment exceeding the acceptable risk level, the extent to which the hazardous substances:

(A) Are present in concentrations exceeding risk-based concentrations corresponding to:

(i) 100 times the acceptable risk level for human exposure to each individual carcinogen;

(ii) 10 times the acceptable risk level for human exposure to each individual non-carcinogen; or

(iii) 10 times the acceptable risk level for exposure of individual ecological receptors or populations of ecological receptors to each individual hazardous substance.

(B) Are reasonably likely to migrate to such an extent that the conditions specified in subsection (a) or paragraphs (b)(A) or (b)(C) would be created; or

(C) Are not reliably containable, as determined in the feasibility study.

3.3.1 Groundwater Beneficial Use Determination

A beneficial use determination for groundwater and surface was completed in the Feasibility Study. Beneficial uses were evaluated for each water-bearing zone considering current use and the following factors listed in OAR 340-122-080(3)(f)(F):

- Historical land and water uses
- Anticipated future land and water uses
- Concerns of community and nearby property owners
- Regional and local development patterns
- Regional and local population projections
- Availability of alternate water sources

The Linn gravels form the primary aquifer in this part of Corvallis. Homes in the Neighborhood Area were using groundwater for domestic tap water prior to the discovery of the TCE contamination. At that time, Evanite connected these homes to city water, and has been paying these residents' water bills since then. Use of water from this aquifer is reasonably likely in the future. Use of groundwater from the underlying aquifers in not likely due to the presence of a thick clay layer and the typical well-drilling in the area with wells placed at the base of the Linn Gravels (see discussion in original FFS).

3.3.2 Surface Water Beneficial Use Determination

Beneficial uses for surface water in the Willamette River Basin are identified in OAR 340-41-0340. The Main Stem Willamette River above Salem is used for domestic public water supplies, irrigation, industrial uses, fishing, recreation and habitat for several threatened or endangered species. Therefore, surface waters must be protected to the most stringent water quality requirements.

3.3.3 Hot Spots

The Oregon cleanup rules require identification of "hot spots" during the remedial investigation and feasibility study. Hot spots are areas where, during the feasibility study, greater preference is given to treatment as the cleanup alternative. Hot spots are evaluated differently for each media and hence described separately in the following sections consistent with DEQ guidance (DEQ 1998). The following discussion identifies hot spots based on the current CSM.

3.3.3.1 Soil and DNAPL

For soil and DNAPL, hot spots are defined as locations where there is an unacceptable baseline risk and the contamination is highly concentrated, highly mobile, or not reliably contained.

Highly Concentrated

This assessment is typically performed by comparing the concentration of individual site contaminants to values in the DEQ's hot spot look-up tables for soil concentrations for human exposures (DEQ 2005). The highly concentrated hot spot criterion for these uses is exceeded in the DNAPL Source Zone (DNAPL Source Zone on Figure 6) where TCE was historically released in the former process area, and pockets of residual saturation remain. This area covers approximately 52,000 square feet. The unsaturated zone extends to a depth of approximately 25 feet as a result of drawdown associated with hydraulic containment and source depletion efforts.

Where DNAPL pools were formerly present on the aquitard in the source zone, high concentrations of TCE are found because the chemical is tightly sorbed into this clay aquitard. The upper two feet of clay is considered a hot spot for intermittent areas of the Source Zone.

In addition, based on SVE results in the Submicro Building during the pilot testing and ongoing SVE efforts, TCE remaining in shallow soil appears to be highly concentrated.

Highly Mobile

Assessment of mobility considers infiltration or leaching through subsurface soils into groundwater, stormwater runoff into surface water, and wind-blown deposition on surface soil, water, foliage, and structures. The area with the highest soil concentrations (referred to as the RCRA landfill) was capped per RCRA closure requirements in the late 1980s and therefore erosion of contaminated soil by stormwater runoff and/or wind-blown erosion and deposition are unlikely.

Mobile DNAPL originally characterized as pools on the lower aquitard and as residual NAPL in soil has been substantially removed through groundwater extraction and SVE. Monitoring wells installed in the source zone and downgradient of the source zone in 2009 through 2014 did not encounter mobile TCE in DNAPL form. Any separate phase TCE blebs encountered during the subsurface explorations were tightly bound in the matrix of the fine grained Willamette Silt soils. However, in the absence of continued groundwater containment, DNAPL dissolution would likely leach considerably into groundwater and thus be highly mobile.

Not Reliably Contained

The residual DNAPL in soil is tightly bound in the matrix of the silts and upper aquifer. Current effort to dewater the aquifer and apply SVE in these zones is successfully depleting this source of TCE mass. The remaining residual NAPL is tightly bound in the soil matrix and is considered reliably contained.

3.3.3.2 Groundwater and DNAPL

DNAPLs are by definition present in high concentrations, and because they are typically in contact with groundwater, pose a highly mobile condition where long-term dissolution may continue to contaminate the groundwater at concentrations approaching the saturation point. The primary exposure pathways for DNAPL are unsaturated soil where it volatilizes to indoor or outdoor air; and saturated soil where it dissolves in groundwater and then can (1) volatilize to outdoor or indoor air (primarily on site), or (2) discharge to surface water. Where present in the aquifer, residual DNAPL is a hot-spot.

Groundwater beneath the Submicro Source Zone is in contact with residual DNAPL and represents a hot spot throughout the saturated thickness (Submicro Source Area in Figure 7). Based on recent source depletion efforts with combined groundwater and soil vapor extraction, the saturated thickness is assumed to be ten feet within this zone.

Due to the migration pathway of separate phase TCE migrating vertically downgradient to the clay aquitard before migrating laterally beneath the millrace and Glass Plant building, the groundwater hot spot in this 118,000 square feet area is limited in vertical extent (Glass Plant Plume Hot Spot in Figure 7). This pattern is consistent with plume migration from DNAPL pools on the aquitard surface at the Submicro source zone. The hot spot of a relatively thin layer of TCE-concentrated groundwater is overlain by uncontaminated groundwater that provides a barrier for potential vapor intrusion into the overlying Glass Plant building.

3.3.3.3 Soil Vapor

Soil vapor being recovered from the active source depletion efforts in the Submicro Source Zone contained average TCE concentrations as high as 10,300 milligrams per cubic meter ($\mu g/m^3$) at system startup in 2011. Current average TCE concentrations are in the range of 500 mg/m^3 as flow lines for the SVE well configuration have been flushed. As new SVE wells are added to the system, high startup concentrations are again anticipated as new soil media zones in the source area are targeted. It is assumed that the soil vapor hot-spot is 25 feet in thickness with a boundary illustrated as the Submicro Source Zone Hot Spot (Figure 7).

3.3.3.4 Surface Water

Surface water in the Willamette and Marys Rivers is sampled annually at low flow conditions. No volatile organic compounds (VOCs) have been detected in these samples. Given these results, surface water at the site does not contain hot spots.

3.4 ESTIMATE OF CONTAMINANT MASS AND CONTAMINATED MEDIA

This section describes the areas and volumes of site media that currently or potentially could represent unacceptable risk to human receptors via the vapor intrusion pathway or from migration to pore water and surface water. These areas therefore require continued remedial action.

3.4.1 On-Site Soil and Associated Soil Gas

In the unsaturated zone, VOCs are present in subsurface soil below the concrete cap, and in an area below the east part of the Submicro Building (i.e., Submicro Source Zone Hot Spot). TCE NAPL is found on an intermittent basis in the Willamette Silts and upper sections of the dewatered Linn Gravel Aquifer in the area of the Submicro Source Zone (Figure 7). High concentrations of TCE in soil gas coincide with the affected soil beneath this same footprint. Areas and volumes are as follows:

- The footprint of the affected area is approximately 52,280 square feet and is bounded by the millrace on the east, center of the Submicro Building on the west, and the building's north and south walls.
- Based on the dewatered conditions associated with the source depletion efforts using SVE, the thickness of the near surface soil-soil gas area is estimated at 25 feet resulting in approximately 48,400 cubic yards of soil (77,400 tons). It is important to note that much of this soil is not affected by TCE. This is because, as the spilled TCE migrated down to the aquitard, it likely followed preferential pathways and therefore is not distributed uniformly.
- The top of the underlying clay aquitard is also affected by TCE in areas where DNAPL pools historically collected. Again, the current distribution is highly variable. Some of this contamination has been flushed by focused groundwater extraction since 1991. Currently no mobile NAPL is observed or expected. It is estimated that residual DNAPL could extend to an average depth of two feet into the clay aquitard. Over the 52,280-square foot area, this would result in approximately 3,800 cubic yards of affected soil.

3.4.2 On-Site Groundwater

The area in which TCE concentrations in groundwater exceed acceptable risk levels is divided into two areas based on plume geometry. The Submicro Source Zone and Glass Plant Plume areas are shown on Figure 7. The groundwater beneath the affected soil area contains TCE throughout the water column because this is the release area where DNAPL migrated to the underlying aquitard. The contaminated groundwater plume area northeast or downgradient of this Submicro Source Zone is much more limited. As shown on Figure 7, the portion of the plume beneath the Glass Plant covers an area roughly equivalent to the building footprint. TCE at concentrations exceeding an applicable RBC in this groundwater plume area are limited to a relatively thin (i.e., few feet thick) wedge or zone immediately above the aquitard surface.

Areas and volumes are discussed below:

- The Submicro Source Zone Plume exceeds the RBC for vapor intrusion in an industrial setting and would be expected to cause exceedances of the applicable pore water standard in the Marys and Willamette Rivers if groundwater extraction associated with the current source depletion actions were ceased. The footprint of the affected area is approximately 52,280 square feet and is bounded by the millrace on the east, center of the Submicro Building on the west, and the buildings north and south walls.

- Assuming a plume thickness of ten feet under the current dewatered conditions and an average porosity of 30%, the Submicro source area plume volume is approximately 1.2 million gallons.
- The Glass Plant area plume contains TCE concentrations exceeding the applicable RBC for vapor intrusion along the southwest side of the building, but is attenuated to much lower concentrations on the northeast side. Vapor intrusion is not a concern in this plume area because the relatively thin wedge of contaminated water with TCE concentrations exceeding the applicable RBC is overlain by a thicker wedge or layer of clean water that acts as a barrier to vapor intrusion. As with the other plume area, the Glass Plant Plume would be expected to cause excessive contamination of pore water in the Marys and Willamette Rivers if groundwater extraction associated with the current source depletion actions were ceased. The footprint of the affected area is approximately 118,500 square feet.

- Assuming a plume thickness of five feet located at the base of the aquifer and an average porosity of 30%, the Glass Plant Plume volume is approximately 1.3 million gallons.

3.5 Off-Site Groundwater

Offsite groundwater has been remediated to acceptable concentrations to protect residents from residential vapor intrusion. TCE in the two monitoring wells on Vera Avenue (IMW-21 and IMW-22) is at concentrations below 1 μg/L and is below drinking water RBCs. Well IMW-20, located north of the neighborhood and nearest to Evanite, contained 18-32 μg/L TCE since 2012 as compared to the vapor intrusion RBC of 160 μg/L for a residential setting. Groundwater extraction at DMW-11, which was done in order to flush TCE from the groundwater beneath the neighborhood, was terminated in late 2010 and no rebound in TCE concentrations has been observed. Offsite groundwater is not a target for future remedial efforts. However, former domestic wells in the area have been taken out of use. If these wells were to be returned to service, it is not known whether contaminant concentrations would exceed drinking water RBCs.

3.5.1.1 Vapor Intrusion and Air

Outside of the Submicro Source Zone, vapor intrusion into buildings that overlie the TCE plume is of limited concern. As illustrated by comparing the original TCE plume footprint and concentrations (Figure 4) to current conditions (Figure 5), the majority of the plume footprint has been remediated to concentrations of less than the occupational RBC of 3,300 μg/L for vapor intrusion. More importantly, the area of concern for vapor intrusion is limited to where TCE is found in unsaturated zone soil or near the surface of the water table. This area is limited to the Submicro Source Zone Hot Spot (Figure 7) that includes the East half of the Submicro Building and outside area to the east that is bounded by the former open millrace.

No TCE has been found in soil beneath the Glass Plant Plume groundwater Hot Spot (Figure 7). Plume migration from the Submicro source to the Glass Plant Plume occurred at the base of the aquifer due to dissolution from the DNAPL pools on the aquitard. This deep plume is overlain by a lens of clean groundwater that has been characterized by up to 15 feet in thickness in several wells. The clean groundwater layer represents a barrier to volatilization from contaminated groundwater at depth and consequently vapor intrusion to overlying buildings is of limited concern. A second barrier to vapor intrusion is the relatively thick sequence of Willamette Silt with layers of plastic silts.

The Submicro Building is currently used for warehousing, and the amount of time that workers spend there is limited. If the building is converted to a full time occupancy, air will be a media that potentially requires attention. Cleanup goals are based on the assumption that eventually the building will be occupied 40 hours per week.

Most recent air data is presented on Figure 8 and Table 4.

Outside air within the Submicro Source Area Hot Spot was sampled in October 2013 after efforts to seal the remediation treatment system shed were performed. Outdoor air adjacent to the building was below the occupational RBC for TCE of 2.9 micrograms per cubic meter ($\mu g/m^3$) and air at the downwind property line was below the residential RBC of 0.44 $\mu g/m^3$.

Indoor air in Submicro has been sampled on eight occasions between 2005 and 2013. TCE concentrations in air have exceeded the occupational RBC of 2.9 $\mu g/m^3$ with concentrations ranging from 5.1 to 150 $\mu g/m^3$.

Recent efforts to minimize fugitive emission sources of TCE (i.e., other than vapor intrusion from contaminated subsurface environmental media) from the Submicro Building have included removal of historic equipment associated with the TCE use in battery separator manufacturing and further sealing of the Remediation Treatment System Shed. Currently, a sub-slab depressurization system has been constructed and is fully functional as an element of the mass depletion SVE technology.

All effluent air discharge from the SVE system and the groundwater air stripper is currently routed under a closed loop system to a CatOx for destruction. Discharge from the CatOx is routed through to the Glass Plant industrial process wet scrubbers for additional treatment prior to atmospheric discharge.

4. PILOT TESTS AND INTERIM REMEDIAL ACTIONS

4.1 Pumping

Groundwater extraction for hydraulic containment has been implemented from three to six wells since 1991 to maintain an aggressive capture zone that includes the Evanite property as well as surrounding neighborhoods. By the end of 2014, over 460 million gallons of contaminated groundwater had been extracted and treated through an air stripper tower. Currently, the extraction is focused on the heart of the DNAPL source zone. This creates inward radial flow from the dissolved phase plume edges. Over 82,000 pounds of dissolved phase TCE have been recovered to date from this groundwater extraction system.

Dissolved phase concentrations have steadily declined as the plume area has been flushed several times. Over the past few years, the average concentration of water entering the treatment system has ranged from 7 to 10 mg/L. This compares to influent concentrations of over 100 mg/L in 1991. Many of the wells in the dissolved phase edges of the original plume are now as low as a few micrograms per liter (μg/L) or even below detection limits. However, wells in the original DNAPL source zone and specifically the extraction wells do not provide a representative profile of aquifer conditions.

DNAPL source removal through SVE and DNAPL pumping has been ongoing since 1991. Over 47,000 pounds of TCE is estimated to have been removed through the SVE system which targets the former TCE process area where spills and TCE handling occurred. The recovery was excellent in the early years of operation (e.g., 12,600 pounds in 1991), and as new areas of the subsurface are opened up to the system there has generally been a period of high yield.

DNAPL pumping to recover the mobile phase TCE from three source zone wells has yielded an estimated 24,553 pounds of DNAPL since 1991. Yields exhibit a decreasing pattern with over 12,000 pounds recovered in 1991 and no direct DNAPL recovery since 2007.

4.2 Cap

Following issuance of the post-closure permit in 1990, an engineered cap was constructed between the Submico Building and Glass Plant 2, including the area above the millrace culvert.

4.3 Neighborhood water use

Following discovery of extensive groundwater contamination in the 1980s, six residences to the South of the Evanite Site that previously used groundwater were provided access to city water at

Evanite's expense. Evanite (and now Hollingsworth and Vose) have been paying water bills or these residents ever since that time.

4.4 Submicro Sub-Slab depressurization

Following ambient and sub-slab air evaluations of the Submicro building between 2006 and 2009, a sub-slab depressurization system was installed to draw contaminated air beneath the floor slab into the treatment system. This system has been operating continuously since that time.

4.5 Enhanced Reductive Dechlorination

An enhanced reductive dechlorination (ERD) pilot test was conducted over a 25 week period in 2013. The layout of the test involved a substrate source injected into well pair MW-27 (consisting of DMW-27 and IMW-27), circulated through well pairs MW-17 and MW-24, and extracted through well DMW-3. The groundwater was recirculated back to the injection wells where it was augmented and re-injected. This circulation cell provided hydraulic control and focused the ERD test to specific flow lines that originated in a relatively clean area on the upgradient end of the plume and circulated into the heart of the DNAPL source zone.

4.5.1 Objectives

The Evanite site presents unique issues for the application of ERD that required a rigorous monitoring program in support of the pilot test. Separate phase TCE (DNAPL) is rarely observed as site investigations to find DNAPL are generally impractical and ineffective. At Evanite, over 24,000 pounds of pure phase DNAPL were recovered from pools by three wells between 1991 and 2007 from the Submicro source zone. Subsequent drilling exploration efforts have not encountered mobile DNAPL, but field screening and other indicators such as a TCE concentration greater than 1% of TCE solubility in dissolved phase groundwater have provided a boundary for the DNAPL source zone. The DNAPL boundary extends east to west from the former millrace to the center of the Submicro Building and north to south beneath the footprint of the building.

The properties of residual DNAPL complicate remediation for several reasons. First, DNAPL distribution through the unsaturated zone and aquifer is highly heterogeneous. As DNAPL sinks, the TCE spreads on any lower permeability zones and forms small pools and binds to the geologic matrix. Once it reaches an aquitard and can form a mobile pool, flow is driven by topography rather than the groundwater flow direction. This was observed at Evanite with pool migration to the south in the upgradient direction.

A second factor involves the low solubility of TCE (approximately 1,100 mg/L in water). Reduction of TCE mass via dissolution into a groundwater plume migrating primarily through advection is again hindered by the DNAPL isolated in fine grained materials that do not readily yield groundwater.

A third factor with DNAPL involves the very slow rate of diffusion from the aquifer matrix as compared to diffusion into that matrix.

ITRC (1999) reports that native bacteria necessary for reductive dechlorination are present at approximately 75% of all sites. As mentioned earlier, these bacteria exist at the Evanite site based on ongoing dechlorination in plume areas downgradient of the DNAPL source zone. Based on minimal degradation chemicals within the source zone, it appeared the source area environment was not well suited for reductive dechlorination based on the high TCE concentrations associated with DNAPL in the source zone. During pilot test planning, it was unknown if sufficient bacteria existed in the source zone and if they did exist, whether or not they could thrive.

The primary objective of the pilot test was to determine if ERD is applicable for full-scale implementation as a polishing technology in this unique physical, chemical, and biologic setting.

4.5.2 ERD Results

ERD operations are discussed in detail in Appendix E of the 2013 annual report (PNG 2014) with focus sections on substrate injection, substrate delivery to the plume, reductive dechlorination, and rebound.

Well DMW-17, which received an almost immediate pulse of substrate with the aquifer, displayed a classic pattern of reductive dechlorination. TCE immediately began to decrease in early June, concurrent with a very large increase in breakdown chemical cis-1, 2-DCE. As this secondary product began to decrease in August, vinyl chloride increased. By July, TCE was undetected and the two breakdown chemicals began to decrease as the dissolved plume at this location was consumed (Figure 9). The next downgradient monitoring well location is MW-24 which also indicated a nearly immediate response of dechlorination. Intermediate well IMW-24 is very similar to DMW-17, in that there was a decrease in TCE followed by an increase in cis-1, 2-DCE and eventual increase in vinyl chloride. TCE reached a low of 4.21 μg/L in December 2013. Cis-1, 2-DCE started to decrease by September 2013 and vinyl chloride started to decrease in November 2013. Deep well DMW-24 results indicated a steady increasing trend in TCE with startup of the test. This may have been because this well was no longer used to pump groundwater, so there was less dilution of TCE by the inflow of upgradient groundwater. Evidence of dechlorination included an increase in cis-1, 2-DCE evident through October 2013. Vinyl chloride was not detected in this well.

The extraction well (DMW-3) did not show a decreasing trend in TCE concentrations, similar to DMW-24. This could be the result of rebound, as the pumping rate from this well was reduced from a pre-ERD rate of 12.5 to 4.1 gallons per minute (gpm). This location in the center of the DNAPL source zone likely contains relatively large quantities of residual DNAPL and eventual rebound of TCE concentrations from dissolution and diffusion is anticipated whenever pumping is reduced. Evidence of dechlorination in groundwater at DMW-3 included an increase in cis-1, 2-DCE starting in June 2013 and the detection of vinyl chloride in July. It is unknown if the dechlorination was occurring at this location, or if the TCE breakdown chemicals were being captured from groundwater flowing to the well from upgradient areas.

5. DESCRIPTION OF REMEDIAL ACTION OPTIONS

5.1 REMEDIAL ACTION OBJECTIVES

Acceptable risk levels, as defined in OAR 340-122-115(1) through (6), and remedial action objectives were developed based on the identified beneficial uses, exposure pathways and the risk assessment.

5.1.1 Acceptable Risk Levels

Acceptable risk levels for groundwater, surface water, soil and air to protect the identified beneficial uses and potential receptors correspond to DEQ's risk based concentrations for each pathway and receptor and are included in Table 6.

5.1.2 Remedial Action Objectives

Site-specific remedial action objectives (RAOs) were developed for groundwater, surface water, soil and air, for the purpose of achieving protection of human health, ecological receptors, and beneficial uses, as required by OAR 340-122-040. The RAOs for the site are as follows:

Short-Term Goals

For DNAPL source zone remediation, these typically involve the mitigation of immediate risks to humans or natural resources and the prevention of further expansion of the source zone. Often this goal is addressed through some form of mass removal or containment to minimize further mobilization of a DNAPL mass. Short-term goals for a source zone might include:

1 Recovering mobile DNAPL.

2 Mitigating the potential for vapor intrusion.

3 Preventing further migration of DNAPL.

Short term goal #1 has been met through the groundwater and direct DNAPL pumping since 1991. Goal #2 is only applicable for the source zone area and is currently controlled through SVE and sub-slab depressurization. Goal #3 appears to have been achieved, though continued operation of the existing remedial measures will be needed.

Intermediate-Term Goals

These goals target the achievement of desired cleanup levels at a response boundary or, depending on the performance assessment methodology, a series of control planes. It may take a year (or several) to make a determination that the target cleanup level has been achieved at a response boundary. Long-term monitoring is required to ascertain that the cleanup levels are sustainable and are not subject to a rebound in groundwater contaminant concentrations once post-treatment equilibrium is established in the aquifer. Intermediate goals include:

1 Depleting the source sufficiently to allow for natural attenuation.

2 Reducing dissolved-phase concentrations outside the source zone.

3 Reducing the mass discharge rate or flux from the source.

4 Reducing the DNAPL source mass or volume to the extent practicable.

5 Preventing the migration of remediation fluids beyond the treatment zone.

A critical goal for this site is limiting the mass discharge from the Submicro Source Zone such that TCE does not reach the rivers at unacceptable concentrations. The source depletion efforts applied over the past few years (primarily dewatering the aquifer at the source zone combined with aggressive SVE of the unsaturated zone) have proven efficient at reducing source zone concentrations.

Another critical goal for the site is the reduction of TCE concentrations in soil and shallow groundwater in the source zone to prevent unacceptable vapor intrusion into the overlying Submicro Building. The current SVE system has two components or targeted zones: a vapor mitigation SVE system in the sub-slab gravels beneath the Submicro building and a deeper SVE system utilizing wells screened in the unsaturated soils beneath and adjacent to the Submicro Building.

Long-Term Goals

As defined here, long-term goals target the achievement of compliance with RBCs applicable to all contaminated media at the site. For groundwater, achievement of regulatory criteria may lead to the discontinuation of the plume control measures and ultimately the monitoring program.

Hot Spots will be treated to the extent feasible, as specified in OAR 340-122-090(4). Hot Spots for several media are present in the DNAPL source zone as described above and on Figure 7.

5.2 REMEDIAL ACTION OPTIONS

General response actions and remedial technologies were screened in the Focused Feasibility Study (Tuppan, PNG, and RSV, 2007). The general response actions included groundwater containment, extraction, ex-situ treatment, in-situ treatment, soil treatment, excavation, disposal, and institutional and engineering controls. Several remedial technologies were evaluated for each general response action. Viable response actions and technologies that can meet the RAOs were assembled into remedial action options. The remedial alternatives proposed in the original feasibility study included the following (Kennec 2007):

5.2.1 Alternative 1: No Action

5.2.2 Alternative 2: Engineering and Institutional Controls, Subslab Soil Venting, and Groundwater/DNAPL Extraction

This alternative involves engineering and institutional controls, maintenance and inspection of the existing concrete cap, continued monitoring of wells and extraction of contaminated groundwater (and DNAPL where present), implementation of a subslab soil venting system beneath the Submicro building, and additional monitoring and optimization of the remedy.

5.2.3 Alternative 3: Engineering and Institutional Controls, In-Situ Chemical Oxidation, and Groundwater Extraction

This alternative involves engineering and institutional controls, relocation, demolition, and replacement of the Submicro Building and Glass Plant #2, installation of approximately 2,700 soil borings for injection of oxidizing agent into the source zone area, and continued groundwater extraction.

5.2.4 Alternative 4: Engineering and Institutional Controls, Electrical Resistance Heating and Groundwater/DNAPL Extraction

This alternative involves institutional controls, relocation, demolition, and replacement of the Submicro Building and Glass Plan #2, installation of approximately 1,500 electrodes for electrical resistance heating in the source zone area, and continued groundwater extraction.

5.2.5 Alternative 5: Soil Excavation and Off-Site Disposal

This alternative involves institutional controls, relocation, demolition, and replacement of the Submicro Building and Glass Plant #2, relocation of utilities around the excavation area, construction of a slurry wall around the excavation area, extraction, treatment, and disposal of approximately 16 million gallons of groundwater and 950,000 tons of soil from the source zone area.

5.3 Pilot Studies Phases

Following DEQ review of the original FFS and discussion with Evanite Representatives, Evanite proposed a sequence of pilot studies, interim remedial actions, and attention to data gaps (PNG, 2008). This included installation of sub-slab depressurization measures beneath the Submicro Building; constructing additional wells in the source zone for extracting contaminated groundwater and SVE; enhancing the monitoring scheme, including the pore water discharge zone; testing several technologies for the treatment of off-gas from groundwater and SVE, and ultimately implementing a catalytic oxidation system; testing enhanced anaerobic remediation (bioremediation) through a circulation cell in the source zone. These actions have taken place over several years and have generally been quite successful.

Following the successful completion of these pilot studies and other measures, an addendum to the original FFS was submitted to DEQ in late 2014, modified with input from DEQ, and resubmitted in February of 2015. The primary purpose of this document was to propose an amended version of remedial alternative 2, which was referred to as Alternative 2am.

5.3.1 Alternative 2am: Source Depletion with Soil Vapor/Groundwater/ DNAPL Extraction Followed by In-situ Bioremediation

In the 2007 FFS, potentially applicable technologies were screened prior to assembly into remedial action alternatives (including RA-2). This technology screening is summarized in Table 7 and has been updated to reflect the results of technology pilot testing completed at the site since 2007. Alternative 2am builds upon the basic remediation components of Alternative 2, but in addition, incorporates enhancements to achieve greater source depletion and treatment based upon results from pilot testing completed following the 2007 FFS.

RA-2a involves the following remedial action elements, shown graphically on Figure 10:

- Institutional controls and an Easement and Equitable Servitude (E&ES) preventing residential use of the tax lots with shallow soil contamination. These will include three tax lots that are underlain by the Submicro Source Area Hot Spot illustrated on Figure 10.
- Continued DNAPL monitoring and extraction, if accumulations are observed (recovery amounts of DNAPL have not been observed since 2007).
- Continued soil vapor extraction (SVE) in the DNAPL source zone to promote physical removal of TCE mass and mitigate potential vapor intrusion to the Submicro Building. (Currently SVE is being conducted using intermediate-depth wells in the DNAPL source zone.)
- Continued groundwater extraction to flush the DNAPL source zone, to expand the unsaturated zone within the source area to facilitate SVE mass removal, and maintain containment of impacted groundwater (Currently, groundwater is being extracted through wells DMW-2, 3, 23, 24, and 29).
- Treatment of off-gas from the SVE system and air stripper as necessary. Currently, contaminated air is treated using catalytic oxidation. However, carbon adsorption may be used in the future as physical mass removal rates decline. Eventually, mass of TCE from pumping will be low enough that treatment is not needed.
- ERD in-situ treatment of groundwater in the Glass Plant Plume and Submicro Source Areas.
- Continued monitoring of groundwater and air quality and remedial system performance.
- Follow active groundwater remediation (i.e., groundwater extraction and ERD) with conversion to passive groundwater remediation involving reduced mass flux from source area together with natural attenuation to protect surface water.
- In the event of a land use change (allowable by the current zoning) the footprint of ERD application and/or timeframe for remediation of the Glass Plant Plume may increase as

the applicable occupational RBC for TCE (currently 3,300 µg/L) could get reduced to the urban resident (380 µg/L) RBC or even residential (160 µg/L) RBC.

Multiple lines of evidence indicate anaerobic degradation and natural attenuation are active in the area downgradient of the source area, with TCE and TCE breakdown products at concentrations substantially below applicable screening levels (except for the screening level for groundwater consumption). Currently, all pore water and groundwater from near shore wells in the downgradient area are below the applicable pore water ecological screening value. In addition, surface water samples collected in the Willamette and Marys Rivers have been non-detect for TCE and other chemicals.

In areas outside of the Submicro Source Zone where aggressive mass depletion is unnecessary, ERD can be immediately implemented to address the TCE plume that is limited to the base of the aquifer. These areas can be converted to anaerobic conditions. It is expected that subsurface volatile contaminants will not reach the ground surface because of the barrier provided by overlying clean groundwater and the layer of uncontaminated plastic silts. However, monitoring will be conducted to verify that this assumption is correct.

In the source zone, simultaneous application of these two technologies can be problematic for two reasons. First, SVE effectiveness relies on creation of an expanded unsaturated zone while ERD is applied to saturated media. Second, ERD requires anaerobic conditions while SVE creates aerobic conditions.

To address this, the current plan is to dewater the aquifer to the extent possible in the source area by adding extraction wells and air stripper capacity to allow a greater groundwater extraction rate and expand the unsaturated zone, and then apply SVE for more aggressive mass depletion. This operation will promote aerobic conditions in the underlying aquifer, so pump and treat will remain in place during source depletion. Pumping also provides the protection of hydraulic containment in the source zone.

ERD will be applied to areas immediately surrounding the source zone at the same time. This will require careful placement of the ERD injection and extraction wells such that a saturated anaerobic zone is maintained outside of the influence of the dewatering and SVE. As the source zone shrinks, as gauged by the SVE recovery becoming less efficient at mass removal, SVE wells will be taken offline. The ERD will then be expanded towards the core of the source zone.

6. EVALUATION OF REMEDIAL ACTION OPTIONS

6.1 EVALUATION CRITERIA

The criteria used to evaluate the remedial action alternatives described in Section 5 are defined in OAR 340-122-090, and establish a two-step approach to evaluate and select a remedial action. The first step evaluates whether a remedial action is protective; if not, the alternative is unacceptable and the second step evaluation is not required. The remedial alternatives considered protective are evaluated and compared with each other using five balancing factors. These are 1) effectiveness in achieving protection, 2) long-term reliability, 3) implementability, 4) implementation risk, and 5) reasonableness of cost.

Where a hot spot has been identified, an evaluation of how each alternative achieves the specific requirements for treatment of hot spots is also included. The alternative that compares most favorably against these balancing factors, and complies with the hot spot criteria, is selected for implementation. A residual risk assessment is then conducted for the selected alternative to document that it is protective of human health and the environment.

6.2 PROTECTIVENESS

The protectiveness of a given remedial action is evaluated by comparing actual or estimated future contaminant concentrations to the risk based concentrations identified in Table 5. These concentrations correspond to acceptable risk levels. This evaluation considers the following site conditions:

- Contaminant concentrations in soil in the DNAPL source zone are highly variable and there are areas of high concentration, perhaps even with residual NAPL. It is therefore likely that risk based concentrations will be exceeded for several pathways, that may include leaching to groundwater and volatilization to indoor and outdoor air. Soil contaminant concentrations meet hot spot criteria for several pathways in the Source Zone. However, soil is generally not contaminated outside of the source zone.

- Contaminant concentrations in groundwater in much of the site exceeds tap water standards.

- Contaminant concentrations in groundwater in the source zone exceed standards for volatilization to outdoor air, vapor intrusion to buildings, and groundwater in excavations.

- Contaminant concentrations in the Hardboard area and the Downgradient area exceed some ecological and surface water standards.

- TCE in the Hardboard area exceeds screening levels for residential vapor intrusion to buildings and groundwater in excavations.

- Air in the Submicro building exceeds occupational air standards.

- Air in other parts of the site has, at times, exceeded standards for residential and occupational exposure.

OAR 340-122-090 states that protectiveness may be achieved by any of the following methods:

- Treatment
- Excavation and off-site disposal
- Engineering controls
- Institutional controls
- Any other method of protection
- A combination of the above

With the exception of hot spots, there is no preference for any one of the above methods for achieving protectiveness. Where a hot spot has been identified, OAR 340-122-090(4) establishes a preference for treatment to the extent feasible, including a higher threshold for evaluating the reasonableness of costs for treatment.

6.2.1 Alternative 1 - No Action

Alternative 1 would not involve any action to reduce potential human or environmental exposure. Therefore, Alternative 1 is not protective and will not be evaluated further.

6.2.2 Alternative 2 – Engineering and Institutional Controls, Subslab Soil Venting, and Groundwater DNAPL Extraction

Alternative 2 would provide containment of contaminated media and would prevent human and ecological exposure to contaminated soil and groundwater. However, this alternative, as described in the 2007 feasibility study, did not include treatment of off-gas air or address hot spots. Therefore, this version of Alternative 2 is not protective.

6.2.3 Alternative 2 Amended – Engineering and Institutional Controls, Subslab Soil Venting, and Groundwater DNAPL Extraction

Alternative 2 amended (2am) includes the measures listed above, with the addition of aggressive SVE, ERD, and treatment of off-gas from remediation. In addition to controlling current risk, this alternative works to treat hot spots and addresses site air issues. Therefore, alternative 2am is protective and was retained for further consideration.

6.2.4 Alternative 3 – Institutional Controls, In-Situ Chemical Oxidation, and Groundwater Extraction

Alternative 3 would involve continued groundwater pumping and controls while the source zone is chemically treated to oxidize and destroy these organic contaminants. This remedy would be protective and was retained for future consideration.

6.2.5 Alternative 4 – Electrical Resistance Heating and Groundwater/DNAPL Extraction

Alternative 4 would involve continued groundwater pumping and controls while the source zone is heated to volatilize and destroy TCE and other VOCs. This remedy would be protective and was retained for future consideration.

6.2.6 Alternative 5 – Soil Excavation and Off-Site Disposal

Alternative 5 would involve removal of contaminated soil, which would also facilitate restoration of groundwater. This remedy would be protective and was retained for future consideration.

6.3 BALANCING FACTORS

The four remedial action alternatives determined to be protective were evaluated against the following balancing factors defined in OAR 340-122-090(3):

- **Effectiveness in achieving protection.** The evaluation of this factor includes the following components:
  - Magnitude of the residual risk from untreated waste or treatment residuals, without considering risk reduction achieved through on-site management of exposure pathways (e.g., engineering and institutional controls). The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bio-accumulate, and propensity to degrade.
  - Adequacy of any engineering and institutional controls necessary to manage residual risks.
  - The extent to which the remedial action restores or protects existing or reasonably likely future beneficial uses of water.
  - Adequacy of treatment technologies in meeting treatment objectives.
  - The time until remedial action objectives are achieved.

- **Long-term reliability.** The following components are considered when evaluating this factor, as appropriate:

  – The reliability of treatment technologies in meeting treatment objectives.

  – The reliability of engineering and institutional controls needed to manage residual risks, taking into consideration the characteristics of the hazardous substances being managed, the ability to prevent migration and manage risk, and the effectiveness and enforceability over time of the controls.

  – The nature and degree of uncertainties associated with any necessary long-term management (e.g., operations, maintenance, monitoring).

- **Implementability.** This factor includes the following components:

  – Practical, technical, legal difficulties and unknowns associated with the construction and implementation of the technologies, engineering controls, and/or institutional controls, including the potential for scheduling delays.

  – The ability to monitor the effectiveness of the remedy.

  – Consistency with regulatory requirements, activities needed to coordinate with and obtain necessary approvals and permits from other governmental bodies.

  – Availability of necessary services, materials, equipment, and specialists, including the availability of adequate treatment and disposal services.

- **Implementation Risk.** This factor includes evaluation of the potential risks and the effectiveness and reliability of protective measures related to implementation of the remedial action, including the following receptors: the community, workers involved in implementing the remedial action, and the environment; and the time until the remedial action is complete.

- **Reasonableness of Cost.** This factor assesses the reasonableness of the capital, operation and maintenance, and periodic review costs for each remedial alternative; the net present value of the preceding; and if a hot spot has been identified at this site, the degree to which the cost is proportionate to the benefits to human health and the environment created through treatment of the hot spot.

In general, the least expensive remedial action is preferred unless the additional cost of a more expensive corrective action is justified by proportionately greater benefits to one or more of the other balancing factors. For sites with hot spots, the costs of remedial actions must be evaluated to determine the degree to which they are proportionate to the benefits created through restoration or protection of beneficial uses of water. A higher threshold will be used for evaluating the reasonableness of costs for treatment of hot spots than for remediation of areas other than hot spots. The sensitivity and uncertainty of the costs are also considered.

6.4 EVALUATION OF BALANCING FACTORS

This section evaluates each of the remedial action alternatives that meet the protectiveness criteria in terms of the balancing factors described in Section 6.3. This evaluation is also summarized in Table 7.

6.4.1 Alternative 2am: Source Depletion with Soil Vapor/Groundwater/ DNAPL Extraction Followed by In-situ Bioremediation

Effectiveness. Based on pilot studies at this site, RA 2am is expected to be effective at controlling exposure to contaminants and reducing concentrations to the point that eventually the site will be protective without significant engineering controls.

Long-term Reliability. This remedial alternative is reliable over the long term. Source depletion through aggressive SVE and ERD reduces the need for the additional measures.

Implementability. This alternative is relatively easy to implement. Much of the remedy is already present and the additional infrastructure is similar to that used in pilot studies.

Implementation Risks. Implementation risks are relatively low. The main risk involved is creating too much VC during ERD. However, this has not been observed during recent pilot tests.

Reasonableness of Cost. The estimated cost of alternative 2am is approximately $6 million, which is considerably less than the costs of Alternatives 3, 4, and 5.

Hot Spot Treatment Alternative 2am will treat hot spots to the extent practicable through aggressive SVE and ERD, which will remove or destroy contaminants from the DNAPL source zone.

6.4.2 Alternative 3: Institutional Controls, In-Situ Chemical Oxidation, and Groundwater Extraction

Effectiveness. Based on studies at other sites, this remedy is expected to be effective. However, contaminants in fine-grained materials add some extra difficulties with delivery of chemical amendment.

Long-term Reliability. This remedial alternative is reliable over the long term.

Implementability. Difficulty of implementation is moderate; this alternative would require a very large number of borings for injection of chemical amendment. As described in the FFS, this alternative would require relocation of buildings above the contaminated areas, which add significantly to the difficulty of implementation.

Implementation Risks. Implementation risks are relatively low, but injection of chemical amendments would require significantly more chemical handling than alternatives 2 and 2 am.

Reasonableness of Cost. Estimated costs for alternative 3 are approximately $30 million, which is several times higher than the costs of alternatives 2 and 2am.
Hot Spot Treatment Alternative 3 is expected to be relatively effective at treating DNAPL and groundwater hotspots.

6.4.3 Alternative 4: Electrical Resistance Heating and Groundwater/DNAPL Extraction

Effectiveness. This alternative is expected to be effective at treating TCE and related contaminants.

Long-term Reliability. This remedial alternative is reliable over the long term because the VOCs would be removed.

Implementability. Obstacles to implementation include relocation of the Submicro building and glass plant and presence of sufficient electricity for electrical resistive heating.

Implementation Risks. Implementation risks are relatively low with this technology, but contaminant migration during implementation is possible. The high energy use of this method also increases the greenhouse gas footprint of the remedy.

Reasonableness of Cost. The cost estimate for this alternative is approximately $66 million. As shown in Table 7, this is several times higher than the costs of alternatives 2, 2am, and 3.

Hot Spot Treatment. This alternative is expected to be effective at treating hot spots.

6.4.5 Alternative 5: Soil Excavation and Off-Site Disposal

Effectiveness. This alternative is expected to be extremely effective.

Long-term Reliability. This remedial alternative is reliable over the long term.

Implementability. This alternative is very difficult to implement. Building removal, utility relocation, and engineering concerns with a relative deep and large excavation make this a difficult alternative to implement.

Implementation Risks. Implementation risks are moderate because of the large excavation, more direct handling of contamination, and transport of contaminated soils to landfills, some as hazardous waste.

Reasonableness of Cost. Estimated costs of this remedy are over $100 million, which is the highest of all the alternatives considered.

Hot Spot Treatment. This alternative would effectively treat hot spots.

7 RECOMMENDED REMEDIAL ACTION ALTERNATIVE

On the basis of the detailed evaluation of the alternatives in Sections 5 and 6, Alternative 2 amended (2am) is recommended for implementation at the Evanite site. This remedy best meets the balancing factors for selection of a remedial alternative. Alternative 2 would not treat hot spots and would be less reliable over the long term than 2am. Alternative 3 would be much more expensive than 2am, and may not be any more effective or reliable. Alternatives 4 and 5 would be much more expensive and would involve more implementation risks than 2am.

7.1 DESCRIPTION OF THE RECOMMENDED ALTERNATIVE

Many of the technology components of this alternative have been in place at Evanite since 1991, when groundwater and soil vapor extraction and enhanced DNAPL recovery were first implemented. After more than 20 years of aggressive remediation, the existing technical components of this alternative have been optimized and modified to address current site contaminant conditions, as well as newly established cleanup criteria for the indoor air pathway in Oregon. The alternative is summarized in Figure 10.

RA-2am involves the following remedial action elements:

7.1.1 Institutional and engineering controls

An Easement and Equitable Servitudes (E&ES) document will be put in place that prohibits residential use of the tax lots with shallow soil contamination. This will apply to three tax lots that are underlain by the Submicro Source Area Hot Spot illustrated on Figure 11. These tax lots will also require a soil management plan specifying conditions under which digging can take place for any future development and/or utility work. The integrity of the cap between the Submicro building and the millrace shall be maintained to prevent direct exposure to contaminated soils. Groundwater use will be prohibited for these three tax lots.

Potential future groundwater use will be evaluated for other tax lots currently owned by H&V as the site work progresses. Restrictions may be needed depending on future success of the remedy and future use of these tax lots.

If residents of the homes in the Neighborhood Area rehabilitate and use their wells in the future, then H&V will sample and analyze the wells for constituents of potential concern. If site-related contaminants are found above safe levels an alternative water supply will be provided.

7.1.2 Groundwater containment, pump-and-treat, and DNAPL pumping.

Groundwater extraction will be continued to flush the DNAPL source zone, to expand the unsaturated zone within the source area to facilitate SVE mass removal, and to maintain containment of impacted groundwater (This is currently being done using wells DMW-2, 3, 23, 24, and 29). This groundwater will continue be treated in an air stripper and disposed of under a permit with DEQ.

Continued DNAPL monitoring will also be done for these wells, with extraction if accumulations are observed (historically wells MW-3, MW-16, and MW-17 were used for recovery of separate phase DNAPL. Recovery amounts of DNAPL have not been observed since 2007).

The Responsible Party has conducted continuous remedial action with EPA and DEQ approval since April 30, 1990. Hydraulic containment through groundwater pumping at up to six site wells began in 1991 with over 460 million gallons of groundwater extracted and treated thorough January 2015. Evanite's hydraulic containment and groundwater monitoring system historically included six groundwater extraction wells, thirteen monitoring wells located onsite, and up to seventeen residential water wells in the adjacent neighborhood to the south. Additional source zone, dual purpose monitoring and treatment wells were installed in 2009, 2013, and 2014. Currently, the site well network includes 45 wells screened either at the top or base of the aquifer, and are designated as either intermediate or deep wells. The Evanite groundwater extraction and treatment system currently involves active pumping from five extraction wells (Wells DMW-2, DMW-3, DMW-23, DMW-24, and DMW-29) containing 10- or 20-gpm submersible pumps connected to a 2-inch diameter riser pipe. Approximately 35 to 40 gpm of groundwater total (combined from all wells) is currently pumped to an oil/water separator tank, then a surge tank, and ultimately to an air stripper rated at 100 gpm with 340 cubic feet per minute (cfm) and 99 percent removal efficiency.

7.1.3 Soil vapor extraction and sub-slab depressurization

SVE will continue to remove VOCs, much of which originate in the DNAPL source zone. This will mitigate potential vapor intrusion to the Submicro Building (currently SVE from Wells IMW-3, 16, 24, 25, 26, 28, and 29).

Starting in 1991, Evanite operated six SVE wells that were screened in the Willamette Silts between depths of approximately 7 and 17 feet. These wells were plumbed to a common header of an SVE system and operated during summer months (not operated during winter months due to high moisture content during wet seasons) between 1991 and 2008. Evanite reported an estimated 27,074 pounds of TCE were recovered from these wells between 1991 and 2008. However, nearly 75% of this TCE mass removal (approximately 19,000 pounds) occurred in the first three years of operation (1991 through 1993).

As noted above, intermediate and deep wells were installed in and around the source area in 2009 and 2013 to support the physical pilot testing activities. These wells allowed more aggressive groundwater extraction in the source area and resulted in greater drawdown of groundwater levels (particularly in the summer and fall months). This greater drawdown of groundwater facilitated pilot testing of more aggressive SVE in the upper portions of the aquifer that was effective in increasing TCE mass removal in recent years. Since 2012, the SVE system has removed almost as much TCE mass (approximately 20,000 pounds) as was removed by SVE in the previous 20 years.

Sub-slab depressurization will continue beneath the Submicro building to ensure that contaminated vapors do not migrate into this building from the subsurface. Additional work will be done to remediate fugitive emissions into the Submicro building from contaminated building materials and/or the adjacent treatment shed. This is intended to reduce contaminant concentrations sufficiently so that the Submicro building is safe for people working there40 hours per week.

7.1.4 Off-gas treatment

Treatment of off-gas from the SVE system and air stripper will continue until the quantity of TCE (and decay products) being removed from the subsurface is below levels which would potentially cause a risk to site workers or nearby residents. This site's CatOx is currently used for this, but carbon adsorption might be used in the future if future contaminant levels drop to the point where this would be more cost-effective. As of December 2014, the CatOx system was treating an average influent TCE concentration of 170 mg/m^3 at 370 cfm as provided by the groundwater air stripper and SVE systems. TCE destruction efficiencies as measured by influent and effluent TCE air concentrations have ranged from 96% to 99%.

7.1.5 Enhanced reductive dechlorination

In-situ ERD pilot testing was performed in 2013. The ERD pilot test was implemented over a 25 week period from May through October 2013. Enhanced in-situ bioremediation by reductive dechlorination, or ERD, involves stimulating bacteria to encourage the breakdown of chlorinated solvents such as PCE to TCE and so on. This process is often used in combination with other technologies or as a polishing step after the DNAPL source zone has been sufficiently depleted (ITRC 2004).

The ERD pilot testing was completed with the primary objective of determining if ERD is an applicable technology for full-scale implementation at the site. Evaluation of the data collected during the ERD pilot testing supports that ERD is an appropriate technology for full-scale application, particularly in site areas where physical mass removal technologies and flushing from groundwater extraction have substantially reduced residual TCE mass (i.e., Submicro Source and Glass Plant Plume areas). As soon as substrate was delivered to subsurface in the pilot test area, the aquifer system started to migrate to anaerobic conditions and dechlorination was observed. Although mobile DNAPL had been historically present in the pilot test area, the historical combination of groundwater extraction and SVE was able to reduce TCE concentrations to a level that existing microbes could thrive.

Based on the results of the pilot test, ERD will be included as part of this remedy.

7.1.6 Monitoring and monitored natural attenuation

Continued monitoring of groundwater and air quality and remedial system performance will be a necessary part of the remedial alternative. This will be necessary both to show success or failure of the remedy, and to move through the different stages of remedial action.

This information will be used to determine when to transition from active groundwater remediation (i.e., groundwater extraction and ERD) to passive groundwater remediation involving reduced mass flux from the source area, combined with natural attenuation to protect surface water.

In this remedial alternative, operation of SVE, groundwater extraction systems and ERD will eventually be followed by conversion to passive groundwater remediation involving reduced mass flux from the source area and monitored natural attenuation to protect surface water. Following the ERD stage of work on the Source Zone, the groundwater monitoring program will be tuned to determine if groundwater containment is still needed. This will depend on the rate of TCE dissolution still ongoing after ERD concludes and the ultimate use of the downgradient area so that receptors in the hardboard area, the downgradient area and surface water will still be protected from unacceptable levels of TCE (and decay product) contamination. Six monitoring wells were installed in 2014 along the downgradient boundary of the Submicro DNAPL source zone to provide data along the leading edge of the DNAPL zone groundwater plume. These wells, together with DMW-2, DMW-11, and DMW-12, provide long-term monitoring locations downgradient of the DNAPL source zone for evaluation of TCE mass flux as a primary tool for characterizing long-term remedy performance.

The area downgradient of the source area is monitored using two rows of wells that are aligned perpendicular to the original plume flow direction (i.e., northeast migrating from the source zone toward surface water). Wells DMW-2, IMW and DMW-34, DMW-11, IMW and DMW-35 and DMW-12 form a row of wells at the leading edge of the highly concentrated groundwater plume. The other four wells (MW-6, DMW-15, DMW-13, and former well DMW-4) stretch across the historical discharge face of shallow groundwater to the Willamette River. These are designated as near-shore wells. TCE concentrations in the first row of wells are now below 1,000 μg/L. TCE concentrations in the near-shore wells are below 15 μg/L. (Note that TCE concentrations were as high as 160,000 μg/L prior to the start of hydraulic containment in the early 1990s). Unlike the other groundwater plume areas, TCE degradation has been strongly evident in these near shore wells with cis-1, 2-DCE and trans-1, 2-DCE composing as much as 80% of the total VOC concentrations. For example, MW-15 (located north of the T&E Center and about 120 feet from the river) has routinely contained vinyl chloride and cis-DCE at much higher concentrations than TCE. In recent years, MW-6 (located northwest of MW-15) has demonstrated a similar relationship between vinyl chloride, cis-DCE and TCE concentrations.

Multiple lines of evidence indicate anaerobic degradation and natural attenuation are active in the area downgradient of the source area, with TCE and TCE breakdown products at concentrations substantially below applicable screening levels. Currently, all pore water and groundwater from near shore wells in the downgradient area are below the applicable pore water ecological screening values. In addition, these VOCs have not been detected in surface water samples collected in the Willamette and Marys Rivers.

Performance monitoring during implementation of RA-2am will include:

- Monitoring of remedial system off-gas to provide data to quantify the mass of TCE removed from the subsurface, evaluate the efficiency of the treatment system, and quantify the masses of TCE destroyed and TCE discharged by the CatOx/scrubber treatment system.
- Monitoring of the progress of SVE and groundwater extraction systems that are operated in a focused mode of aggressive mass reduction in the DNAPL source zone.
- Monitoring of the progress of the in-situ ERD groundwater treatment system to support further mass reduction in the Source Area.

- Monitoring of groundwater conditions in the TCE plume to evaluate the following:
  - Hydraulic containment.
  - Progress with plume cleanup through comparison of soil vapor, groundwater, and surface water concentrations to applicable cleanup standards.
  - Potential rebound of TCE concentrations.
  - Mass flux from the Source Area.
  - Natural attenuation in areas downgradient of the Source Area.

Details of the performance monitoring associated with RA-2am will be defined in a Remedial Design/Remedial Action Work Plan.

7.2 RESIDUAL RISK ASSESSMENT

OAR 340-122-084(4)(c) requires a residual risk evaluation of the recommended alternative that demonstrates that the standards specified in OAR 340-122-040 will be met, namely:

- Assure protection of present and future public health, safety, and welfare, and the environment
- Achieve acceptable risk levels
- For designated hot spots of contamination, evaluate whether treatment is reasonably likely to restore or protect a beneficial use within a reasonable time
- Prevent or minimize future releases and migration of hazardous substances in the environment

The selected remedy is expected to be protective of human health and the environment and to address all unacceptable risks either through treatment or engineering and institutional controls.

Risks from soil direct contact, ingestion, and inhalation and risks of excavation worker exposure to groundwater in the source zone will be addressed through maintenance of the concrete cap and through institutional controls. However, it is likely that soil concentrations that could pose unacceptable risks will remain in the source zone for the indefinite future and the institutional and engineering controls will be required.

Volatilization from soil in the source zone to outdoor air will be addressed through SVE and volatilization to indoor air will be addressed by sub-slab depressurization under the Submicro building. As contaminated soils are likely to remain in the source zone, it is expected that these controls may be needed for the indefinite future.

Tap water ingestion and inhalation in the Source Zone and the Hardboard Area will be addressed through institutional controls. TCE concentrations are not expected to be below drinking water screening levels and institutional controls are likely to be required into the future.

Tap water ingestion and inhalation in the neighborhood area is currently controlled through an alternative water source. If any wells are to be used in the future, Hollingsworth and Vose will offer sampling of those wells and if needed, arrange an alternative supply. While vapor intrusion risks have been controlled in the neighborhood area, it is not currently known, due to the condition of the former domestic wells, if this area has been remediated to drinking water standards or if it will be remediated to those standards.

Risks from outdoor air TCE concentrations will be addressed through SVE from the source zone, treatment of off-gas air, and continued upgrades and sealing of the treatment systems.

Potential risks to surface water users and ecological risks to benthic ecological receptors will be addressed through continued groundwater containment until concentrations have been remediated sufficiently to cease containment. Control of this rick pathway is expected to be one of the key measures in determining when the remedy has been completed.

7.3 FINANCIAL ASSURANCE

Hollingsworth and Vose will provide a financial assurance mechanism to cover the performance of the remedial actions described above that meets the requirements of 40 CFR § 264.143. Financial Assurance has recently been established through a trust account. This will be continued in the near future, or modified to another method in compliance with 40 CFR § 264.143.

8 APPENDIX

ADMINISTRATIVE RECORD INDEX

Evanite Site
Corvallis, Oregon

The Administrative Record consists of the documents on which the recommended remedial action for the site is based. The primary documents used in evaluating remedial action alternatives for the Evanite site are listed below. Additional background and supporting information can be found in the Evanite project file located at DEQ Western] Region Office, 165 E. 7th Avenue, Suite 100, Eugene, Oregon.

SITE-SPECIFIC DOCUMENTS

CH2M HILL. 1987/1988. RCRA Part B Post-Closure Permit Application. Prepared for Evanite Battery Separator, Inc., Corvallis, Oregon, by CH2M HILL, Corvallis, Oregon. May 25.

CH2M HILL. 1989. Clay aquitard investigation, Evanite Battery Separator, Inc., Corvallis, Oregon. Prepared for Evanite Battery Separator, Inc., by CH2M HILL, Corvallis, Oregon. March 7.

DEQ/EPA. 1990. Final Post-Closure Permit. Issued to Evanite Battery Separator, Inc., Corvallis, Oregon. Jointly issued by Oregon Department of Environmental Quality and U.S. Environmental Protection Agency. March 20.

DEQ. 2006a (April 20). *Letter (re: Completion of human health risk assessment and consent order addendum for focused feasibility study, Evanite Fiber Corporation, ECSI 40)* to J. Doyle, Evanite Fiber Corporation from A. Obery, Oregon Department of Environmental Quality.

DEQ. 2006b. Email correspondence (re: Evanite FFS Outline) to J. Doyle, Evanite Fiber Corporation from A. Obery, Oregon Department of Environmental Quality. August 17.

DEQ. 2008 (November 12). *Letter Re: Submicro Pilot Test Work Plan.* Oregon Department of Environmental Quality.

Kennec. 2007. Focused Feasibility Study, Evanite Fiber Corporation.

McKenna Environmental. 2002a. Focused remedial investigation, Evanite Fiber Corporation, Corvallis, Oregon.

McKenna Environmental-Technical Assessment Services. 2002. Screening Level Ecological Risk Assessment Report, Evanite Fiber Corporation, Corvallis, Oregon.

OSHD. 1988. Corvallis Bypass Phase I Geology Report. Oregon State Highway Division Region 2 Geology Office.

PNG Environmental, Inc. 2008a (June 3). *Neighborhood Monitoring Well Installation Work Plan – Evanite Fiber Corporation.*

PNG Environmental, Inc. 2008b (August 4). *Submicro Pilot Test Work Plan.* PNG Environmental, Inc. 2008c (December 19). *Letter to DEQ Evanite Performance Monitoring Program.*

PNG Environmental, Inc. 2008d (November 10). *DNAPL Source Zone Installation Work Plan.*

PNG Environmental, Inc. 2009a (May 29). *Neighborhood Monitoring Wells, Evanite Fiber Corporation.* PNG Environmental, Inc.

PNG Environmental, Inc. 2009b (March 4). *Sampling and Analysis Plan – Evanite Fiber Corporation.*

PNG Environmental, Inc. 2010a (February 22). *Physical Remedy Pilot Testing Work Plan – DNAPL Source Zone*.

PNG. 2010b (January 6). *Off-Gas Treatment Pilot Testing Work Plan.*

PNG Environmental, Inc. 2013a (January 8). *DNAPL Source Zone Well Installation Work Plan Addendum 1.*

PNG Environmental, Inc. 2013b (November 22). *DNAPL Source Zone Well Installation Work Plan Addendum 2.*

PNG Environmental, Inc. 2013c (April 18). *Work Plan: Enhanced Reductive Dechlorination Pilot Test.*

PNG Environmental, Inc.2014 (June 16). *2013 Remedial Performance Report.*

PNG Environmental, Inc.2014 (December 19). *Focused Feasibility Study Addendum.*

PNG Environmental, Inc.2015 (February 12). *Focused Feasibility Study Addendum, Revised after DEQ Comments.*

PNG Environmental, Inc. 2015 (March 20). *2014 Remedial Performance Report.*

Rittenhouse-Zeman & Associates, Inc. 1991. Former Chevron Bulk Storage Plan Facility #1001761, 1225 SE 3rd Street, Corvallis, Oregon. Prepared for Chevron U.S.A. Inc.

USDA Soil Conservation Service. 1975. Soil Survey of Benton County, Oregon.

Technical Assessment Services and Tuppan Consultants LLC. 2005. Human Health Risk Assessment, Evanite Fiber Corporation, Corvallis, Oregon.

Technical Assessment Services and Tuppan Consultants LLC. 2006a. Letter to A. Obery (re: Evanite Fiber Corporation – Revisions to Human Health Risk Assessment.

Technical Assessment Services and Tuppan Consultants LLC.2006b. Letter (re: Evanite Fiber Corporation – Addendum to Human Health Risk Assessment) to A. Obery, Oregon Department of Environmental Quality.

Tuppan Consultants LLC. 2006. Email correspondence (re: Draft Evanite FFS Outline) to A. Obery, Oregon Department of Environmental Quality, from E. Tuppan,

USACE. 1971. Flood plain information, Willamette River, Marys River, Corvallis and Philomath, Oregon. Prepared for Benton County, Oregon.

STATE OF OREGON

Oregon's Environmental Cleanup Laws, Oregon Revised Statutes 465.200-.900, as amended by the Oregon Legislature in 1995.

Oregon's Hazardous Substance Remedial Action Rules, Oregon Administrative Rules, Chapter 340, Division 122, adopted by the Environmental Quality Commission in 1997.

Oregon's Hazardous Waste Rules, Chapter 340, Divisions 100 - 120.

Oregon's Water Quality Criteria, Chapter 340, Division 41, [RIVER] Basin.

Oregon's Groundwater Protection Act, Oregon Revised Statutes, Chapter 468B.

GUIDANCE AND TECHNICAL INFORMATION

Allison, 1953. Geology of the Albany Quadrangle, Oregon. Oregon Dept. Geology and Mineral Industries Bulletin 37.

Carey, et al. 2014. *DNAPL Source Depletion: 2. Attainable Goals and Cost-Benefit Analysis.* Carey, R., McBean, E., Feenstra, S.

Frank, 1974. Groundwater in the Corvallis-Albany Area, Central Willamette Valley, Oregon. USGS Water Supply Paper #2032, 48 pages.

DEQ. Cleanup Program Quality Assurance Policy. September 1990, updated April 2001.

DEQ. Consideration of Land Use in Environmental Remedial Actions. July 1998.

DEQ. Guidance for Conducting Beneficial Water Use Determinations at Environmental Cleanup Sites. July 1998.

DEQ. Guidance for Conduct of Deterministic Human Health Risk Assessment. May 1998 (updated 5/00).

DEQ. Guidance for Conducting Feasibility Studies. July 1998.

DEQ. Guidance for Ecological Risk Assessment: Levels I, II, III, IV. April 1998 (updated 12/01).

DEQ. Guidance for Identification of Hot Spots. April 1998.

DEQ. Guidance for Use of Institutional Controls. April 1998.

DEQ. *Guidance for Assessing and Remediating Vapor Intrusion in Buildings*. Oregon Department of Environmental Quality. March, 2010

NRC. 1994. *Alternatives for Ground Water Cleanup.* National Research Council Academy Press, Washington, D.C.

ITRC. 1999. *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices. I*nterstate Technology and Regulatory Council.

ITRC. 2000 (June). *Dense Non-Aqueous Phase Liquids (DNAPLs): Review of Emerging Characterization and Remediation Technologies.* Interstate Technology and Regulatory Council.

ITRC. 2002 (April). *DNAPL Source Reduction: Facing the Challenge.* Interstate Technology and Regulatory Council.

ITRC. 2003 (September). *An Introduction to Characterizing Sites contaminated with DNAPLs.* Interstate Technology and Regulatory Council.

ITRC. 2004 (August). *Strategies for Monitoring the Performance of DNAPL Source Zone Remedies.* Interstate Technology and Regulatory Council.

ITRC. 2008a. *Enhanced Attenuation: Chlorinated Organics.* Interstate Technology and Regulatory Council.

ITRC. 2008b. *In Situ Bioremediation of chlorinated Ethene: DAPL Source Aones.* Interstate Technology and Regulatory Council.

Kavanaugh, Michael C. and Rao, P. Suresh C. 2003 (December). *The DNAPL Remediation Challenge: Is There a Case for Source Depletion?* EPA/600/R-03/143.

Stroo. 2012 (May 18). *Chlorinated Ethene Source Remediation: Lessons Learned.* Environmental Science & Technology 19; 46(12):6438-47. Stroo HF, Leeson A, Marqusee JA, Johnson PC, Ward CH, Kavanaugh MC, Sale TC, Newell CJ, Pennell KD, Lebrón CA, Unger M.

USEPA. Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA. Office of Emergency and Remedial Response. OSWER Directive 9355.3-01. October 1988.

USEPA. Transport and Rate of Contaminants in the Subsurface. Robert S. Kerr Environmental Research Laboratory. EPA/625/489/019. 1989.

USEPA. Exposure Factors Handbook. Office of Health and Environmental Assessment. EPA/600/8-89/043. May 1989.

USEPA. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final. Office of Solid Waste and Emergency Response. EPA/540/1-89/002. December 1989

USEPA. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive No. 9285.6-03, March 1991.

USEPA. Effectiveness of groundwater pumping as a restoration technology. U.S. Environmental Protection Agency ORNL/TM-11866. May1991.

USEPA. Supplemental guidance for Superfund Risk Assessments in Region 10. U.S. Environmental Protection Agency. August 1991.

USEPA. Integrated Risk Information System. Office of Research and Development. Cincinnati, Ohio. 1992.

USEPA. Pump-And Treat Ground-Water Remediation, A Guide For Decision Makers And Practitioners. U.S. Environmental Protection Agency. EPA/625/R-95/005. July 1996.

USEPA. *Rules of Thumb for Superfund Remedy Selection.* OSWER Directive 9355.0-69. 1997 www.epa.gov/superfund/resources/rules/rulesthm.pdf

USEPA. *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action.* OSWER, EPA/530/R-01/015. 2002 www.epa.gov/epaoswer/ hazwaste/ca/resource/guidance/gw/gwhandbk/gwhndbk.htm

Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold, New York. 1983.