Explanation of Significant Difference – Modifications to Remedy
Tektronix Beaverton Campus (ECSI #167), Multnomah County, Oregon
August 2015

Introduction and Purpose

This Explanation of Significant Difference (ESD) document provides a description of changes to the selected remedial action for dense, non-aqueous phase liquid (DNAPL) contamination at Evaluation Area 1 (EA1) of the Tektronix Incorporated Beaverton Campus. The remedial action for this site is described in an Oregon Department of Environmental Quality (DEQ) Record of Decision (ROD) dated July 2009. The remedial action was selected in accordance with Oregon Revised Statute (ORS) 465.200 et. seq. and was based on the Administrative Record for this site. This ESD summarizes the more detailed information presented in work plans and technical memoranda, and will also become part of the Administrative Record.

Summary of Site History, Contamination, and Selected Remedial Action

The Tektronix Beaverton Campus is located at 14200 Karl Braun Drive in Beaverton, Oregon (Section 8, T.1S, R.1W, Willamette Baseline and Meridian, see Figure 1). The Tektronix Campus, encompassing 300 acres, is divided into Evaluation Areas 1 through 6 for the purpose of conducting site investigation and remedial activities. The Tektronix Campus lies within the City of Beaverton urban area and is surrounded by commercial and residential properties. Beaverton Creek, a tributary of the Tualatin River, flows east to west through the center of EA1.

EA1 is further divided into ten discrete operational units (see Figure 2): Building 02; West Park and Tracts A through D bracketing Beaverton Creek; former Building 40; the former industrial waste water treatment facility (IWWTF) and Lot 14 units which included the Resource Conservation and Recovery Act (RCRA) treatment, storage and disposal facility; Building 38 unit north of Beaverton Creek and in the center of the property; the Building 16 unit adjacent to the east of the RCRA facility; and Building 04/10/12 unit north of Beaverton Creek and at the eastern property boundary. DEQ has issued conditional No Further Action (NFA) determinations for the Building 02 and West Park parcels.

Historically, Tektronix managed hazardous materials and wastes onsite, and has been subject to regulation under RCRA (permit number ORD 009020231; dated July 25, 1990). Tektronix began a facility investigation and corrective action under the RCRA permit in the late 1980s. In 2002, Tektronix entered into a Consent Order (ECSR-NWR-01-13) to complete a site investigation, develop a feasibility study, and implement remedial actions at the site under DEQ cleanup authority. The corrective action plan and post-closure care requirements of the RCRA permit are referenced in the Consent Order.

Site investigation and characterization were initiated under the RCRA permit and continued under the Consent Order. Extensive soil and groundwater sampling have been performed at various locations across the campus to define the nature and extent of site-related contamination. The *Remedial Investigation Report* summarizes the nature and extent of contamination within EA1 (Landau, 2007). Environmental investigations detected chlorinated solvents in select source areas in groundwater at concentrations likely to reflect the presence of a free product, also known as dense non-aqueous phase liquid (DNAPL). The primary contaminants of concern are halogenated volatile organic compounds (VOCs) including trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC).

Groundwater data were collected from the three identified hydrogeologic zones, which extend from the top of the water table at 9 feet below the ground surface (fbgs) to greater than 49 fbgs. Groundwater sample results were compared to DEQ risk-based concentrations (RBCs) for the vapor intrusion to indoor air pathway for occupational workers and direct contact exposure pathway for construction and excavation workers. Drinking water is not a beneficial use for groundwater at the site, and therefore the vapor intrusion and excavation/construction worker direct contact pathways are the primary source of risk from VOCs in groundwater. Groundwater data collected near Beaverton Creek were also compared to aquatic water quality criteria.

The ROD documenting the selected remedial action for EA1 identifies in-situ thermal technology to address high levels of VOCs in soil and groundwater at source areas, and monitored natural attenuation (MNA) to assess contaminated groundwater until applicable risk-based levels are achieved. The ROD also requires additional delineation and toxicity evaluation of contamination of bank soils, contingency measures, and institutional controls. Four source areas are identified for active treatment in the ROD: in Tract C adjacent/within the channel of Beaverton Creek, two areas within the former Building 40/IWTTP, and the Building 38 unit. At each location, contamination extends from shallow to intermediate to deep hydrogeologic zones (see Figure 3).

Site-specific remedial action objectives (RAOs) were developed for soil and groundwater for the purpose of achieving protection of human health, ecological receptors, and beneficial uses, as required by OAR 340-122-0040. The RAOs for EA1 are as follows:

RAO 1. Prevent human exposure to TCE in shallow groundwater through dermal contact for excavation workers that would result in unacceptable excess lifetime cancer risk greater than 1x10-6 and a hazard index (HI) greater than 1.
RAO 2. Prevent human exposure to TCE in surface water through dermal contact and inhalation for recreational users that would result in an unacceptable risk.
RAO 3. Prevent human exposure to TCE in indoor/outdoor air through inhalation that would result in an unacceptable risk.
RAO 4. Prevent ecological receptor exposure to metals in creek bank soil that would result in unacceptable risk for populations of non-T&E species.
RAO 5. Prevent migration of VOCs in shallow groundwater into surface water or indoor/outdoor air at concentrations that exceed acceptable risk levels.
RAO 6. Remediate hot spots of contamination in groundwater, and bank soil by reducing their concentration, volume or mobility to be protective of human and ecological receptors as specified in OAR 340-122-0090(4).

The primary goal of this last RAO is to remediate DNAPL contamination by thermal methods. Thermal remediation heats the subsurface to temperatures that volatiles groundwater and residual DNAPL. Once volatized the steam and contaminants migrate upward through subsurface to be collected in a groundwater and vapor extraction system, with treatment of groundwater prior to discharge. When VOC source areas have been treated and concentrations have been reduced to acceptable levels, then additional treatment will rely upon MNA. MNA is also performed outside of source areas where contamination is present which exceed applicable risk-based levels but not at levels requiring treatment.

The actions selected in the 2009 ROD are considered protective, implementable, effective, reliable, and reflect a reasonable cost. A more detailed description of the selected remedy can be found in Section 7.0 of the ROD.

ROD Implementation - 2009 to Present

Bank Study
Further evaluation of the toxicity of creek bank soils was conducted in accordance with the ROD, and the evaluation concluded that the metals in creek bank soil did not pose an unacceptable ecological risk Specifically, the study showed that select metals in bank soils exceed screening levels for soil and terrestrial receptors; however, the toxicity results for exposure of bank soils to soil invertebrates did not show an adverse effect to these representative terrestrial receptors (Windward Environmental, 2010). DEQ concurred with that conclusion; therefore, RAO 4 and the bank soil component of RAO 6 have been addressed.

Building 02 Operational Unit
Based on more current groundwater data, Tektronix requested that a NFA determination be granted for the Building 2 Operational Unit. Tektronix sold Building 02 in 1999; however, retained environmental responsibility for impacted groundwater beneath the property. In accordance with the ROD, the Building 02 area was subject to MNA. However, groundwater sampling conducted in the Building 02 Area has not detected any contaminant concentrations above relevant RBCs since 2003. Given consistent groundwater data at Building 02 Area have been observed below RBCs in the last ten years and groundwater redox data indicate conditions conducive for continued natural attenuation, DEQ has concluded that RAOs at Building 02 have been achieved.

Remedial action to address environmental contamination at the Building 02 Operational Unit of the Beaverton Tektronix site is complete, and no further action is required provided that site use remains commercial or industrial. This determination is based on DEQ regulations and the following facts as we now understand them, which are described in more detail in DEQ's No Further Action proposal memorandum (DEQ, 2014). DEQ solicited public comment on the proposed action, and in September 2014 issued a conditional NFA for the Building 02 Unit.

Pilot Study
Pilot testing of source area treatment using in-situ thermal treatment was performed at a TCE source "Pilot Area" located generally southwest of the former Building 40 source area (Figure 4). The purpose of the pilot test was to demonstrate effectiveness of the remediation system technology. The pilot test was generally implemented in accordance with the DEQ-approved *Final Pilot Test Design Report* (Landau, 2011), and began operation on December 2011 and shut down on November 2012. The study encountered some challenges, including a longer treatment timeframe than anticipated. Nonetheless, the pilot test demonstrated that in-situ thermal remediation can be an effective technology to treat source areas at the site by reducing high concentrations of chlorinated VOCs to low levels or non-detect, achieving treatment goals outlined in the ROD. In February 2013, DEQ approved full-scale treatment of identified TCE treatment areas in accordance to the ROD.

Description of Significant Differences and Basis for Differences

Update in DEQ RBCs

At issuance of the ROD, VOC source areas in groundwater were defined as locations where TCE concentration exceeds applicable RBCs. Certain source areas consist of concentrations of TCE that exceeded hot spot levels of 10,000 µg/l (based on the vapor intrusion to indoor air pathway). For TCE, this concentration is also approximately equal to one percent of the aqueous solubility limit for TCE in groundwater, denoting the potential presence of free product (DNAPL) in the subsurface. The selected treatment threshold concentration, as outlined in the 2009 ROD, are those areas where TCE concentrations in groundwater exceed 1,000 µg/l, providing a conservative treatment margin around potential source/DNAPL areas. Four source areas were identified for treatment in the west area of EA1 based on this threshold (see Figure 3): adjacent to Beaverton Creek, two areas within the former Building 40/IWWTF area, and at Building 38 unit. Contaminated groundwater outside of source areas are subject to MNA until RAOs are achieved.

For the *Human Health Risk Assessment* (Landau, 2006) where site-specific acceptable risk levels were not calculated for the Tektronix site, default values were used from DEQ's guidance, including *Risk-Based Decision Making for Petroleum-Contaminated Sites* (DEQ, 2007). The guidance references DEQ RBCs, which were updated in June 2012. The update to select RBCs based on the current toxicity values include an increase in the groundwater RBC for TCE for vapor intrusion into buildings exposure pathway for the occupational receptor scenario from 110 µg/l, as listed in the ROD, to 3,300 µg/l. Given this change in RBC value, the most stringent applicable RBC for TCE is the groundwater in excavation exposure pathway for the excavation worker scenario at a concentration of 430 µg/l. Nonetheless, DEQ elected to retain the treatment threshold of 1,000 µg /l TCE in groundwater identified in the ROD but acknowledges the change in RBC.

MNA at Source Areas

The selected groundwater remedy is primarily based on remedial investigation (RI) data collected in 2003 and 2004. The RI Report was completed in 2007 and the ROD in 2009. MNA has been performed in accordance with a DEQ-approved groundwater monitoring program since issuance of the ROD, and pre-ROD groundwater monitoring was conducted as a component of the RI and corrective action requirements under the RCRA permit. For investigating groundwater contamination, the RI utilized existing monitoring wells and temporary direct push locations. Monitoring wells installed during pre-ROD activities were also utilized as representative wells for MNA. Based on regular groundwater monitoring activities pre- and post-ROD, concentrations of VOCs in several source areas were observed to decline substantially, presumably from natural attenuation processes.

The most recent annual report, *2014 Monitored Natural Attenuation Results* (Landau, 2015) summarizes historical to current groundwater conditions at areas subject to MNA.

Beaverton Creek Source Area

Based on groundwater quality data collected during the RI, two areas at Beaverton Creek were designated for thermal treatment in the *Feasibility Study* (Landau, 2008) and subsequently in the ROD. These areas were at the locations of shallow groundwater monitoring wells BC-2 and BC-3, which detected contaminant concentrations exceeding the 1,000 µg/l (TCE) threshold for treatment. No direct-push groundwater samples were collected in the creek area during the RI that contributed to that determination. Treatment was designated for areas with a high probability of the presence of TCE NAPL. TCE is also detected in surface water samples taken from Beaverton Creek, at the site and downgradient.

Historically, BC-2 was observed with TCE concentrations greater than 1,000 µg/l, and BC-3 greater than 10,000 µg/l. During the RI, concentrations of TCE at BC-2 had declined by an order of magnitude. Concentrations at BC-3 appeared on a downward trend but continued to consistently detect greater than 10,000 µg/l for TCE. More recent groundwater quality data collected during the 2011 to 2014 MNA annual sampling events indicate that a significant reduction of contaminant mass has occurred in these areas.
TCE concentrations no longer suggest the possible presence of free product; while groundwater conditions near Beaverton Creek indicate ongoing natural degradation of contaminants by reductive dechlorination. MNA monitoring during the last several years has identified TCE concentrations from non-detect to 0.85 µg/l at BC-2, and non-detect to 6.5 µg/l at BC-3. Given these concentrations, treatment is no longer warranted in this area but subject to MNA until RAOs are achieved.

Building 38 Source Area
The RI data supporting DEQ's 2009 ROD suggested unacceptable risk to VOCs present beneath Building 38 in groundwater; however, no groundwater samples collected in this area detected TCE greater than one percent the solubility limit (i.e., hotspot with possible DNAPL). Isolated areas in groundwater contained elevated contaminants, with TCE to approximately 5,000 µg/l. TCE was also detected in indoor air at Building 38. Consequently, the TCE source area at Building 38 is identified in the ROD for in-situ treatment.

In 2013, DEQ approved a supplemental groundwater investigation for Building 38 to determine if current groundwater conditions continue to require remediation and/or alternative measures. In general, DEQ concurred with the findings of the investigation presented in the *Supplemental Groundwater and Sub-slab Vapor Investigation, Building 38, Evaluation Area 1* (Landau, 2013). Results from the supplemental investigation in the Building 38 area indicate DNAPL is not present and active treatment by in-situ thermal remediation is not necessary. However, a combination of mitigation methods may be necessary to prevent migration of VOCs in shallow groundwater into indoor air at concentrations that exceed acceptable risk levels. MNA should continue in the Building 38 area until RAOs have been achieved, in accordance with the ROD.

DEQ also recommends Tektronix consider in-situ treatment in a localized area observed with elevated VOCs (e.g., >1,000 µg/l TCE) to enhance biodegradation. DEQ will work with Tektronix to determine the appropriate measures for the Building 38 area to achieve protectiveness and ensure that contaminant concentrations in this area are reduced in a reasonable timeframe. As outlined below, in June 2015, DEQ approved a work plan for bioremediation design and data gaps investigation for Building 38 and former Building 40/IWWTF areas (Landau, 2015). Figure 5 provides historical and more current groundwater data, and proposed supplemental investigation locations.

<u>Change in Treatment Technology</u>
As noted above, treatment by in-situ thermal remediation was proven successful at the site based on the pilot study. The remaining TCE source area requiring treatment is comprised of the former Building 40/IWWTF area, hydraulically upgradient and generally northwest of the Pilot Area. In 2014, DEQ approved a supplemental groundwater investigation for Building 40/IWWTF to determine current groundwater conditions and refine remedial design. The results of the 2014 investigation activities generally showed reductions in VOC concentrations, with some contaminant concentrations still requiring treatment and supported slight adjustments to treatment area boundaries (see Figure 4). In addition, one previously unknown area of elevated TCE was observed directly upgradient of the Pilot Area and proposed for treatment, consistent with the intent of the ROD.

Refinement and expansion of the Building 40/IWWTF source area footprint, along with changes in thermal remediation technology since initial remedy selection, indicates a substantial increase in project

costs using in-situ thermal remediation technology for the site area. Information has also evolved regarding the use of in-situ bioremediation techniques to address higher concentrations of VOCs. Based on cost and the likelihood that in-situ bioremediation would be effective in treatment, Tektronix requested a change in treatment technology in early 2015. Additional reasons for proposing in-situ bioremediation are presented in the memorandum, *Request to Perform In-Situ Bioremediation at Building 40 North Area* (Landau, 2015).

Enhanced reductive dechlorination (ERD) treatment methods were also considered during remedy selection and identified as a contingency measure in the ROD. While challenges exist to treat source areas concentrations by ERD, groundwater monitoring site-wide over several years suggests reductive dechlorination is occurring. DEQ has concluded implementation of ERD technology is significantly more cost effective than thermal remediation and likely to be effective in reducing solvent concentrations below levels requiring active treatment (as opposed to MNA).

DEQ therefore approves of Tektronix proceeding with treatment of the Building 40/IWWTF area using ERD techniques, consistent with the 2009 ROD and Consent Order DEQ NO. ECSR-NWR-01-13. Approval of the source area treatment alternative includes conditions documented in DEQ's February 18, 2015 letter to Tektronix. Specifically, Tektronix is subject to:

- A strict and acceptable project schedule agreed upon by DEQ and Tektronix. A detailed schedule shall be provided for DEQ approval before or in combination with the ERD work plan.
- If ERD is unsuccessful in treating VOC source areas in a reasonable timeframe, it will be necessary to implement thermal treatment as a contingency measure to "complete" active treatment unless otherwise approved by DEQ.

Tektronix has agreed to these conditions.

DEQ approved the work plan, *Bioremediation Design and Data Gaps Investigation* (Landau, 2015), with comments and Landau provided a response to DEQ comments in July 2015, which clarify several elements of the work plan. The work plan proposes collecting additional field data and environmental samples, and installation of new monitoring wells (see Figure 4 and 5). The purpose of the data gap investigation at Building 40 is to support an informed selection of a bioremediation approach, treatment system design and selection of an appropriate electron donor material. Building 38 data will be evaluated and next steps discussed with DEQ prior to proceeding with bioremediation design and implementation in that area. DEQ has also been provided an acceptable schedule for project implementation up to system installation (early 2016). A schedule for system operation and performance monitoring will be provided with the remedial design scheduled for submittal in late 2015.

Statutory Determinations

The remedy, as modified, remains protective and continues to reflect the best balance of trade-offs considering treatment of hot spots, effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. Performance monitoring will provide the basis for DEQ's final determination of whether the remedial action satisfies these statutory requirements. The selected remedial action with the modification described in this document, therefore, satisfies the requirements of ORS 465.315 and Oregon Administrative Rule (OAR) 340-122-040.

Public Notice

Public notice of this remedial action change will be published in the Secretary of State's Bulletin and The Oregonian newspaper. The Administrative Record is available for public review.

Signature

Kevin Parrett, Manager
NW Region Cleanup Program
Oregon DEQ

Attachments

Figure 1	Vicinity Map
Figure 2	Evaluation Area 1 Operational Units
Figure 3	TCE Concentrations in Groundwater, West
Figure 4	Building 40, IWWTF Unit
Figure 5	Building 38 Operational Unit