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FINAL

Stead Solvent Site 2019 Long-Term Monitoring and Remediation Progress Report

Operable Unit 1
Washoe County, Nevada
Facility ID Number – D-001280

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Abbreviations and Acronyms

AAWC	Airport Authority of Washoe County
ACL	Alternative Concentration Limit
AEEC	American Environmental and Engineering Consultants, LLC
AS	Air Stripper
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
ºC	Degrees Celcius
COPC	Chemical of Potential Concern
DCA	Dichloroethane
DCE	Dichloroethene
DO	Dissolved Oxygen
DPE	Dual Phase Extraction
EDB	Ethylene Dibromide (1,2-Dibromoethane)
EPA	Environmental Protection Agency
FS	Feasibility Study
FSP/QAPP	Field Sampling Plan and Quality Assurance Project Plan
GAC	Granular activated carbon
GWEX	Groundwater Extraction
LNAPL	Light non-Aqueous Phase Liquid
LTM	Long Term Monitoring
MCL	Maximum Contaminant Level
MDL	Analytical Method Detection Limit
mg/L	Milligram(s) per liter
mV	Millivolt
µg/L	Microgram(s) per liter
µmhos/cm	Micromhos per centimeter
Mgal	Million gallons
MNA	Monitored Natural Attenuation
MS/MSD	Matrix Spikes/Matrix Spike Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection, Department of Conservation and Natural Resources
NDWR	Nevada Division of Water Resources
NM	Not Measured
NOT	Non-Operational Test

NTU	Nephelometric Turbidity Units
ORP	Oxidation/Reduction Potential
OU1	Operable Unit 1
OWS	Oil/Water Separator
PCE	Tetrachloroethene
POTW	Public Owned Treatment Works
QA/QC	Quality Assurance/Quality Control
RAG	Remedial Action Goal
RAO	Remedial Action Objective
RBCG	Risk-Based Cleanup Goal
ROD	Record of Decision
RPD	Relative Percent Difference
RL	Laboratory Reporting Limit
RTAA	Reno-Tahoe Airport Authority
SVE	Soil Vapor Extraction
TCA	Trichloroethane
TCE	Trichloroethene
TMWA	Truckee Meadows Water Authority
USTs	Underground Strorage Tanks
VGAC	Vapor Phase Granulated Activated Carbon
VM	Vapor Monitoring
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WCHD-AQMD	Washoe County Health District - Air Quality Management Division

1.0 Introduction

AEEC is pleased to provide this *2019 Long-Term Monitoring and Remediation Progress Report* for the Stead Solvent Site (the Site) Operable Unit 1 (OU1) to the Nevada Division of Environmental Protection (NDEP). AEEC is coordinating the OU1 Remedial Action on behalf of the Reno-Tahoe Airport Authority (RTAA), formerly known as the Airport Authority of Washoe County (AAWC), the City of Reno, Moya Olson Lear, Leareno Development, Lear Family Trust, Moya Corporation and Lear Fan Corporation, which are defined as the Appropriate Parties in the Consent Decree.

The primary purpose of this report is to document groundwater monitoring activities conducted in calendar year 2019 and evaluate progress made towards achieving remedial action objectives (RAOs). The report also includes discussion on the status of remediation systems and observations about the Post-Remedial Phase currently being conducted at the Site.

1.1 Report Objectives

The objectives and purpose of this report are:

- Present the results of long-term monitoring (LTM) events performed in February, May, August, and November 2019. These events included groundwater elevation monitoring, measuring groundwater quality parameters in the field, and sampling groundwater for laboratory analysis of volatile organic compounds (VOCs);
- Provide an update on the status of the Post-Remedial Phase;
- Document permit compliance for 2019; and
- Summarize the progress of the OU1 remedies toward achieving RAOs.

1.2 Report Organization

The report is organized as follows:

- ***Section 1.0 – Introduction*** describes the purpose and objectives of the Long-Term Monitoring and Remediation Progress Report and the report organization;
- ***Section 2.0 – Operable Unit 1 Background*** describes the OU1 Record of Decision (ROD) requirements, including the RAOs, remedial action goals (RAGs), and the selected remedy.
- ***Section 3.0 – Groundwater Monitoring Results for 2019*** presents the results of quarterly groundwater monitoring for calendar year 2019;
- ***Section 4.0 – Remedial Action Objectives Evaluation*** reviews the 2019 quarterly groundwater monitoring results in the context of the RAOs and the Long-Term Monitoring program;

- ***Section 5.0 – Conclusions and Recommendations*** summarizes the progress of the OU1 remedies towards achieving RAOs and provides recommendations for modifying the groundwater monitoring program; and

- ***Section 6.0 – References*** lists the references cited in this report.

2.0 Operable Unit 1 Background

The Stead Solvent Site OU1 is located in the northwest portion of the former Stead Air Force Base, adjacent to the southern portion of the Reno-Stead Airport approximately 13 miles north of Reno in Washoe County, Nevada as shown in Figure 1 – Site Location Map. The Air Force Base was constructed in the 1940s and was used as a military training facility, light aircraft airport, and for light industrial and manufacturing activities. Following site investigation activities in the 1990s, a single operable unit (OU1) was defined to address groundwater contaminated by various organic solvents. Fuel related constituents have also been detected in groundwater in localized areas of the Site (CDM 2000).

The Appropriate Parties joined in a *Consent Decree* with the United States, the National Guard, and NDEP whereby they agreed to implement remedial actions at the Site. The United States District of Nevada Court entered the *Consent Decree* on January 31, 2000 to supervise its implementation and ensure adherence to applicable environmental regulations. Lear entities reached a settlement with the Appropriate Parties in March 2005 resulting in a payment to the trust account that is being used to administer the OU1 Remedial Action. Several Federal Agencies reached a funding agreement with the Appropriate Parties including the National Guard (the National Guard Bureau, the Nevada National Guard, the Nevada Army National Guard, and the Nevada Air National Guard); and the United States on behalf of the United States Air Force, the United States Army, and the U.S. Army Corps of Engineers.

The ROD dated July 21, 2000 was developed pursuant to the Consent Decree to define the RAOs and RAGs as well as to define the selected remedy for the Stead Solvent Site OU1. The selected remedy was based on the results presented in the *Final Feasibility Study* (FS) dated June 28, 1999 (CDM 1999b). Design parameters for the selected remedy were developed and presented in the *Revised Preliminary Design Report* dated November 15, 2002 (CDM 2002). The technical specifications and design documentation for the construction of the remediation system is presented in the *Contract Documents and Technical Specifications* (Design Specifications) dated April 12, 2004 (SECOR 2004).

Chemicals of Potential Concern (COPCs) in groundwater have been variously defined in documents pertaining to site characterization and remediation at the Site. A baseline human health risk assessment was conducted using data collected in 1995 and was updated using data collected in 1997/1998. The eight chemicals that were originally identified as COPCs using data from 1995 are shown in Table 3-5 of the ROD (CDM 2000). The result of the updated risk assessment was to remove carbon tetrachloride from the list of COPCs because it was not detected in the 1997/1998 data set and to add tetrachloroethene (PCE) to the list of COPCs based on concentrations that were two orders of magnitude higher than those reported in 1995. The updated list of eight COPCs is presented in Table H-17 of the Final Feasibility Study along with possible source area risk based cleanup goals (RBCGs). In contrast to Table 3-5 of the ROD, Section 3.6 of the ROD lists nine COPCs, which include the updated list of eight COPCs in Appendix H of the Final Feasibility Study plus 1,1-Dichloroethane for which no RBCG was developed in the Final Feasibility Study (CDM 1999b). Previous Long-Term Monitoring and Remediation Progress Reports attempted to incorporate all the COPCs that had been identified in the various evaluation and decision documents for the sake of completeness. Consistent with the revised risk assessment in the Final Feasibility Study and the updated list of potential risks from exposure to site chemicals listed in Table 3-15 of the ROD, the following chemicals are presented as COPCs in this report along with associated Maximum Contaminant Levels (MCLs) and RBCGs.

COPC	RBCG [1] (source areas) (µg/L)	ACL [2] (tributaries)	MCL (µg/L)	Offsite Point of Exposure[3] (SLWDC-4)
Trichloroethene (TCE)	210	37.5 µg/L	5	0.5 µg/L
Tetrachloroethene (PCE)	218	none	5	none
1,1-Dichloroethene (1,1-DCE)	490	none	7	none
1,2-Dichloroethane (1,2-DCA)	9,750	none	5	none
1,1,1-Trichloroethane (1,1,1-TCA)	42,697	none	200	none
1,1,2-Trichloroethane (1,1,2-TCA)	3,840	none	5	none
Benzene	1,470	none	5	none
Ethylene Dibromide (EDB)	20	none	0.05	none

[1] From Table H-17, Human Health Risk Assessment, Appendix H of the Final Feasibility Study (CDM 1999b).
[2] From ACL Calculations, Appendix J of the Final Feasibility Study (CDM 1999b).
[3] Offsite Point of exposure concentration based on conversations with NDEP. (Appendix J, p. J-1 of the Final Feasibility Study, CDM 1999b).

2.1 Record of Decision Requirements

RAOs were established in the OU1 ROD to protect human health and the environment and to address potential future risk scenarios (CDM 2000). RAGs were developed for areas with groundwater contamination above Safe Drinking Water Act MCLs. Figure 4 shows the estimated distribution of TCE above MCLs in the A-horizon as well as pertinent site features.

2.1.1 Remedial Action Objectives

RAOs state the overall objectives and goals for the Site and include:

- **RAO #1:** Prevent ingestion and/or inhalation exposure from the use of or exposure to contaminated groundwater in excess of a 10^{-5} [excess] cancer risk;

- **RAO #2:** Prevent the distribution of groundwater for public water supply containing constituent concentrations above MCLs in accordance with the Safe Drinking Water Act; and

- **RAO #3:** Prevent the distribution of groundwater for irrigation or watering of livestock containing constituent concentrations in excess of toxic material standards listed in Nevada Administrative Code (NAC) Part 445A.1236 [1].

2.1.2 Remedial Action Goals

NAC 445A.22735 indicates that the action level for a hazardous substance, hazardous waste, or a regulated substance in groundwater must be established based on the MCL pursuant to the Safe Drinking Water Act, the background concentration, or in the absence of an MCL, an appropriate level of concentration that is based on the protection of public health and safety and the environment using the Integrated Risk Information System or equivalent method. If more than one action level for groundwater is established, the most restrictive action level must be used.

RAGs for the Stead Solvent Site were developed for areas with groundwater contamination above MCLs and are presented in Table H-17 of the Human Health Risk Assessment based on the RAOs (CDM 1999b). In the risk assessment, RBCGs were developed for two potential future exposure pathways:

1) Future onsite construction workers performing excavation work; and
2) Future offsite groundwater users.

The RBCGs for future onsite construction workers assume exposure within the source areas where groundwater contaminant concentrations result in a cancer risk in excess of 10^{-5} or a hazard index of greater than 1. The point of exposure for the future offsite groundwater user is drinking water production and recharge well SLWDC-4 (Figure 4). The allowable exposure concentration at this location was determined only for TCE, presumably because TCE is the primary risk driver among the COPCs. In addition, mass loading calculations indicated that concentrations above the MCL could reach the offsite point of exposure well without active remediation. The allowable exposure concentration for TCE at SLWDC-4 is 0.5 micrograms per liter (µg/L), which is one-tenth of the Environmental Protection Agency (EPA) MCL. This was considered to be an appropriately conservative exposure concentration (CDM 1999b).

The RBCG for impacted groundwater tributary to SLWDC-4 was determined to be 37.5 µg/L for TCE. Tributary is explained in Appendix J of the Final Feasibility Study as contaminant plume areas in the upper water bearing zone that may flow downward to the aquifer systems feeding water supply wells SLWDC-4 and SLWDC-1 due to a discontinuity of the aquitard that normally separates these aquifers (CDM 1999b). Consistent with NAC 445A.22735, the Alternative Concentration Limit (ACL) for TCE is the lower of the two RBCGs (i.e., 37.5 µg/L vs. 210 µg/L).

2.1.3 Selected Site Remedies

The purpose of remedial action at the Site is to address COPCs in the shallow groundwater aquifer using source area controls which include dual phase extraction (DPE) and soil vapor extraction (SVE). Groundwater hydraulic containment, COPC mass removal using groundwater extraction wells (GWEX), and phytoremediation were also implemented in areas where TCE concentrations exceeded the site-specific ACL. Remediation system construction details were developed in the Construction Specifications and Engineering Design Drawings (SECOR 2004).

[1] The ROD references NAC Part 445A.144. The Nevada Administrative Code currently lists "toxic material standards" under NAC Part 445A.1236. Section 1236 is therefore the applicable reference in this report.

2.2 Remedial Infrastructure

The remediation system at the Stead Solvent Site OU1 consists of nine DPE, nine SVE, six GWEX wells, and two remediation compounds containing treatment equipment. The wells, the layout of associated conveyance piping, and locations of the remediation compounds are shown on Figure 3. The components of the remediation compounds are discussed in previous Long-Term Monitoring and Remediation Progress reports and are documented in the Technical Specifications and Design Drawings (SECOR 2004).

2.2.1 Phytoremediation

Phytoremediation was implemented in April 2006. The phytoremediation system was intended to intercept and treat contaminated groundwater downgradient of the TCE plume source areas. However, ambient climate conditions and the depth to groundwater at the Site rendered the system difficult to maintain and of negligible utility. Therefore, the phytoremediation effort was discontinued as part of the Stead remediation program in 2015.

2.2.2 Monitoring Well Network

The monitoring well network at the Site is shown in Figure 2. Monitoring well locations and construction details are summarized in Table A1 (Appendix A). The network consists of 86 monitoring wells of varying diameters which are screened through the different groundwater horizons. The horizons are defined here as:

- ***A-Horizon Aquifer*:** The uppermost groundwater bearing aquifer which includes monitoring and remediation wells with average screen intervals ranging from approximately 20 to 36-feet below ground surface (bgs);

- ***B-Horizon Aquifer*:** The mid-depth groundwater bearing aquifer which includes monitoring wells with average screen intervals ranging from approximately 56 to 69-feet bgs; and

- ***C-Horizon Aquifer*:** Deep groundwater bearing aquifer which includes monitoring wells with average screen intervals ranging from 99 to 111-feet bgs.

2.2.3 Operations and Maintenance

Groundwater extraction from the operating DPE and GWEX wells was suspended at the start of the NOT period (December 2015). Soil vapor extraction activities were also suspended at that time. The remediation systems are being maintained in standby status should remediation recommence at the Site in the future. Remediation equipment was tested in 2019 during annual O&M system checks to ensure that system components remain operational and ready for use. The following activities were completed at the Site during calendar year 2019:

- November 5, 2019 – changed oil, cleaned air filters, and tested function of air compressors in remediation compound #1; pneumatically purged air lines; tested all transfer pumps, changed oil in SVE blowers and greased bearings; tested function of SVE blowers; tested function of float switches in remediation compound #1 equalization tank; tested function of heaters and exhaust fans; tested lighting and control panel bulbs; tested system alarms; cleaned air intake filters for SVE blowers; sealed building with caulk.

- November 6, 2019 – changed oil, greased bearings, adjusted belt tension, and cleaned air intake filters on SVE blowers in remediation compound #2; tested all transfer pumps in remediation compound #2; tested function of float switches for equalization tank and oil water separator; replaced high-high level floats for both the equalization tank and oil water separator; replaced oil, cleaned air intake filters, and tested function of air compressor; pneumatically purged air lines; tested function of air stripper unit; tested system alarms; tested heaters and exhaust fans; removed vegetation around remediation compound #1 and #2 buildings.

  November 7, 2019 – Inspected remediation well vaults.

2.3 Stead Solvent Site OU1 Permits

Operation of remediation systems at the Site requires permits from: (1) the State of Nevada Division of Water Resources (NDWR) for groundwater extraction; (2) the City of Reno Publicly Owned Treatment Works (POTW) for wastewater discharge to the sanitary sewer; and (3) and the Washoe County Health District – Air Quality Management Division (WCHD-AQMD) for emitting treated air to the atmosphere. Although the treatment systems remain inactive during the Post-Remedial Phase, permits are kept current due to the possibility that the systems will resume operation in the future. Descriptions of remediation system operating permits are provided below.

2.3.1 Water Production Permit

Groundwater extraction at the Stead Solvent Site OU1 occurs under the provisions of NDWR permit numbers 72015E and 72016E, first issued on February 9, 2004. Per the conditions of the permits, water production totals are required to be submitted to the NDWR on an annual basis. A copy of the permit is included in Appendix B. No groundwater was extracted during the 2019 operational year; however, an annual groundwater pumpage report was prepared for permit compliance purposes (AEEC 2020). A copy of the 2019 Groundwater Pumpage Report is provided in Appendix C.

2.3.2 Wastewater Management

Discharge of treated groundwater from the Stead Solvent Site OU1 remediation system to the POTW is authorized according to the terms of City of Reno Environmental Control Permit #913336-01. The permit requirements include effluent limitations on concentrations of specific constituents, including various inorganic water quality parameters, benzene, BTEX (benzene, toluene, ethylbenzene, and xylenes), VOCs, SVOCs, metals, total petroleum hydrocarbons, oil and grease, and pH. Self-monitoring requirements include semi-annual sampling and laboratory analysis of treated groundwater and submittal of semi-annual reports to the City of Reno (Appendix D). The permit applicable for this operating period is included in Appendix B. The system remained inactive during 2019, therefore, no groundwater was treated and discharged to the sanitary sewer.

The remediation system was last activated to process and treat groundwater on November 2, 2017, when approximately 350 gallons of purged groundwater that was collected during quarterly groundwater sampling events were discharged (AEEC, 2018). Since that time, groundwater has been transported offsite for disposal and the air stripper has only been turned on during annual maintenance to ensure that the system is operational.

2.3.2.1 Air Discharge Permit

The WCHD-AQMD approved the Appropriate Parties' Application for an Authority to Construct/Permit to Operate a contaminated groundwater remediation system at the Reno-Stead Airport Facility. The permit approval provided Conditions for Operation in a letter to AEEC dated January 3, 2005. A subsequent final Permit to Operate was issued by the WCHD-AQMD in September 2005 (Permit A05-0001). The WCHD-AQMD conditions for operation included granular activated carbon (GAC) efficiency testing. The purpose of the carbon efficiency testing was to demonstrate a capture efficiency of 90% (or greater) of total VOCs in system emissions using carbon adsorbers. A request to remove the air treatment process from the groundwater treatment system was approved by WCHD-AQMD in a letter dated June 19, 2015. The letter granted authority to discontinue use of GAC attached to the air stripper system and discharge vapor emissions directly to the atmosphere as long as the VOC emissions remained below the *de minimis* value of one pound per day. The permit continues to be renewed annually should the remediation system resume operation. The permit number was updated from A05-0001 to AAIR16-0067 by the WCHD-AQMD during the 2017 reporting period. The applicable permit for this operating period, valid through September 30, 2020, is included in Appendix B.

2.4 Deferral of Corrective Action Study

In addition to chlorinated organic solvents, which have been the focus of groundwater remediation at the Site, fuel products such as BTEX and EDB have also been detected in groundwater and are routinely monitored. The remediation strategy that was developed in the Feasibility Study (CDM 1999b) and formalized in the ROD (CDM 2000) assumed that remediation of TCE in groundwater to RBCGs would effectively reduce other COPCs to levels that are protective of human health and the environment. Consistent with that strategy, the remedial alternative that was implemented at the Site was designed to address chlorinated organic solvents only (AEEC 2012).

Following a period of active remediation, it became apparent that the quantity and extent of fuel-related contamination in the subsurface was greater and more widespread than originally thought. This negatively affected the groundwater treatment process as fuel compounds interfered with the efficient removal of TCE and consumed GAC at a faster rate than designed and budgeted for. As a result, the remediation system operated below its designed capacity for several years to conserve GAC and continue to operate within the project budget.

An evaluation of historical BTEX/EDB contamination was conducted based on groundwater data that was collected between 1990 and 2012. A Deferral of Corrective Action Study report (AEEC 2012) resulting from this evaluation presented the following conclusions and recommendations:

- The presence of free-phase fuel compounds near Source Area 1 represents a continuing source of BTEX and EDB contamination in groundwater;

- Elevated BTEX is preventing the efficient removal of TCE and other chlorinated volatile organic compounds in the area(s) where these plumes are co-located and is increasing the time required to clean up the TCE plume;

- A revised operational strategy that temporarily minimizes or defers the removal and treatment of fuel related compounds, particularly in the vicinity of Source Area 1, will return the remediation systems to efficient removal of TCE and related chlorinated organic compounds;

- Specific operational changes may include deactivating one or more of the dual-phase extraction wells in Source Area 1, where the majority of BTEX and EDB-impacted groundwater is located;

- Deferring the remediation of environmental media impacted by BTEX and EDB would not increase the risk to potential receptors;

- The BTEX/EDB plume appears to be stable and/or decreasing; and

- BTEX/EDB contamination does not appear to present a risk to the nearest water supply well.

2.5 Non-Operational Test and Post-Remedial Phase

A Non-Operational Test Plan was submitted to the Nevada Division of Environmental Protection in November 2015 (AEEC 2015) and was implemented in December 2015. The objective of the NOT was to determine if continued groundwater extraction for hydraulic plume containment and contaminant mass removal was necessary or could be optimized to progress the Site towards conclusion of remedial action.

Justification for implementing the NOT included:

- TCE concentrations in source area monitoring wells remained near or below the TCE Source Area RBCG of 210 µg/L;

- Source area groundwater samples exhibited decreasing or stable TCE trends with the exception of DPE-302;

- With the exception of three ACL Plume Area monitoring wells, TCE concentrations were near or below the ACL or exhibited decreasing trends towards the ACL; and

- From the beginning of 2011 through the end of 2014, TCE mass removal efficiency by groundwater extraction and treatment decreased from approximately 2.5 to 1.5 lbs. per million gallons per quarter.

Groundwater extraction from the operating DPE and GWEX wells was suspended at the start of the NOT period (December 2015) and continued through calendar year 2019.

A Post-Remedial Phase began in 2019 to continue data collection to assess the possibility of termination of remediation. Data collected during the Post-Remedial Phase will be used to evaluate contaminant concentrations and trends and plume stability and if an exemption of corrective action and termination of remedial actions at the Site should be pursued.

2.6 Termination of Remediation

Nevada Administrative Code, NAC 445A.22725 establishes the requirement for corrective action at sites where groundwater is contaminated by the release of a hazardous substance, hazardous waste, or regulated substance, and the level of contamination exceeds the action levels for groundwater at the site. This section of the Code also allows for exemptions from the corrective action requirement at any time before, during, or after termination of remediation at a site if the following conditions are satisfied:

- The owner or operator submits a request for exemption from the requirement for corrective action;
- Each source of contamination is identified and controlled or no longer remains;
- The magnitude and extent of contamination is known; and
- Data from a minimum of three years of quarterly monitoring are available and indicate contaminant concentrations are not increasing in the body of the plume.

The request for exemption must be in writing and include any supporting documentation required by NDEP. In addition, it must be demonstrated that natural attenuation will reduce contaminant concentrations below action levels or prevent migration of the contamination to a receptor or other point established by NDEP at concentrations above the action levels. The contaminated groundwater cannot be a current or future source of drinking water because it is impractical to recover and treat the groundwater for human consumption, or because of legal restrictions or institutional controls preventing the use of groundwater. A demonstration of effective natural attenuation may rely on:

- Analytical or numerical modeling of diffusion and dispersion or other calculations approved by NDEP;
- Any known biological degradation mechanism;
- Evidence of metabolic activity; and
- The appropriate redox potential that supports biological degradation of the contamination.

Other supporting evidence may be used such as the presence of daughter products indicating that degradation is taking place and applicable risk-based factors may be specified by NDEP, which support the request for exemption.

NAC 445A.22745 allows an owner or operator of a contaminated site to terminate remediation under the following conditions:

- Contamination can be shown to be consistently below the action level established for the site;
- Following treatment for at least one year, monthly measurements indicate that the concentration of dissolved constituents fits a substantially linear curve that approaches a zero slope at the final portion of the curve (asymptotic); or
- A test for asymptotic concentrations is not appropriate based on:
    - The nature of treatment used;
    - Site conditions that limit the effectiveness of any available treatment; and
- Termination of remediation must be in accordance with the conditions established in an approved corrective action plan or amendment thereof.

Termination of remediation is subject to submittal of written documentation and concurrence from NDEP. After remediation has been terminated in accordance with the above provisions, groundwater must be

monitored for not less than one year at a frequency determined by NDEP to evaluate the levels of contamination in groundwater.

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3.0 Groundwater Monitoring Results for 2019

This section summarizes groundwater monitoring activities conducted in calendar year 2019 and associated results. Specific data collection activities included:

1) Measuring static groundwater levels;
2) Taking physical and chemical measurements of groundwater using field instrumentation;
3) Collecting groundwater samples for laboratory analysis;
4) Collecting quality control samples for laboratory analysis;

These activities were performed in accordance with the *Field Sampling Plan and Quality Assurance Project Plan* (FSP/QAPP), dated June 25, 1999 (CDM 1999a) and in accordance with protocols described in the 2019 LTM Work Plan (AEEC 2019). Specific groundwater monitoring procedures are summarized below along with the results of data evaluation and interpretation.

3.1 Groundwater Elevation Monitoring

Water depth measurements were collected from selected wells on February 5, May 7, August 13, and November 5, 2019. Prior to collecting groundwater samples for chemical analysis, the depth to groundwater was measured in each accessible monitoring well using a Solinst® Model 101 water level indicator. The 2019 quarterly water levels are tabulated in Tables 1A through 1D along with calculated groundwater elevations that were used to prepare potentiometric surface maps.

3.1.1 Local Groundwater Elevation Trends

Historical depths to groundwater and calculated groundwater elevations are presented in Table F1 of Appendix F. Groundwater elevations are plotted as a function of time for selected, representative monitoring wells in the A-, B-, and C-Horizons and are presented in Appendix G. As would be expected, water levels in wells that were previously within the areas of influence of extraction wells have risen since active remediation was suspended in 2015 and appear to have generally stabilized since about 2017, except for seasonal fluctuations. Groundwater elevation graphs for MW-101A (Figure G-7), MW-115A (Figure G-15) and MW-123A (Figure G-18) provide some examples of increased water levels since the suspension of groundwater extraction. It also appears that increasing water level trends and decade-high groundwater levels have occurred at some monitoring locations.

3.1.2 Potentiometric Surfaces

Groundwater potentiometric surface maps have been generated to analyze local groundwater flow patterns during the reporting period. The A-, B-, and C-Horizon potentiometric surfaces measured during the 2019 quarterly LTM events are presented in Figures 5A1, 5B1, and 5C1 for the February 2019 event; Figures 5A2, 5B2, and 5C2 for the May 2019 event; Figures 5A3, 5B3, and 5C3 for the August 2019 event; and Figures 5A4, 5B4, and 5C4 for the November 2019 event. These figures also include the estimated distribution of the 2019 TCE plumes. The groundwater gradient immediately to the west of the aquifer discontinuity is steeper than that to east of the discontinuity, likely due to a decrease in hydraulic conductivity related to the fault (Figure 4). The predominant groundwater flow direction is to the northwest in all three horizons; however, the C-Horizon has a stronger west component than the other two horizons. Groundwater elevation contouring of the A-Horizon indicates the presence of a potentiometric surface depression in the vicinity of

MW-110A, MW-111A, MW-117A, and MW-118A (Figures 5A1-5A4). This area has historically been near the northwestern margin of the TCE plume and has been referred to as the "Plume Termination Area" in previous reports (see Figure 4).

Due to the proximity of wells SLWDC-4 and SLWDC-1, TMWA's injection and extraction program may affect the flow of groundwater adjacent to the Stead Solvent Site. Therefore, the evaluation of the LTM data includes monitoring the possible impact of TMWA's activities upon the groundwater flow patterns and migration of contaminants from the Stead Solvent Site OU1. The nearest production well is SLWDC-4, which is located approximately 3,000 feet west of Source Area 3, just north of monitoring well P-1. SLWDC-4 is screened from 192 to 812 ft. bgs in deeper aquifers (Appendix A, Table A1). Figure 5A4 shows apparent groundwater mounding around well P-1, which corresponds to periods of time during which TMWA recharged SLWDC-4 in the last quarter of 2019. The mounding effect may therefore be more pronounced than shown on the figures, which are limited by the available data that don't include groundwater elevations from SLWDC-4. TMWA provides annual reports to the NDWR and NDEP to summarize the results of its subsurface monitoring. The *Report on Aquifer Storage and Recovery – West Lemmon Valley Hydrographic Basin 92A*, *January 1 Through December 31, 2019* has been included as Appendix H. Monthly water production and recharge volumes for the closest public water supply well, SLWDC-4, are summarized in Table 2 of this report for calendar years 2014-2019. During 2019, 19.6 million gallons of water were recharged into the aquifer and 1.9 million gallons were extracted from SLWDC-4 (Table 2 and Appendix H).

3.1.3 Light Non-Aqueous Phase Liquids

Light non-aqueous phase liquids (LNAPLs) have historically been observed in monitoring wells MW-123A and MW-123B in the form of a petroleum sheen. Prior to May 2014, measurable free-phase petroleum product had also been documented in MW-123A. These wells are located downgradient of Source Area 1 within the petroleum plume greater than 1,000 µg/L benzene isocontour line (see Figure 9). Due to the potential presence of free-phase petroleum product, all wells on the sampling schedule were monitored using an oil/water interface probe. LNAPL was not detected in any of the wells that were monitored in 2019. Historical LNAPL detections are shown in the comments in Table F1 of Appendix F.

3.2 Physical and Chemical Parameters

Groundwater was monitored for water quality parameters in the field during well purging using a flow-through cell to determine when parameters had stabilized prior to sampling. Water quality parameters included pH, conductivity, temperature, turbidity, oxidation-reduction potential (ORP), and dissolved oxygen (DO). The 2019 quarterly water quality parameters are presented in Tables 3A, 3B, 3C, and 3D. Historical water quality parameter results since remediation system startup in 2005 are presented in Table F2 of Appendix F.

3.3 Groundwater Sampling and Analysis

Groundwater samples were collected during scheduled monitoring events in February, May, August, and November of 2019. Monitoring wells were sampled for VOCs using EPA low-flow micro purge techniques. Each groundwater sample was collected in three 40 milliliter volatile organic analysis (VOA) vials that had been prepared in advance by the laboratory using hydrochloric acid as a preservative. VOA vials were inspected prior to shipping to ensure that no headspace or bubbles remained within the vials. The sample

containers were then labeled, sealed in Ziploc-type bags, placed in ice-filled, insulated coolers and transported under chain-of-custody protocol to Alpha Analytical, Inc. in Sparks, Nevada. The laboratory was instructed to analyze the groundwater samples for VOCs according to SW846 Method 8260B. Alpha Analytical is certified by the NDEP Laboratory Certification Program to perform the required analysis. Groundwater samples collected during the second quarter sampling event were also analyzed for ethylene dibromide (EDB) by EPA Method 504.1, which enabled assessment of concentrations below the MCL (0.05 µg/L) for EDB. Analytical data are summarized in Table 4A through Table 4D for the 2019 quarterly sampling events.

3.3.1 Quality Assurance/Quality Control

Each VOC sample was analyzed within the required 14-day holding time. The following quality control (QC) samples were collected in the field to enable evaluation of analytical data quality: trip blanks, equipment rinsate samples, field duplicates, matrix spikes, and matrix spike duplicate samples (MS/MSDs). QC samples were collected at the frequencies specified in the 2019 LTM Work Plan and FSP/QAPP (a total of 5% or 1 per every 20 field samples). The laboratory also prepared surrogate spike samples and method blanks in addition to performing routine instrument calibration checks.

Tables 5A, 5B, 5C, and 5D summarize the results of the Quality Assurance/Quality Control (QA/QC) sample analyses for 2019 quarterly monitoring events. In accordance with the field QA/QC procedures described in the FSP/QAPP, duplicate (split) samples and triple quantity media samples were collected at a frequency of one per 20 samples (5%) for purposes of MS/MSD analyses. Equipment rinsate blanks were also collected at the same frequency. Trip blanks accompanied every shipment of samples to the laboratory. Specific QA/QC results are summarized below:

3.3.1.1 Trip Blanks

The laboratory prepared trip blanks by filling VOC sample bottles with analyte-free water. Trip blanks were transported to the sampling site and remained with the field sample bottles during storage and transport to the laboratory. A total of nine trip blanks were submitted to the laboratory during 2019 quarterly sampling; two in February, three in May, two in August, and two in November. No contaminants of concern were detected in trip blanks, indicating samples were not affected by potential ambient conditions.

3.3.1.2 Rinsate Samples

Rinsate samples were collected with analyte-free water following the decontamination of the non-dedicated sampling equipment to check the effectiveness of the decontamination process. A total of seven equipment rinsate samples were submitted for laboratory analysis during 2019 quarterly sampling events. VOCs were not detected above RLs in rinsate samples with the exception of the sample collected on 10 February 2019. Dichloromethane was detected at 2.2 µg/L, however, it was just above the laboratory reporting limit of 2.0 µg/L (Table 5A). This indicates that equipment decontamination methods were effective.

3.3.1.3 Field Duplicate Samples

Field duplicate samples were collected to evaluate the degree of heterogeneity of the sample matrix and precision or variability attributable to field sampling/handling and laboratory preparation/analytical methods. Samples were collected at a rate of 1 in 20 (5%) according to the FSP/QAPP.

Performance acceptance criteria were not established for field duplicates in the QAPP. However, the laboratory has established Relative Percent Difference (RPD) limits for laboratory duplicates (MS/MSDs), which are split from the same sample collected in the field and vary depending on the analyte. All COPCs were analyzed in MS/MSD samples.

Because additional variability is expected between co-located (duplicate) samples collected in the field, the acceptance criteria for field duplicates is generally higher than for laboratory duplicates, which are typically aliquots split from the same sample container. It is common to use <30% to <40% RPD as the acceptance criterion for field duplicates with aqueous matrices. A 30% upper threshold has been adopted as the RPD acceptance criteria for COPCs in field duplicate samples when both sample results are greater than 5 times the laboratory reporting limit. If one or both detected results are less than 5 times the reporting limit, an alternate acceptance criterion of ±2 times the reporting limit is compared to the difference between field duplicate results. If field duplicate results do not meet the acceptance criteria, they are qualified in summary tables with a "J" and analytical results are considered estimates. All field duplicate samples evaluated for this report were below the applicable 30% RPD or ± 2x the RL acceptance criteria. Any "J" flagged data appearing in summary tables have therefore been qualified by the laboratory for other quality control reasons.

3.3.1.4 Matrix Spike & Matrix Spike Duplicate Samples

Matrix spike (MS) and matrix spike duplicate (MSD) samples were collected at a frequency of one per every 20 primary samples, in accordance with the FSP/QAPP. Samples were subsequently submitted for analysis by EPA Method 8260B for VOCs. MS/MSD samples were spiked by the laboratory with known concentrations of target analytes before sample analysis. The calculated percent recovery of analytes in the MS and MSD measures the accuracy of the analytical method relative to the laboratory control spike. In addition to spike recoveries, the RPD between analyte concentrations detected in the MS and MSDs were calculated as a measure of precision of the analytical method or reproducibility.

Tables 5A through Table 5D summarize the results of MS/MSD analyses performed during calendar year 2019. These tables identify individual analytes that were outside of the laboratory's control limits. When RPDs are outside of the laboratory control limits, the reproducibility of the analysis of a particular compound is less than normal, which may suggest heterogeneity of the sample matrix and a lower degree of analytical precision. Spike recoveries that are outside the laboratory's control limits indicate a lower than normal degree of accuracy for a given analyte due to matrix interferences and the analytical results indicate a high or low bias of that analyte in any of the field samples analyzed in the same analytical batch.

Percent recovery and RPD calculations were within the laboratory control limits for MS/MSD samples, except for the following instances:

- RPDs were outside of laboratory control limits for 16 analytes from the MS/MSD prepared from MW-108C and analyzed on 10 May 2019;
- The RPD was outside of laboratory control limits for Chloromethane from the MS/MSD prepared from MW-126B and analyzed on 16 May 2019;
- Percent recovery was outside of laboratory control limits for 1,1-DCE from the MS/MSD prepared from MW-124B and analyzed on 22 May 2019;
- Percent recovery was outside of laboratory control limits for TCE from the MS/MSD prepared from MW-27R and analyzed on 08 August 2019;
- Percent recovery was outside of laboratory control limits for Benzene from the MS/MSD prepared from MW-123A and analyzed on 26 August 2019;

3.3.1.5 Surrogate Spikes

Surrogate spikes were added to laboratory QC samples and groundwater samples collected in the field for laboratory analysis of VOCs. The spikes consisted of a mixture of compounds with similar but not identical properties as the target analytes potentially found in the sample matrices. Interference affecting the sample will have a similar effect on the spiked surrogate compound. Percent recovery values for the surrogate compounds can therefore be used to assess the accuracy of the reported analyte concentrations. The majority of surrogate spikes were recovered within the control limits established by the laboratory. However, the following surrogate recoveries were outside of the laboratory control limits (70% - 130%):

- 1,2-Dichloroethane-d4
  - MW-114A, 5/14/2019, 131% recovery

- 4-Bromofluorobenzene
  - DPE-105, 5/12/2019, 66% recovery

- Toluene-d8
  - MW-110A, 5/11/2019, 137% recovery
  - MW-109B, 5/14/2019, 131% recovery

3.3.1.6 Method Blanks

The laboratory analyzed method blanks consisting of purified, analyte-free, reagent-grade water that were processed through the entire analytical procedure to determine if samples had been exposed to laboratory chemicals. Method blanks were analyzed at a frequency of one per analytical batch. A total of nine method blanks were analyzed for VOCs during the 2019 quarterly groundwater monitoring events. None of the method blanks contained target compounds at concentrations above the laboratory's PQLs/RLs.

3.3.2 Analytical Results

This section provides a summary of analytical results for groundwater samples collected during the 2019 calendar year. An evaluation of the distribution of the COPCs detected in groundwater at the Site and concentration trends over time is provided in Section 4.2.2. The following summary focuses on TCE as it is the most prevalent COPC that is driving risk. Discussions are also provided for 1,1-DCE, benzene, and EDB because these constituents have been consistently detected above MCLs in various areas and contribute to the overall risk at the Site. Brief summaries are provided for the remaining COPCs (PCE, 1,1,1-TCA, 1,1,2-TCA, and 1,2-DCA) as historical detections of these constituents above MCLs are limited.

Quarterly sampling results for 2019 are summarized in Tables 4A, 4B, 4C, and 4D, respectively. Isoconcentration contour maps are included as Figures 6 and 7 for TCE and Figures 8, 9, and 10 for 1,1-DCE, benzene, and EDB, respectively. The isoconcentration contours in these figures are based on the highest concentration of a given analyte detected in each monitoring well during any of the quarterly groundwater sampling events. They are intended to conservatively represent COPC plume conditions in calendar year 2019.

3.3.2.1 TCE in Source Areas

The TCE plume in the A-Horizon includes the ACL Plume, the Main MCL Plume, and the South MCL Plume (Figure 4). TCE isoconcentration contours for the shallow A-Horizon are shown in Figure 6. TCE

detected in the B- and C-Horizons are depicted in Figure 7. The following discussions compare detected TCE concentrations to the Source Area RBCG (210 µg/L), the TCE ACL (37.5 µg/L), and the TCE MCL (5 µg/L). All TCE concentrations at monitoring wells within the source areas were below the Source Area RBCG during 2019 except for MW-115A and GWEX-006 in the core of the Main ACL plume. Sampling was conducted in accordance with the 2019 Long-Term Monitoring Plan sampling schedule, shown in Table 6 (AEEC 2019). Wells used to monitor Source Areas 1, 2, and 3 are shown within the red boxes in Figure 4. The following observations are noted for wells in this area:

Source Area 1. Groundwater samples were collected from the following monitoring and remediation wells in Source Area 1 during 2019: MW-114A, DPE-101, DPE-104, DPE-105, and DPE-106.

The highest TCE concentrations detected in Source Area 1 in 2019 were in quarterly groundwater samples collected from MW-114A, where TCE exceeded the ACL (37.5 µg/L) but not the RBCG (210 µg/L) during all four quarterly events, and ranged from 110 µg/L to 190 µg/L. TCE was also detected above the ACL but below the RBCG from annual samples collected from DPE-106 at 140 µg/L and DPE-101 at 76 µg/L. A 100-210 µg/L isocontour surrounding MW-114A and DPE-106 represents the highest TCE concentrations in Source Area 1. TCE was also detected in Source Area 1 monitoring wells below the ACL but above the MCL at DPE-104 and DPE-105. TCE was detected up at 7.8 µg/L in quarterly samples collected from DPE-104 and at 11 µg/L from the annual sample collected from DPE-106.

Source Area 2. Source Area 2 wells include: LDI-1A, LDI-1B, LDI-3A, LDI-3B, LDI-4A, LDI-4B, and DPE-201. LDI-1A was the only Source Area 2 well scheduled to be sampled during 2019. TCE was present in the May sample at a concentration of 1.9 µg/L, below the MCL of 5 µg/L.

Source Area 3. Groundwater samples were collected from the following Source Area 3 wells in 2019: MW-102A, MW-102B, MW-102C, DPE-301, and DPE-302. The analytical results for these samples are presented in Tables 4A through 4D and F3 (Appendix F).

MW-102A, MW-102B, and MW-102C were sampled in May 2019. TCE concentrations were below the RL of 1.0 µg/L in samples collected from these wells. TCE concentrations were below the MCL of 5 µg/L in both DPE-301 and DPE-302 samples. TCE was detected at 3.2 µg/L from the annual sample collected in May 2019 from DPE-301 and ranged from 2.0 µg/L to 3.5 µg/L from quarterly sampled collected from DPE-302 (Figure 7).

3.3.2.2 TCE Plume Distribution

There are two areas in which TCE concentrations exceed the ACL. Within these areas, some groundwater samples have also exceeded the source area RBCG. The first area is centered on Source Area 1 and has been discussed in Section 3.3.2.1. This has been referred to as the Source Area 1 ACL Plume (Figure 4). The second area is located to the west of Source Area 3 between approximately GWEX-004 and MW-28R (east/west) and MW-101A and MW-27R (north/south) (Figure 4). The second area has been referred to as the Main ACL Plume in previous reports. Surrounding these two areas are more diffuse plumes defined by TCE concentrations exceeding the 5 µg/L MCL, which is referred to here as the Main MCL Plume (Figure 4).

M**ain ACL Plume.** Groundwater samples were collected from the following wells in this area: MW-29, MW-101A, MW-101B, MW-115A, MW-125A, and GWEX-006. Wells used to update the main ACL TCE plume are identified in Figure 4 with a gold color code and results of samples collected during 2019 are discussed below.

The highest TCE concentrations were found in samples collected from GWEX-006, MW-115A, and MW-101A with TCE concentrations as high as 260 µg/L, 330 µg/L, and 99 µg/L, respectively. Exceedances of the RBCG are represented by a greater than 210 µg/L plume contour surrounding GWEX-006 and MW-115A (Figure 7). During 2019, TCE concentrations exceeded the ACL but not the RBCG at MW-27R, MW-29, MW-125A, and MW-101A and are represented by a greater than 37.5 µg/L plume contour surrounding these locations. TCE concentrations fluctuated above and below the ACL in quarterly samples collected from MW-27R (21 µg/L to 49 µg/L), MW-29 (14 µg/L to 38 µg/L), and MW-125A (1.2 µg/L to 75 µg/L). A groundwater sample collected from MW-101B in May 2019 was below the laboratory RL with respect to TCE.

Main MCL Plume. A diffuse plume of TCE with concentrations exceeding 5 µg/L surrounds the Source Area 1 ACL and Main ACL Plumes. Figure 7 presents an estimate of the area impacted by the plume in 2019. Monitoring wells within the Main MCL plumes include MW-127A, MW-126A, MW-28R, GWEX-004, DPE-104, and DPE-105. Wells used to update the Main MCL plumes are identified in Figure 4 with a blue color code. The following observations apply to TCE concentrations in the remaining wells within the Main MCL Plume:

The toe of the plume extends towards but does not include MW-117A, where TCE was detected just below the MCL at 4.9 µg/L. Further upgradient at MW-127A, TCE was detected up to 6.1 µg/L. MW-126A, which was previously outside of the MCL plume boundary, is within the plume boundary based on 2019 results where TCE was detected at 7.3 µg/L. At GWEX-004, TCE was detected between 16 µg/L and 28 µg/L, above the MCL, but below the ACL and is now outside of the ACL plume boundary when compared to 2018. In Source Area 1, TCE concentrations were detected above and below the MCL in quarterly samples collected from DPE-104, ranging from 2.0 µg/L to 7.8 µg/L and above the MCL at 11 µg/L from a sample collected from DPE-105 in May 2019.

Other TCE Plume Areas. Historically, TCE concentrations have been detected above the MCL in wells to the south of the Main MCL Plume. This South MCL Plume has been defined by TCE detections in groundwater samples collected from MW-22R, MW-31, and MW-32 (Figure 4). MW-22R was sampled in May 2019 and TCE was detected above the MCL at 13 µg/L. MW-31 and MW-32 are both scheduled to be sampled biennially and were most recently sampled in 2018. In 2018, TCE was detected at concentrations of 20 µg/L and 23 µg/L in MW-31 and at 1.3 µg/L in MW-32 (Figure 6). Based on these results, the South MCL plume is depicted by a greater than 5 µg/L contour surrounding MW-22R and MW-31.

TCE has been depicted as isolated occurrences in B-Horizon wells in recent years. During 2019, TCE was detected above the MCL in four B-Horizon wells: MW-105B (68 µg/L), MW-123B (68 µg/L), MW-127B (95 µg/L), and MW-124B (5.5 µg/L); and in one C-Horizon well: MW-110C (5.4 µg/L). MW-105B and MW-123B contained TCE concentrations that exceeded the ACL.

3.3.2.3 1,1-DCE

1,1-DCE is an abiotic decomposition byproduct of TCE and is also manufactured for use in adhesives, synthetic fibers, refrigerants, and coating resins. 2019 plume boundaries and analytical results for 1,1-DCE in the A-, B-, and C-Horizons are shown in Figure 8. 1,1-DCE concentrations in samples collected in 2019 are also shown in Table 4A through Table 4D. 1,1-DCE has a Source Area RBCG of 490 µg/L and a MCL of 7 µg/L.

1,1-DCE in the A-Horizon is partially co-located with the Main ACL Plume described for TCE in Section 3.3.2.2. This plume is defined by recent 1,1-DCE concentrations exceeding the MCL of 7 µg/L.

Concentrations of 1,1-DCE did not exceed the RBCG of 490 µg/L in any of the monitoring wells sampled for this compound in 2019. The maximum 1,1-DCE concentration in the A-Horizon (41 µg/L) was from a sample collected at MW-115A. A small 1,1-DCE outlier with a concentration of 12 µg/L was detected at MW-109A, consistent with previous years.

Several B-Horizon wells: MW-109B, MW-124B, and MW-127B, contained 1,1-DCE concentrations above the MCL of 7 µg/L. Figure 8 depicts the distribution of the 1,1-DCE plume, based on the 2019 monitoring results for B-Horizon wells. 1,1-DCE was not detected above the MCL in any groundwater samples collected from the C-Horizon, in which concentrations ranged from <1 µg/L to 2.0 µg/L.

3.3.2.4 Benzene

The estimated distribution of benzene exceeding the MCL of 5 µg/L is shown in Figure 9 for the A- and B-Horizons. Benzene exceeded the RBCG of 1,470 µg/L in two samples collected in August and November 2019 from MW-123A (2,000 and 2,400 µg/L, respectively), which is west and downgradient of Source Area 1. Benzene was also detected in samples collected from this well at 100 µg/L in February 2019 and 1,400 µg/L in May 2019. A sample collected from GWEX-002 in November 2019 contained benzene at a concentration of 190 µg/L and a sample collected from DPE-101 in May 2019 contained benzene at 4.3 µg/L. All other samples collected from the A-horizon wells were below the RL.

Benzene was detected above the RL in samples collected from MW-109B and MW-123B. Concentrations ranged from 1.0 µg/L in February 2019 to 2.0 µg/L in August 2019 in quarterly samples collected from MW-109B. Benzene was also detected in quarterly samples collected from MW-123B at concentrations ranging from 4.7 µg/L in August 2019 to 46 µg/L in May 2019.

3.3.2.5 EDB

EDB is a fuel constituent with a MCL of 0.05 µg/L. In addition to EPA analytical method SW-846 8260B, samples are collected annually from a subset of wells for analysis by EPA analytical method 504.1, which has a reporting limit below the MCL for EDB. The reporting limit normally used by the laboratory for EDB in groundwater according to SW-846 Method 8260B is 2 µg/L, which is two orders of magnitude higher than the MCL. This additional sampling and analysis allow for assessment of the EDB plume distribution at levels which exceed the MCL. EDB was detected in 12 samples collected from the A-Horizon and six samples collected from the B-Horizon in 2019. It was not detected in any samples collected from the C-Horizon during 2019. EDB plumes in the A- and B-Horizons and the 2019 analytical results are shown in Figure 10. Changes to the 2019 A-Horizon EDB plume from 2018 include an isolated contour around MW-113A, where EDB was detected at 0.067 µg/L, just above the MCL of 0.05 µg/L. The boundary of the leading edge of the plume has also changed to now include MW-126A, MW-115A, and MW-101A where samples were previously not collected for EPA analytical method 504.1.

3.3.2.6 Other Chemicals of Potential Concern

Concentration trends of the other COPCs include:

PCE (MCL = 5 µg/L): PCE was not detected above the RL in any of the wells that were sampled during 2019 quarterly events.

1,1,1-TCA (MCL = 200 µg/L): 1,1,1-TCA was detected at low concentrations above the RL during 2019 monitoring events. It has been observed primarily in and around the area of the main ACL plume (MW-29,

MW-101A, MW-115A, and GWEX-006); in LDI-1A near Source Area 3; and in MW-124B and MW-127B at concentrations ranging from 0.57 J µg/L to 2.6 µg/L. 1,1,1-TCA has not been reported at concentrations above the MCL in any samples collected since April 2000, when it was detected in a sample collected from LDI-1A at a concentration of 460 µg/L;

1,1,2-TCA (MCL = 5 µg/L): 1,1,2-TCA was not detected above the RL in any of the wells sampled in 2019; however, it was estimated at a concentration between the RL and the MCL (0.69 µg/L) in a sample collected from MW-124B in February; and

1,2-DCA (MCL = 5 µg/L): 1,2-DCA has historically been below the RL in the majority of wells monitored for this analyte. During 2019, it was only detected above the RL in samples collected from MW-123B at concentrations ranging from 1.6 µg/L to 2.2 µg/L. Groundwater samples collected from several wells (MW-124B and GWEX-004) also contained 1,2-DCA at concentrations below the RL.

3.3.2.7 Non-COPC TCE Daughter Products

The cis- and trans- isomers of 1,2-DCE are not COPCs but are present at the Site below their respective MCLs. They are constituents of interest as they are potential degradation products of TCE. Cis-1,2-DCE was detected in seven monitoring wells and seven extraction wells during 2019 monitoring events. Concentrations ranged from below the laboratory RL of 1.0 µg/L to 7.8 µg/L (MW-27R) in samples collected from monitoring wells. Slightly higher concentrations were detected in groundwater extraction and dual-phase extraction wells where cis-1,2-DCE ranged from below the RL to 26 µg/L (GWEX-004). By comparison, trans-1,2-DCE has infrequently been reported above RLs and was only detected in one well during the 2019 sampling events: MW-123B at concentrations as high as 1.6 µg/L in May 2019.

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4.0 Remedial Action Objectives Evaluation

This section discusses the results of quarterly groundwater monitoring for the performance period of January 1, 2019 to December 31, 2019 in the context of RAOs that have been established for the Site in the ROD. Section 4.1 addresses preventing exposure to contaminated groundwater in source areas. Section 4.2 discusses the distribution of the contaminant plumes and monitoring to confirm that groundwater contamination above MCLs does not encroach on public water supply extraction points. Section 4.3 focuses on preventing the distribution of groundwater for irrigation or livestock watering purposes if it exceeds the toxic material standards listed in the NAC Part 445A.1236.

4.1 RAO #1: Prevent ingestion and/or inhalation from the use of or exposure to contaminated groundwater in excess of a 10^{-5} cancer risk.

COPC concentrations have been detected in source area groundwater in excess of a 10^{-5} cancer risk or a hazard index of 1. Potential human health risks associated with shallow groundwater beneath OU1 are possible under two future exposure scenarios:

- Future construction workers exposed to the shallow groundwater if construction activities require excavation to the depth of the water table; and

- Future off-site groundwater users if the contaminant plume reaches SLWDC-4 and the water is distributed for potable use (CDM 1999b)

The first scenario can be addressed by limiting onsite construction worker exposure to contaminated groundwater. Construction practices that limit exposure to contaminated groundwater within the OU1 boundary should be followed and may include:

- Preparation of an adequate health and safety plan;
- Engineering controls;
- The use of appropriate personal protective equipment; and
- Knowledge of the location of remedial infrastructure and areas of groundwater contamination.

The second scenario has been addressed through implementation of institutional controls, which are defined in the ROD as follows:

- Prevent groundwater contaminants emanating from beneath OU1 to reach SLWDC-4 at concentrations above the MCL;

- Zoning restrictions prohibiting residential land use within the OU1 boundary; and

- Restrictions on use of shallow groundwater within OU1.

Groundwater remediation began at the Site in 2005 to treat and control the migration of contaminated groundwater. Remediation equipment was deactivated at the end of 2015 to conduct the NOT. A Post-Remedial Phase began in 2019 to continue data collection to evaluate the possibility of site closure. During the Post-Remedial Phase, Long-Term Monitoring is being conducted to monitor COPC concentrations throughout the Site and to assess contaminant plume stability. Remediation equipment continues to be maintained and relevant permits are current should the system need to be restarted based on monitoring results. These practices are designed to prevent contaminated groundwater from reaching downgradient public water supplies.

The Site is zoned for light industrial and commercial land use. Future land uses are not expected to differ from current land uses. The institutional controls include deed restrictions and zoning ordinances on the airport and surrounding properties that prohibit permitting of new groundwater wells and prevent residential land use within OU1. Any changes to institutional controls would require a formal ROD modification process that is defined in EPA guidance (CDM 2000).

4.2 RAO #2: Prevent the distribution of groundwater for public water supply containing constituent concentrations above MCLs in violation of the Safe Drinking Water Act.

Hydraulic containment and COPC mass removal using groundwater extraction wells was implemented in March 2005 in the plume areas, outside, and downgradient of the source areas, where TCE concentrations exceeded the site-specific ACL of 37.5 µg/L. As discussed in Section 2.2.3 and 2.3, extraction and treatment of groundwater from these wells was discontinued in December 2015 to perform a NOT at the Site. The NOT continued through 2018, and in 2019, a Post-Remedial Phase began to evaluate the possibility of termination of remediation at the Site. The following analyses have been conducted to evaluate progress toward achieving RAO #2:

- Analysis 1: Evaluate the extent of dissolved contamination;
- Analysis 2: Monitor COPC concentrations in the plume areas; and
- Analysis 3: Assess conditions for termination of remediation activities.

The results of each analysis are presented below.

4.2.1 Analysis 1: Evaluate the extent of dissolved contaminant plumes

Evaluation of contaminant plumes is based on a review of analytical results from quarterly groundwater samples collected in 2019, construction of plume maps, and quarterly potentiometric surface maps. Copies of original laboratory reports are provided in Appendix I. Quarterly analytical results from 2019 are summarized in Tables 4A through 4D and Appendix F, Table F3. This evaluation is supported by potentiometric surface maps for the A-, B-, and C-Horizons that were constructed to assess local groundwater flow patterns across the Site. This section focuses mainly on TCE because it is the most widespread of the COPCs and is of considerable importance from a human health risk perspective. The majority of TCE mass has been observed in the shallow A-Horizon aquifer (Figure 7).

The local groundwater flow direction in the A-Horizon is generally to the west-southwest across Source Area 1 and Source Area 3 and from southeast to northwest in and downgradient of the western part of the Main ACL Plume. To some extent, the groundwater flow patterns control the shape of Main MCL plume

resulting in a southeast-northwest elongation of the area defined by TCE concentrations above 5 µg/L. The Main MCL Plume appears to terminate in the area of a groundwater depression that is visible on the potentiometric surface maps generally to the west of an imaginary line drawn between MW-104A and MW-117A. The South MCL Plume appears elliptical and oriented in a southeast-northwest direction. It is centered in the area of MW-22R and MW-31. The groundwater flow patterns in the Main MCL Plume and South MCL Plume areas may also be influenced by the presence of a fault-controlled groundwater discontinuity (Figure 4).

The plume control mechanisms discussed above appear to result in potential movement of the A-Horizon, Main MCL Plume tangentially away from (to the northwest of) TMWA well SLWDC-4. Located crossgradient of the A-horizon TCE plume and in between the plume and SLWDC-4 are MW-104A and MW-111A. TCE concentrations appear to have generally decreased in MW-104A since 2016 and concentrations have fluctuated below the MCL in MW-111A (Appendix J, Figures J-8 and J-11). Downgradient of the leading edge of the plume, TCE concentrations at MW-117A have also generally decreased since 2016, supporting plume termination in this area (Appendix J, Figure J-13). MW-116A is located west of the Main MCL Plume in between MW-104A and SLWDC-4 and has not been sampled since May 2009, however, there are no detections of COPCs in historic analytical data. SLWDC-1 is located approximately 1.5 miles north-northwest of the source areas, at a farther distance than SLWDC-4, which makes it less likely to be impacted by the TCE plume.

The South MCL Plume is located generally upgradient, and at approximately ½ mile to the southeast of SLWDC-4. Plume control mechanisms discussed above may also affect the South MCL Plume and serve to limit TCE migration from this area toward SLWDC-4. Another monitoring well, MW-20, is located northeast of the leading edge of the South MCL Plume, but has not been sampled in recent years, however, there are no detections of COPCs in historic analytical data.

The effects of the plume control mechanisms are less apparent with respect to TCE in the B- and C-Horizons; however, the B- and C- Horizon plumes are significantly less extensive, more localized, and less likely to reach SLWDC-4 at concentrations exceeding 5 µg/L. Natural attenuation as a plume control mechanism is discussed in Section 4.2.3 along with trend analysis.

4.2.2 Analysis 2: Monitor COPC concentrations in plume areas

A summary of analytical results for groundwater samples collected in 2019 is provided in Section 3.3.2. This section provides an evaluation of the distribution of the COPCs detected in groundwater and concentration trends over time. TCE in the A-Horizon is the focus of this discussion because TCE is an important risk driver at the Site, has been consistently detected at concentrations above MCLs and is most wide spread in the A-Horizon. However, 1,1-DCE, benzene, and EDB concentrations are also discussed because these constituents have been consistently detected above MCLs in various areas and contribute to the overall risk at the Site. Although COPC concentrations continue to be monitored in the B- and C-Horizon wells, the potential risk of contamination to point of exposure well SLWDC-4 from these horizons appears to be lower than from COPCs in the A-Horizon, based on contaminant distribution observed to date. The following discussions are supplemented by Table F3 and Figures 7 - 10.

4.2.2.1 TCE

Source Area 1. TCE concentrations were below the RBCG in all groundwater samples collected from this source area during 2019 and exceeded the ACL at three locations (Figure 7 and Table F3). Other observations regarding TCE in Source Area 1 include:

- TCE concentrations exceeded the ACL in samples collected from MW-114A during all four quarterly sampling events and from samples collected from DPE-101 and DPE-106 in May 2019;

- TCE concentrations exceeded the MCL but not the ACL in samples collected from DPE-104 in August and November 2019 and in DPE-105 in May 2019;

- With the exception of DPE-101 and DPE-106, TCE concentrations in the Source Area 1 plume area appear to have decreased or remained stable since remediation equipment was deactivated. DPE-101 and DPE-106 have exhibited increases in TCE concentrations since 2016 (Table F3); and

- The distribution of TCE above the MCL appears to have decreased in area when compared to 2016, 2017, and 2018 TCE plume distribution maps.

Source Area 2. Only monitoring well LDI-1A has been sampled recently and was sampled in 2019. The following observations can be made regarding TCE in Source Area 2:

- At monitoring well LDI-1A, TCE concentrations appear to have remained relatively stable and below the MCL since remediation equipment was deactivated; and

- Source Area 2 wells are currently outside (south) of the Main MCL Plume boundary.

Source Area 3. The following observations are noted for Source Area 3:

- All Source Area 3 wells are currently outside of the Main MCL Plume boundary. TCE was detected up to 3.5 µg/L at DPE-302 and 3.2 µg/L at DPE-301. TCE was not detected above the laboratory reporting limit at MW-102A. TCE concentrations have generally decreased in samples collected from MW-102A and DPE-302 and remain relatively stable and below the MCL at DPE-301 since remediation equipment was deactivated.

- TCE concentrations have been below the MCL in MW-102B since 2007 and in MW-102C since 1997;

Main ACL Plume Area. Monitoring and remediation wells within, or near the eastern portion of the Main ACL Plume area (wells downgradient of Source Area 3) include MW-27R, MW-29, MW-101A, MW-101B, MW-115A, MW-125A, MW-125B, and GWEX-006. Wells used to update the TCE Main ACL plume are identified in Figure 4 in gold. The characteristics of the Main ACL Plume include:

- In 2019, the center of mass for the Main ACL plume was approximately 700 feet to the west of Source Area 3 in the area of MW-115A and GWEX-006 (Figure 7). TCE concentrations appear to have rebounded in MW-115A and GWEX-006 since late 2015 when the remediation systems were deactivated, but have since decreased at GWEX-006;

- TCE concentrations appear to have increased in samples collected from MW-27R after the beginning of the NOT in 2016 until 2018 and then generally stabilized, compared to more stable concentrations

observed from 2008 through 2016. The ACL plume contour has extended to the south to now include MW-27R beginning with the 2018 plume;

- TCE concentrations in MW-101A appear to have initially increased and then decreased since the remediation systems were deactivated in late 2015. Concentrations have historically fluctuated between the ACL and RBCG, but have generally remained above the ACL since 2016. TCE concentrations in MW-101B have remained below the RL since May 2009;

- At MW-125A, TCE concentrations appear to have decreased since remediation equipment was deactivated in late 2015, but remained above the ACL in three of the four 2019 quarterly sampling events. TCE was reported at 1.2 µg/L from the sample collected in August 2019, but this result is inconsistent with historical results. MW-125B is not within the B-Horizon TCE plume and TCE was not detected above the laboratory reporting limit during 2019.

Main MCL Plume Area. Figure 7 supports the following observations that can be made about TCE in monitoring wells which surround the Source Area 1 and Main ACL plumes:

- TCE concentrations in MW-28R appear to have decreased since remediation equipment was deactivated in late 2015;

- Analytical results for groundwater samples collected from MW-102A indicate that TCE concentrations have decreased from above the ACL and the MCL to less than the RL in 2017, 2018, and 2019. Analytical results also indicate that TCE concentrations have remained below the MCL in samples collected from DPE-301 and DPE-302. These observations continue to support that the Main MCL plume is no longer present in the area between MW-123A and DPE-302 and remains separated into two areas;

- A comparison of TCE concentrations and plume maps from 2015 to 2017 (presented in previous reports) suggest that the Main MCL Plume surrounding Source Area 1 may have receded slightly along the northern edge near MW-105A and GWEX-001;

- The southern portion of the Main MCL Plume no longer extends as far south as MW-23 as the TCE concentrations have been below the MCL at this location since 2017;

- The northwest leading edge of the Main MCL Plume appears to have receded slightly when comparing to previous plumes based on TCE concentrations detected in MW-117A. MW-117A is located in the Plume Termination Area; and

- MW-110A, which is located near the Plume Termination Area, had a TCE concentration of 3.6 µg/L in a sample collected in May 2019 and is depicted as outside of the Main MCL Plume based on 2019 data interpretation. It was previously within the 2018 plume boundary.

MW-104A is a key monitoring well located to the west of the Main ACL plume (West), which has been identified as a point of exposure well for potential offsite receptors. A groundwater sample collected from MW-104A in March 2017 contained detectable TCE (14 µg/L) for the first time in the history of sampling this well. However, samples collected in August 2017, May 2018, and May 2019 were below the laboratory

RL. It is possible that the March 2017 sample result is anomalous or the result of incomplete decontamination of the sampling pump. MW-104A was sampled after MW-115A in March 2017, which contained TCE at a concentration of 260 µg/L.

Southern MCL Plume. The Southern MCL Plume defined by TCE concentrations in MW-22R (13 µg/L, sampled May 2019), MW-31 (23 µg/L, most recently sampled November 2018) and surrounding wells that are or historically have been below the MCL with respect to TCE. It should be noted that:

- TCE concentrations detected in MW-22R and MW-31 have historically been below the ACL with a few exceptions;
- The Plume is oriented in a southeast-northwest orientation; and
- The overall plume distribution appears generally consistent with that estimated in previous plumes.

Other TCE Detections. TCE has also been detected in the following locations:

- In 2019, samples collected from three wells in the B-Horizon contained TCE concentrations above the ACL: A sample collected from MW-105B in November 2019 contained 68 µg/L; a sample collected from MW-123B in May 2019 contained 68 µg/L; and a sample collected from MW-127B in February 2019 contained 95 µg/L (Figure 7). Elevated TCE concentrations in samples collected from MW-105B appeared beginning in November 2018 when TCE was detected at 120 µg/L. This result is anomalously high compared to historical results, but there is no evidence to indicate cross contamination or quality control issues. Additionally, TCE was again detected above the ACL at 68 µg/L during 2019. TCE in samples collected from MW-123B and MW-127B are consistent with historical analytical results for these wells.

  TCE was detected above the MCL, but below the ACL in one B-Horizon well during 2019: MW-124B. MW-124B is sampled quarterly and results ranged from below the MCL at 2.6 µg/L to just above the MCL at 5.5 µg/L (Figure 7). TCE concentrations in MW-124B appear to have decreased over the long term but continue to fluctuate above and below the MCL (Appendix F, Table F3).

- TCE has been depicted as isolated occurrences in B-Horizon wells in recent years. TCE fluctuates above and below the MCL at several B-Horizon monitoring wells, including MW-126B and MW-124B, therefore, the plume is depicted in the area between MW-127B and MW-124B in some years. In 2018, the isolated TCE occurrences appeared to coalesce into a single plume, potentially impacting a broader area, however, based on 2019 data, there is a break in the plume between MW-127B and MW-124B (Figure 7).

4.2.2.2 1,1-DCE

The 1,1-DCE plume in the A-Horizon plume is defined by 1,1-DCE concentrations exceeding the MCL of 7 µg/L. The following observations apply to groundwater samples collected from these wells:

- The 1,1-DCE plume occupies a similar, but slightly larger area of the A-Horizon aquifer compared to the 2018 plume. MW-125A is now within the plume boundary when compared to the 2018 1,1-DCE

plume. MW-125A is sampled quarterly, and all results were below the MCL ranging from 4.2 µg/L to 4.8 µg/L except for the result from August 2019 where 1,1-DCE was detected at 15 µg/L (Figure 8);

- A small, isolated 1,1-DCE outlier persists around MW-109A, whereas MW-111A is no longer within a plume outlier;
- The main 1,1-DCE plume in the B-Horizon appears to have retracted to the east and no longer includes MW-108B. 1,1-DCE detections decreased from 8.3 µg/L in 2018 down to 2.4 µg/L in 2019 at MW-108B, supporting the change in plume boundary along the western edge.
- 1,1-DCE was not detected above the MCL at any C-Horizon monitoring wells during 2019. The highest 1,1-DCE concentration detected in the C-Horizon during 2019 was 3.4 µg/L at MW-104C.

4.2.2.3 Benzene

The estimated distribution of benzene exceeding the MCL in 2019 is shown in Figure 9 for the A- and B-Horizons. Benzene was not detected above the laboratory RL in groundwater samples collected from any C-Horizon wells. Historical benzene concentrations since remediation startup in 2005 are shown in Appendix F, Table F3. Historically, benzene appears to have been centered in the area of MW-123A and GWEX-002. Benzene has a Source Area RBCG of 1,470 µg/L and a MCL of 5 µg/L.

The following observations are noted for benzene:

- Benzene is present downgradient of Source Area 1 and to the north of Source Area 2 in A- and B-Horizon wells. The A-Horizon benzene plume is centered on MW-123A and GWEX-002.
- Benzene concentrations exceeding the RBCG have been detected historically in groundwater samples collected from MW-113A, MW-123A, MW-123B, DPE-102, and DPE-103. Only samples collected from MW-123A exceeded the RBCG in 2019;
- Benzene concentrations at MW-123A remained consistent from 2005 to 2013, fluctuating between 1,100 µg/L and 2,100 µg/L. Concentrations varied much more widely between 4.9 µg/L and 2,400 µg/L from 2014 to 2019, generally exceeding the MCL of 5 µg/L and exceeding the Source Area RBCG of 1,470 µg/L during 2019. Benzene concentrations have increased since the beginning of the NOT at MW-123A;
- Significant decreases in benzene concentrations, up to three orders of magnitude, have been observed in samples collected from MW-123B since November 2008, however, benzene concentrations have generally increased since 2016. An isolated benzene plume contour is depicted in the B-Horizon centered around MW-123B, where benzene was detected up to 46 µg/L in 2019;
- The highest benzene concentration since remediation system startup at the Site was 3,700 µg/L, measured in May 2015 in monitoring well MW-113A. Benzene has generally been below the laboratory reporting limit in samples collected from this well since May 2016 (Appendix F, Table F3).

4.2.2.4 EDB

Historical EDB concentrations since groundwater remediation system startup began in 2005 are provided in Appendix F, Table F3. EDB has a Source Area RBCG of 20 µg/L and an MCL of 0.05 µg/L. All groundwater samples were analyzed by SW846 Method 8260B, which has a laboratory RL of 2.0 µg/L for EDB. Selected samples collected in May 2019 were also analyzed for EDB by EPA Method 504.1, which has a laboratory RL of 0.020 µg/L. Samples are analyzed for EDB by EPA Method 504.1 to achieve a lower detection limit. Monitoring locations that were sampled for EPA Method 504.1 were used to update the EDB plume and are denoted in Figure 10 with an asterisk.

EDB was detected in the following wells at concentrations above the analytical RL during 2019: MW-101A, MW-101B, MW-105B, MW-109A, MW-109B, MW-113A, MW-115A, MW-123B, MW-124A, MW-124B, MW-125A, MW-125B, MW-126A, MW-126B, GWEX-001, GWEX-002, GWEX-005, and GWEX-006. The following observations are noted for this compound:

- The footprint of the 2019 EDB plume is similar to recent interpretations of the plume. It encompasses the area approximately between MW-115A to GWEX-001, immediately downgradient of Source Area 1 (east-west) and GWEX-006 to MW-109A (north-south). The highest concentrations were observed in the core of the plume at MW-124A (6.8 µg/L) and GWEX-001 (8.2 µg/L) and just downgradient of Source Area 1 at GWEX-001 (8.2 µg/L).

- An isolated contour is depicted surrounding MW-113A as shown in Figure 10. EDB by EPA Method 504.1 was previously less than the RL in 2018, however, EDB has historically been detected periodically at this location as high as 80 µg/L in 1996.

4.2.3 Analysis 3: Assess Conditions for Termination of Remediation

Section 2.1.4 of this report discusses the regulatory requirements for termination of remediation of groundwater contaminated by a release of a hazardous substance, hazardous waste, or regulated substance, and filing for an exemption from the corrective action requirement at any time before, during, or after termination of remediation at a site. The conditions required for meeting these requirements are also discussed. Several of these conditions have been or are being assessed as a part of ongoing LTM at the Site, including:

- Source identification and control;

- Long-term quarterly monitoring to establish the concentration trends, the extent, and the magnitude of contamination;

- Natural attenuation;

- Identification of biological degradation mechanism(s) including evidence of metabolic activity and appropriate ORP conditions;

- Establishment of risk-based source area concentration goals for COPCs and alternate cleanup levels for TCE; and

- Establishment of institutional controls preventing the use of groundwater at the Site as a drinking water supply.

Continued LTM and additional work will be required to justify termination of remediation. This additional work is discussed in Section 5.2. However, source identification and controls have been established and a LTM database has been developed based on data collected throughout the monitoring well network since 1994. LTM continues to be performed to document the progress of the remedial action and to evaluate the extent and magnitude of dissolved contamination.

Evaluation of the natural attenuation potential at the Site was presented in Appendix A of the Feasibility Study (CDM 1999b). The results of the most recent natural attenuation monitoring event are documented in Section 2.5 of the 2009 First Semi-Annual Report (AEEC 2009). The results indicate that the degradation of TCE by reductive dechlorination for most areas of the Site is likely very limited due to highly oxidative conditions in the subsurface**.** This is indicated by the presence of competing electron acceptors (DO, nitrate, and sulfate) and high ORP values. The limited occurrence of TCE daughter products such as cis- and trans-1,2-DCE, vinyl chloride, ethene, ethane, and methane also supports this conclusion. Further confirmation comes from the apparent stability of the 1,1-DCE plume which has likely originated from abiotic degradation of 1,1,1-TCA.

An exception to the above scenario is suggested for areas downgradient of Source Area 1, where significant TCE concentrations have not been observed historically. This may be attributable to the high BTEX concentrations immediately downgradient of Source Area 1. Microbial activity is likely occurring in this area due to the high concentrations of this supporting substrate and the presence of electron acceptors such as dissolved oxygen, nitrate, and sulfate.

4.2.3.1 Trend Analysis

Trend analysis was conducted using AquaChem statistical software to identify contaminant concentration trends that may be indicative of natural attenuation. The Mann-Kendall test was used to determine if a significant linear trend was present for groundwater contaminants in samples collected from individual monitoring wells. Mann-Kendall tests the assumption (the null hypothesis) that contaminant concentrations have not changed over time (i.e., there is no trend). This test is a non-parametric method that does not rely on a normal data distribution and is not particularly sensitive to statistical outliers. The test was run at a 0.05 significance level (95 percent confidence that a trend is present) with a minimum of four observations. Data reported as less than the detection limit by the laboratory were assigned a common value of ½ the lowest concentration of an analyte detected anywhere at the Site. The Mann-Kendall statistic (*S*) is computed by examining all possible pairs of measurements in a time-series data set and scoring each pair as follows:

- If an earlier measurement is less in magnitude than a later one, the two measurements are assigned a value of 1;

- If an earlier value is greater in magnitude than a later sample, the pair is assigned a value of –1; and

- Two identical measurements are assigned a value of 0.

After scoring each pair and adding up the total, a positive value suggests an upward or increasing trend and a negative value suggests a downward or decreasing trend. A value near zero indicates approximately equal numbers of positive and negative values and no apparent trend (EPA 2009). For this analysis, the data set

consisted of selected COPCs (TCE, 1,1-DCE, EDB, and benzene) concentrations in samples that were collected from since the deactivation of remediation equipment in late 2015 (January 2016) through December 2019.

If a statistically significant trend was identified with Mann-Kendall, then a second non-parametric test, the Sen's method (also known as the Theil-Sen slope estimator), was performed to estimate how much contaminant concentrations change over time. The Sen's method is also used to determine whether or not the median slope (linear trend) is significantly different from zero. This provides an additional line of evidence that can be used in conjunction with the results of the Mann-Kendall test. Like Mann-Kendall, Sen's method does not require a normal distribution of data points (EPA 2009).

Trend analysis was conducted for TCE, 1,1-DCE, EDB, and benzene and was performed on a total of 70 monitoring wells which currently constitute the monitoring well network. Data collected since the beginning of the NOT through calendar year 2019 was used for the trend analysis. Trend analysis results identify wells with statistically significant trends (increasing or decreasing), no statistically significant trends, and wells at which analysis could not be performed due to too few analytical results. The results of trend analyses are provided in graphical form in Appendix J and are also summarized in Appendix J, Tables J1 through J4.

TCE Trend Analysis. The results of the TCE trend analyses are presented in Appendix J, Figures J-1 through J-18 and can be summarized as follows:

- Statistically significant increasing trends were identified for two of the 70 locations;
- Statistically significant decreasing trends were identified for ten of the 70 locations;
- No statistically significant trends were identified for TCE in 40 of the 70 groundwater monitoring locations; and
- Trend analysis could not be performed on analytical results for 18 monitoring locations as the data did not conform to trend analysis criteria discussed above.

Decreasing TCE concentration trends were observed throughout the Main ACL and MCL Plumes (MW-127A, MW-28R, MW-101A, GWEX-006, GWEX-005, and MW-125A) to the west of the B-Horizon TCE Plume (MW-104B), between the Main MCL plume and Source Area 1 ACL plume (MW-12 and MW-102A), and within the Source Area 1 plume (MW-114A). Increasing TCE concentration trends were exhibited by samples collected from MW-110C, which appears as an isolated occurrence in the C-Horizon. Although a statistically significant increasing trend is exhibited at MW-110C, TCE concentrations from samples collected since the beginning of the NOT are near or below the MCL (5 µg/L). MW-115A, which also exhibits an increasing trend is in the center of the Main ACL Plume Area (Figure 4).

1,1-DCE Trend Analysis. The results of the 1,1-DCE trend analyses are presented in Appendix J, Figures J-19 through J-36 and can be summarized as follows:

- Statistically significant trends were identified for 12 of the 70 monitoring locations. Eight of these groundwater monitoring locations exhibited decreasing trends. The other four groundwater monitoring locations exhibited increasing trends;
- No statistically significant trends were identified for 40 groundwater sampling locations; and

- Trend analysis could not be performed on analytical results for 18 monitoring locations as the data did not conform to trend analysis criteria discussed above.

Two of the four locations which exhibit increasing 1,1-DCE concentration trends (MW-127B and MW-115A) are within the A-Horizon and B-Horizon 1,1-DCE plumes (Figures J-20 and J-21). Increasing concentration trends were also identified at MW-101B and MW-27R, which are outside of the boundary of the B-Horizon and A-Horizon 1,1-DCE plume (respectively), however, all results of samples collected since the deactivation of remediation equipment are below the MCL of 7 µg/L (Figures J-19 and J-21).

Benzene Trend Analysis. The results of the benzene trend analyses are presented in Appendix J, Figures J-37 through J-54 and can be summarized as follows:

- Two statistically significant increasing trends were identified for benzene (Figure J-37). No statistically significant decreasing trends were identified;

- No statistically significant trends were observed for data from 50 monitoring locations; and

- Groundwater samples collected from the remaining 18 wells could not be analyzed with trend analysis because they did not meet the criteria for the Mann-Kendall trend test.

Statistically significant increasing trends for benzene were identified in data collected from monitoring well set MW-123A and MW-123B. MW-123A is located in the area of elevated BTEX (Figure 4) and within the extent of the current benzene plume. MW-123B is also located within the current extent of the B-Horizon benzene plume. Benzene has historically been detected at these locations at high concentrations since 2005 (Table F3).

EDB Trend Analysis. Trend analysis for EDB was performed on a total of 72 monitoring locations. The results of the EDB trend analyses are presented in Appendix J, Figures J-55 through J-73 and can be summarized as follows:

- One statistically significant increasing trend was identified for EDB (Figure J-55); no statistically significant decreasing trends were identified;

- No statistically significant trends were observed for data from 51 monitoring locations; and

- Groundwater samples collected from the remaining 20 wells could not be analyzed with trend analysis because they did not meet the criteria for the Mann-Kendall trend test.

A statistically significant increasing trend for EDB was identified in data collected from monitoring well MW-125A. MW-125A is located within the EDB plume (Figure 10).

4.3 RAO #3: Prevent the distribution of groundwater for irrigation or watering of livestock containing constituent concentrations in excess of toxic material standards listed in NAC Part 445A.144 [2]

NAC Part 445A.1236 establishes "Standards for toxic materials applicable to designated waters". These standards are designed to protect the beneficial use(s) of streams or other surface water bodies in the State of Nevada. Although the NAC includes standards for organic compounds applicable to municipal or domestic water supplies and aquatic life, no standards for organic chemicals are listed for irrigation and livestock watering. Standards for inorganic chemicals are listed below.

COPCs at the site have the potential to affect public supply water quality, if allowed to migrate to within the area of influence of a supply well. Three municipal water supply wells have been identified within an approximate 1.5 mile radius of the center of the Main ACL Plume. These wells are identified on the NDWR website as QM34219 (TMWA SLWDC-4, the Silver Lake Well); QM47915 (Washoe County Well); and QM35497 (TMWA SLWDC-1, the Army Air Guard Well). No private irrigation wells were identified within this area; the closest private irrigation well is the Zimmerman-Hastings well located approximately 2.8 miles to the west of the Main ACL Plume. Extraction from a public water supply source such as SLWDC-4, the closest to the plume, could be used for irrigation and stock watering purposes and could affect local groundwater flow patterns.

The Truckee Meadows Water Authority prepares an annual permit compliance Report on Aquifer Storage and Recovery for the West Lemmon Valley Hydrographic Basin 92A (TMWA 2020). Along with recharge rates, production volumes, and water levels, this report summarizes water quality and provides laboratory reports which include analytical data for general water chemistry, metals, halo acetic acids, and trihalomethanes. The 2019 annual report indicates that metals in samples collected from the Silver Lake Well (SLWDC-4) were below the Nevada standards for irrigation and stock watering, with the exception of beryllium, boron, cadmium, mercury and selenium, which are not reported. Analytical results shown below are the highest concentrations detected in recharge and production water throughout calendar year 2019. The annual report does not present analytical data for the organic compounds identified as COPCs at the Stead Solvent Site OU1.

[2] The ROD refers to "…toxic material standards listed in NAC Part 445A.144". NAC Part 445A.1236 was substituted in revision for NAC 445A.144. Therefore, NAC Part 445A.1236 is currently the applicable part of the Code.

Chemical Name	TMWA Analytical Results: SLWDC-4 (µg/L)	Irrigation (µg/L)	Watering of Livestock (µg/L)
INORGANIC CHEMICALS[(1)]			
Arsenic	11	100[b]	200[c]
Beryllium	NR	100[b]	NE
Boron	NR	750[a]	5,000[c]
Cadmium	NR	10[c]	50[c]
Chromium (total)	<5.0	100[c]	1,000[c]
Copper	71	200[c]	500[c]
Fluoride	400	1,000[c]	2,000[c]
Iron	250	5,000[c]	NE
Lead	3.5	5,000[c]	100[c]
Manganese	<5.0	200[c]	NE
Mercury	NR	NE	10[c]
Nickel	<30	200[c]	NE
Selenium	NR	20[c]	50[c]
Zinc	61	2,000[c]	25,000[c]
ORGANIC CHEMICALS [(2)]	NR	NE	NE

Notes:

NE = Not Established under NAC 445A.1236
NR = Not Reported by Truckee Meadows Water Authority

(1) The standards for metals are expressed as total recoverable, unless otherwise noted

References:

a. U.S. Environmental Protection Agency, Pub. No. EPA 440/5-86-001, *Quality Criteria for Water* (Gold Book) (1986).
b. U.S. Environmental Protection Agency, Pub. No. EPA 440/9-76-023, *Quality Criteria for Water* (Red Book) (1976).
c. National Academy of Sciences, Water Quality Criteria (Blue Book) (1972).

As discussed in Section 4.2, the distribution of the contaminant plumes is monitored to confirm that groundwater contamination above applicable RAGs does not encroach on public water supply extraction points. The closest public water extraction point is SLWDC-4. However, inorganic chemicals were never identified as COPCs at the Site and groundwater samples have not historically been analyzed for inorganic chemicals. In addition, groundwater extracted from SLWDC-4 is not routinely analyzed by the TMWA for all inorganic chemicals included under the toxic materials standards listed in NAC Part 445A.1236. Therefore, it is not possible to determine if:

1) Groundwater extracted from SLWDC-4 exceeds any of the toxic materials standards listed in NAC Part 445A.1236;

2) Inorganic chemical concentrations in groundwater extracted from SLWDC-4 differ significantly from inorganic chemical concentrations in groundwater associated with contaminant source and

plume areas; or

3) Inorganic chemical concentrations in groundwater extracted from SLWDC-4 differ significantly from background groundwater concentrations.

5.0 Conclusions and Recommendations

5.1 RAO #1: Prevent exposure to contaminated groundwater through ingestion and inhalation pathways in excess of a 10^{-5} excess cancer risk.

5.1.1 Conclusions

Potential future exposures to contaminated groundwater in the source areas are possible under two future exposure scenarios:

- Future construction workers exposed to the shallow groundwater if construction activities require excavation to the depth of the water table; and
- Future off-site groundwater user if the contaminant plume reaches SLWDC-4 and the water is distributed for potable use (CDM 1999b).

COPCs have been detected in source area groundwater at concentrations exceeding a 10^{-5} excess cancer risk or a hazard index of 1. Institutional controls in the source areas are effective at preventing human exposure to contaminated groundwater. Institutional controls include deed restrictions and zoning ordinances on the airport and surrounding properties. Exposure to contaminated groundwater by unauthorized and unprotected personnel through contact with remediation equipment is prevented by secured fencing around remediation compounds. In addition, installation of new production wells for potable uses is restricted within the OU1 boundary.

Soil vapor and groundwater extraction and treatment was conducted from 2005 through 2015 in three source areas (except for a brief period in 2010 at Source Area 1) to reduce groundwater contamination to below RBCGs. The NOT began at the end of 2015 to evaluate the impact of taking the extraction systems offline and continued through calendar year 2018. A Post-Remedial Phase began in 2019 to continue groundwater monitoring and data collection to evaluate the possibility of termination of remediation at the Site.

5.1.2 Recommendations

The following recommendations apply to RAO #1:

- Continue to monitor COPC concentrations in OU1 groundwater monitoring wells;
- Maintain the remediation system in good working condition should it be restarted in the future;
- Maintain institutional controls, i.e., deed restrictions, zoning ordinances, secured fencing around remediation compounds, until a reduction in the risk of exposure to contaminated groundwater to less than 10^{-5} excess cancer risk and less than a hazard index of 1 has been achieved in the source areas and can be demonstrated to be a sustainable condition; and

- Reactivate hydraulic containment and soil vapor and groundwater extraction and treatment systems if plume conditions are demonstrated to be unstable and/or expanding through the application of statistical analysis.

5.2 RAO #2: Prevent the distribution of groundwater for public water supply containing constituent concentrations above MCLs in violation of the Safe Drinking Water Act.

5.2.1 Conclusions

With the exception of MW-114A, TCE in Source Area 1 wells has remained below the RBCG since December 2008 and concentrations appear to have remained stable in recent years. Samples collected from MW-114A have generally remained above the RBCG since March 2016 but were below the RBCG during all four quarterly monitoring events in 2019 with concentrations ranging from 110 µg/L to 190 µg/L. This monitoring well exhibits a decreasing TCE concentration trend (Appendix J, Figure J-2). Other Source Area 1 monitoring wells did not have statistically significant trends (increasing or decreasing). MW-114B has historically been below the ACL and has been below the MCL since May 2006. Dual Phase Extraction Wells DPE-101 and DPE-106 were above the ACL in 2019. DPE-101 has exhibited increasing TCE concentrations since the beginning of the NOT (Appendix J, Figure J-4). DPE-104 and DPE-105 have been below the ACL since February 2018 and August 2017, respectively. The orientation of the Main MCL and Main ACL plumes changed slightly in 2019 compared to recent plume configurations, however, the concentrations within these areas appear consistent with previous years. The distribution of TCE above the ACL in the Source Area 1 ACL Plume appears to have decreased in 2019 when compared to 2016 through 2018 TCE plume distribution maps.

In the vicinity of Source Area 2, TCE concentrations have remained below the MCL since May 2010 and June 2011 based on groundwater samples collected from LDI-1A and LDI-2A. LDI-1A was the only well where trend analysis was performed within Source Area 2, and it did not exhibit a statistically significant increasing or decreasing trend. TCE concentrations have fluctuated below the MCL at LDI-1A since the beginning of the NOT.

At Source Area 3 wells, groundwater samples were collected from MW-102A and MW-102B in May 2019 and were both below the RL of 1 µg/L with respect to TCE. TCE was reported below the MCL (5 µg/L) in samples collected from both DPE-301 and DPE-302 during 2019. Samples collected from MW-102A and DPE-301 have been below the MCL since May 2017 and samples collected from DPE-302 have been below the MCL since November 2018. TCE concentrations in samples collected from GWEX-004, immediately downgradient of Source Area 3, have been below the RBCG since March 2017 and have fluctuated above and below the ACL since that time. TCE concentrations in MW-12 have been reported below the ACL since May 2007 and have remained below the MCL since March 2016. TCE concentrations in MW-124A have been reported below the MCL since November 2006, while concentrations in MW-125A remain above the ACL.

Mann-Kendall trend analysis indicates that the number of decreasing TCE trends (nine) outnumber increasing TCE trends (one) in the A-Horizon. The majority of monitoring wells in the A-Horizon with statistically significant decreasing trend results for TCE are located downgradient of Source Area 3 in the Main ACL Plume area (GWEX-006, GWEX-005, MW-125A, MW-101A, MW-28R, MW-127A, and MW-12). In

addition, MW-102A, which is located within Source Area 3, and MW-114A, which is located within Source Area 1, both have statistically significant decreasing trends. The only monitoring well with a statistically significant increasing trend in the A-Horizon for TCE, MW-115A, is located in the core of the Main ACL plume in the area of the highest TCE concentrations. TCE Trend analysis was conducted on a total of twenty B-Horizon wells and six C-Horizon wells; of which, one well (MW-104B, located downgradient of the leading edge of the B-Horizon TCE plume) exhibited a decreasing concentration trend and one well (MW-110C) exhibited an increasing concentration trend. The majority of the wells did not have statistically significant trend results or trend analysis was unable to be performed due to Mann-Kendall trend analysis requirements. As additional data becomes available due to continued groundwater monitoring, trend analysis will be able to be performed on more monitoring wells as trend analysis requirements will be met (sufficient number of data points).

In MW-104A, MW-111A, MW-116A, MW-117A, and MW-118A west and northwest of the leading edge of the plume TCE concentrations appear to have remained stable or decreased slightly since remediation equipment was deactivated in late 2015. TCE trend analysis conducted on MW-104A, MW-111A, MW-117A, and MW-118A did not identify any statistically significant increasing or decreasing trends. TCE has been below the MCL since May 2017 in samples collected from MW-117A (immediately downgradient of the toe of the Main MCL plume) and a comparison of plumes from recent years indicate the toe of the plume may be receding slightly. Samples collected from MW-118A, located farther downgradient of the toe of the Main MCL plume have been below the RL historically (except for a sample collected in February 2005, which was just above the MCL at 5.6 µg/L). MW-104A, located west of the Main ACL plume edge, has historically been below the RL except for a sample collected in March 2017, in which TCE was detected at 14 µg/L. Subsequent samples collected from MW-104A were below the RL. MW-116A is further downgradient of the Main MCL Plume and has not been sampled since May 2009 with all historical results below the RL (1 µg/L). MW-111A has historically been below the MCL with respect to TCE in groundwater samples, with one exception in 2005, when TCE was detected at 6 µg/L in this well. Groundwater samples collected from MW-110A have fluctuated above and below the MCL since 2015 and this well is depicted as an outside of the Main MCL Plume in 2019.

TCE has been depicted as isolated occurrences in B-Horizon and C-Horizon wells in recent years. TCE fluctuates above and below the MCL at several B-Horizon monitoring wells. During 2018, the isolated TCE occurrences appeared to coalesce into a single plume, impacting a broader area, however, based on 2019 data, there is a break in the plume between MW-127B and MW-124B. No statistically significant increasing trends were identified in B-horizon wells. One well exhibited a statistically significant decreasing trend based on Mann-Kendall analysis (MW-104B, downgradient of the B-Horizon TCE plume). One well in the C-Horizon exhibited a statistically significant increasing trend, (MW-110C), however TCE has fluctuated just above and below the MCL and only exceeded the MCL once during 2019 quarterly sampling at 5.4 µg/L. In addition, TCE appears to be decreasing at MW-110C since late 2018 (Appendix J, Figure J-2).

2019 potentiometric surface maps indicate groundwater flow patterns similar to those identified in previous years for the A- and B-Horizon aquifers suggesting that the TCE plumes flow to the northwest, tangentially away from SLWDC-4. There are currently no indications that TCE at a concentration greater than the MCL (5 µg/L) would approach SLWDC-4 at a distance much closer than the approximate location of MW-104A (approximately 1,500 feet away). Another water supply well, SLWDC-1, is located approximately 1.5 miles to the northwest of the Source Areas, which makes it less likely to be impacted by the TCE plume. The highest detected concentration at MW-111A, which is northeast of SLWDC-4 was 2.7 µg/L in November 2019, but was still below the MCL.

The pattern of groundwater flow across the OU1 Site and the influences of seasonal precipitation remain consistent with observations from previous years. A rebound of groundwater levels is observable in Source Areas 1 and 3, where groundwater extraction occurred prior to system shutdown for the NOT and Post-Remedial Phase (Appendix G, Figures G-8 and G-15). Groundwater level rebound is also observable in Source Area 2, but to a lesser extent (Appendix G Figures G-5 and G-6). Groundwater generally flows from the east-southeast to the west-northwest. The Site is bisected by a fault trending south to north. The shallow soil and underlying unconfined aquifer at the Site consist of unconsolidated to semi-consolidated lacustrine and alluvial deposits with variably inter-bedded gravel, sand, silt and clay sediments. Movement along the fault likely resulted in the development of offset beds that may impede groundwater flow. The effect of this feature is manifested by a persistent, steep break in hydraulic gradient trending south-southwest to north-northeast in the area of the inferred fault. The groundwater gradient is relatively flat to the east and west of the fault line with the groundwater elevations on the west or down gradient side of the fault generally 15 to 20 feet lower than groundwater elevations to the east of the fault. However, hydraulic communication is relatively continuous across the Site as evidenced by the relatively uniform seasonal groundwater elevation fluctuations.

The degradation of TCE by microbial metabolic pathways for most regions of the Site is likely limited by the oxidative capacity of the subsurface as evidenced by generally high ORP values. The presence of a 1,1-DCE plume, near normal pH, and the limited occurrence of cis- and trans-1,2-DCE implies that abiotic degradation (e.g., dehydrohalogenation of 1,1,1-TCA to 1,1-DCE) is a more active mechanism than reductive dechlorination in the central area of the Site. 1,1-DCE concentrations exceeding the RL were detected in approximately 57% of the sampling locations in 2019. Low TCE concentrations west (historically downgradient) of Source Area 1 could be attributable to the high BTEX in this area. Elevated BTEX concentrations may harbor microbial activity in the presence of electron acceptors.

Cis-1,2-DCE concentrations ranged from <1.0 µg/L to 7.8 µg/L in groundwater samples collected from monitoring wells in 2019. Samples collected from DPE and GWEX extraction wells had higher cis-1,2-DCE concentrations ranging from <1 µg/L to 26 µg/L. Overall, cis-1,2-DCE exceeding the RL occurred in about 28% of samples collected in 2019. Trans-1,2-DCE was only detected at one monitoring location (MW-123B) up to 1.6 µg/L. Negative ORP values were recorded in about 37% of the wells measured in 2019. Dissolved oxygen concentrations less than 1.0 mg/L were measured in about 36% of the wells.

Active degradation of TCE to daughter products may occur in certain areas where localized reducing conditions facilitate such reactions such as the area of the hydrocarbon plume downgradient of Source Area 1. This appears evident in samples collected from extraction wells DPE-101, DPE-104, DPE-106, DPE-301, DPE-302, around the periphery of the benzene plume where cis-1,2-DCE concentrations ranged from less than the RL to 16 µg/L and in MW-27R, GWEX-004, and GWEX-006 farther to the west, where cis-1,2-DCE concentrations ranged from 3.8 µg/L to 26 µg/L in 2018. The presence of sufficient electron acceptors has been noted at the Site, which could facilitate reductive dechlorination (AEEC 2009). In 2019, the highest cis-1,2-DCE concentrations were detected in samples collected from wells DPE-301, GWEX-004, and GWEX-006 which occur in a flow path directly downgradient of the highest benzene plume concentration at MW-123A (Figures 5A1 through 5A4 and Figure 9). This further supports the likelihood that localized reductive co-metabolism of TCE is occurring.

Extraction and treatment of groundwater and soil vapor did not occur from 2016 through 2019 while the remediation system remained deactivated for the Post-Remedial Phase. Groundwater monitoring will continue at the Site during 2020 in accordance with the approved LTM Plan.

5.2.2 Recommendations

The Post-Remedial phase should continue to acquire additional data to evaluate plume stability or migration potential and to support statistical analysis of contaminant concentration trends. Laboratory analysis should include the VOCs discussed in this report. Particular attention should be paid to TCE concentrations in areas to the west and downgradient of the Main MCL Plume where increasing concentration trends have been identified through trend analysis in MW-110C and MW-115A.

Analysis of EDB should continue to be performed according to EPA Method 504.1. Laboratories that use this method should be able to provide reporting limits that are below the 0.05 µg/L MCL for EDB. Future additional sampling of natural attenuation parameters should be considered within plume areas to obtain data to support the Post Remedial phase and for planning future actions. Specific parameters that would contribute to an understanding of natural attenuation processes in the areas of interest include:

- VOCs focusing on the chlorinated aromatic hydrocarbons and degradation products of TCE and 1,1,1-TCA;
- Groundwater pH, temperature, and conductivity;
- Electron acceptors (dissolved oxygen, nitrate, sulfate, manganese and iron);
- Electron donors (petroleum hydrocarbons and total organic carbon);
- Oxidation/reduction potential; and
- Metabolic byproducts including chloride, Mn^{2+}, ferrous iron (Fe^{2+}), methane, ethane, and ethane.

Although a sample collected in 2019 from MW-111A, northeast of SLWCD-4 had TCE results reported as high as 2.7 µg/L, there are currently no indications that TCE at a concentration greater than the MCL (5 µg/L) would approach SLWDC-4 at a distance much closer than the approximate location of MW-104A (approximately 1,500 feet away). Groundwater samples have not been collected from MW-116A, closer to SLWDC-1 since May 2009 or from MW-20, which is downgradient of the leading edge of the South MCL Plume, since May 2005. These wells should be added to the monitoring well network if there are future indications of plume migration.

Based on the monitoring data collected during the NOT and Post-Remedial Phase, a decision should be made to either (1) continue the Post-Remedial Phase; (2) reestablish hydraulic plume control and continue remediation of contaminated groundwater; or (3) take steps required for an exemption of corrective action and termination of remedial actions at the Site. Remedial systems have been maintained in working order throughout the NOT and Post-Remedial Phase and can be turned back on with minimal effort, if required. Additional work that would be needed to move toward termination will involve preparation of a corrective action plan for approval by NDEP. The corrective action plan should include procedures for:

- Continued quarterly groundwater monitoring and statistical analysis of the data to establish contamination trends and/or plume stability;
- Reactivation of selected monitoring wells (e.g. MW-116A), if plume expansion or migration is indicated by the data;

- Consideration of assessment of natural attenuation parameters described above;
- Documenting attainment of RBCGs and the ACL for TCE, asymptotic concentration trends within the plumes; and
- Any additional data or documentation required by NDEP.

Additional data and documentation have been discussed with NDEP and will be addressed in the form of a separate technical memorandum. Action items for inclusion in the technical memorandum include:

- Generating asymptotic curves for system mass removal and concentrations at monitoring wells from time of system start-up;
- Calculate plume mass and center of mass;
- Evaluate environmental covenant restriction options; and
- Review DOD drawings and documents to identify the history and status of underground storage tanks (USTs) operated in the area of elevated BTEX concentrations.

5.3 RAO #3: Prevent the distribution of groundwater for irrigation or watering of livestock containing constituent concentrations in excess of toxic material standards listed in NAC Part 445A.1236.

5.3.1 Conclusions

As discussed in Section 4.2, the distribution of the contaminant plumes is monitored to confirm that groundwater contamination above applicable RAGs does not encroach on public water supply extraction points. However, groundwater samples collected from monitoring wells at the Site have not historically been analyzed for inorganic chemicals. Therefore, it is not currently possible to determine if:

1) OU1 groundwater contains inorganic chemical concentrations that exceed the toxic materials standards listed in NAC Part 445A.1236;
2) Inorganic chemical concentrations in contaminant source and plume areas differ significantly from background water quality; or
3) Inorganic chemical concentrations in OU1 groundwater differ significantly from those found in public or private water supply well waters, which may be used for irrigation and/or stock watering.

5.3.2 Recommendations

RAO #3 is written into the ROD for the Site, however, inorganic chemicals were not identified as COPCs at the Site, and groundwater samples have not historically been analyzed for inorganic chemicals. Groundwater monitoring should continue to be limited to COPCs for OU1, consistent with the ROD requirements.

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6.0 Certification

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described herein have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with applicable federal, state, and local statutes, regulations, and ordinances.

I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

_____ August 20, 2020

Kalem Sessions, P.E., C.E.M. Date
Certification #2186
Expiration Date: September 18, 2020

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