# FIFTH FIVE-YEAR REVIEW REPORT FOR

# HEWLETT-PACKARD 620-640 PAGE MILL ROAD SUPERFUND PROPERTY

# PALO ALTO, SANTA CLARA COUNTY, CALIFORNIA

PREPARED BY

U.S. Army Corps of Engineers, Seattle District

FOR

**U.S. Environmental Protection Agency**

**Region IX**

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# Executive Summary

This is the fifth Five-Year Review of the Hewlett Packard 620-640 Page Mill Road (Hewlett Packard Property) Superfund Site and off-Property Area (together, the Site) located in Palo Alto, Santa Clara County, California. The purpose of this Five-Year Review is to review information to determine if the remedy is and will continue to be protective of human health and the environment.

Hewlett-Packard manufactured optoelectronic equipment at the Hewlett Packard Property from 1962 to 1986. In 1981, investigations began after the discovery that at least 300 gallons of waste solvents had leaked from a 1,000-gallon underground storage tank. The primary contaminants of concern are trichloroethene, 1,1-dichloroethene, and tetrachloroethene.

In 1995, EPA selected the following remedy for the Site to protect long-term human health and the environment:

- Continued operation of the existing soil vapor extraction and treatment system.
- Expansion and continued operation of the existing groundwater extraction system.
- Long-term groundwater monitoring.
- A deed restriction for the Hewlett Packard property (Property) prohibiting use of on-Property groundwater for drinking water until final cleanup standards are achieved.

The soil vapor extraction and treatment system operated between 1995 and 1997. Due to rising groundwater elevations and because contaminant concentrations in upper portion of the vadose zone had decreased by approximately 99 percent, the soil vapor extraction and treatment system was shut down around 1997.

The groundwater extraction and treatment system initially began operation in 1982 at the Hewlett Packard Property. The groundwater system was expanded off the Hewlett Packard Property in 1988, 1992, and 1996 to address the off-Property Area, where the groundwater contaminant plume is commingled with releases from 601 California Avenue and 395 Page Mill Road. Currently, only the groundwater extraction and treatment system at the Hewlett Packard Property continues to operate.

Groundwater extraction continues to remove contaminant mass and prevent further migration of the contaminant plume. The treatment plant is successfully removing contaminants to below the effluent or receiving water limitations. The data review indicates Site contamination remains aerially extensive and at concentrations significantly above cleanup levels. The ROD estimated that cleanup levels would be reached in approximately thirty years. After about 25 years of operation, 65 wells out of the 117 wells sampled, exceed cleanup standards. While the furthest downgradient wells all remain non-detect indicating the plume is not migrating off Site, there is little evidence that the remedy will reach cleanup standards in the near future.

Recent groundwater sampling confirmed the presence of 1,4-dioxane, which was not identified as a potential Site contaminant. The extent of 1,4-dioxane remains undefined and does not appear to substantial overlap with other Property contaminants. Neither of these changes impacts the protectiveness of the remedy in the short-term since installation of drinking water wells is prohibited by existing institutional controls, which prevents exposure to contaminated groundwater.

There is no current exposure via vapor intrusion. While the vapor intrusion exposure pathway was previously demonstrated as complete in a building with a subgrade structure during the vapor intrusion investigation, the building has since been demolished. The City of Palo Alto forwards preliminary plans for construction within the Site to the Regional Water Quality Control Board to evaluate whether engineering or other controls are necessary.

The remedy at the Hewlett-Packard Superfund Site currently protects human health and the environment because there are no current exposure pathways for groundwater consumption since 1) the institutional control prohibits installation of wells on the Hewlett Packard Property, 2) the footprint of the groundwater plume is not migrating, and 3) the vapor intrusion study has not detected vapor intrusion in currently occupied living or work spaces above levels of concern. However, to be protective in the long-term, the extent of 1,4-dioxane should be delineated in groundwater, and an evaluation should be conducted for remedy optimization or possibly remedy alternatives to decrease the time to reach cleanup.

# Table of Contents

# List of Tables

# List of Abbreviations

| | |
|---|---|
| bgs | below ground surface |
| COE | California-Olive-Emerson Study Area |
| EPA | Environmental Protection Agency |
| Hewlett-Packard Property | Hewlett-Packard 620-640 Page Mill Road Superfund Property |
| IRIS | Integrated Risk Information System |
| MCL | maximum contaminant level, as defined by the Safe Drinking Water Act |
| mg/kg | milligram per kilogram |
| µg/L | microgram per liter |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| O&M | operation and maintenance |
| PCE | tetrachloroethene |
| ROD | Record of Decision |
| RWQCB | San Francisco Bay Regional Water Quality Control Board |
| TCE | trichloroethene |
| USACE | U.S. Army Corps of Engineers |

# 1. Introduction

The purpose of a Five-Year Review is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act Section 121, 40 Code of Federal Regulation Section 300.430(f)(4)(ii) of the National Contingency Plan and EPA policy.

This is the fifth Five-Year review for the Hewlett Packard 620-640 Page Mill Road Superfund (Hewlett-Packard) property (Property) and the off-Property area (together, the Site). The triggering action for this policy review is the completion date of the previous one. The Five-Year Review has been prepared because hazardous substances, pollutants, or contaminants remain at the property at concentrations that do not allow unlimited use and unrestricted exposure.

The Site consists of the soil and groundwater contamination at the Property as well as the area-wide groundwater contamination in the off-Property Area. While the Site is on the National Priorities List, it is managed by the State of California together with several neighboring source properties that are not listed on the National Priorities List and include the 395 Page Mill Road property and the 601 California Avenue property.

All three properties contributed to the groundwater plume, which underlies these properties as well as the adjacent and downgradient mixed residential/commercial neighborhood. This neighborhood is termed the off-Property Area and consists of the California-Olive-Emerson (COE) Study Area (for the streets, which bound this area) and Perimeter Area (areas south of Olive Avenue to Margarita Avenue). Remediation of the overall groundwater plume is managed as a combined project; however, the Site includes the off-Property Area only (COE Study Area and Perimeter Area), but not the contributing 395 Page Mill Road site or the 601 California Avenue site.

The Hewlett Packard Property Five-Year Review was led by Brian Milton, Remedial Project Manager with EPA and Roger Papler, Engineering Geologist with the State of California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). Participants included Cynthia Wetmore, EPA's Five-Year Review Coordinator, Jennifer Phillippe (Physical Scientist), Jeff Weiss (Geologist), and Justin McNabb (Geologist) with the U.S. Army Corps of Engineers (USACE). The review began on October 28, 2019.

**Table 1. Five-Year Review Summary Form**

| PROPERTY IDENTIFICATION | | |
|---|---|---|
| **Property Name:** Hewlett Packard 620-640 Page Mill Road Superfund Property | | |
| **EPA ID:** CAD980884209 | | |
| **Region:** 9 | **State:** CA | **City/County:** Palo Alto / Santa Clara County |
| **PROPERTY STATUS** | | |
| **NPL Status:** Final | | |
| **Multiple OUs?** No | **Has the property achieved construction completion?** Yes | |
| **REVIEW STATUS** | | |
| **Lead agency:** State | | |
| **Author name (State and Federal Project Managers):** Roger Papler and Brian Milton | | |
| **Author affiliation:** RWQCB and Environmental Protection Agency | | |
| **Review Period:** October 28, 2019 –August 31, 2020 | | |
| **Date of property inspection:** 2/5/2020 | | |
| **Type of review:** Policy | | |
| **Review number:** 5 | | |
| **Triggering action date:** 9/22/2015 | | |
| **Due date *(five years after triggering action date)*:** 9/22/2020 | | |

## 1.1. Background

Hewlett-Packard first occupied the Hewlett-Packard Property in 1962, ceased operations in 1986, and began redevelopment in 1992 with the construction of a new office building. Hewlett-Packard constructed the majority of the new building over a basement parking garage and the remaining on-grade portion of the building over a vapor barrier. Hewlett-Packard sold the building and associated land lease in May 2007 to Stanford University.

Investigations began at the Hewlett-Packard Property in 1981 after the discovery of a leaking 1,000 gallon used solvent underground storage tank. The most frequently detected contaminants in soil and/or groundwater included trichloroethene (TCE), 1,1-dichloroethene, tetrachloroethene (PCE), and 1,2,4-trichlorobenzene.

Initial soil responses at the property included excavations between 1987 and 1992 on the Hewlett Packard Property that removed soil containing semi-volatile contaminants and soil vapor extraction and treatment beginning in 1994. Soil vapor extraction and treatment operations ended in 1997 when soil containing residual volatile contaminants at the Hewlett Packard Property in the upper portion of the former vadose zone reached the cleanup standard.

Initial groundwater responses at the Property consisted of groundwater extraction and treatment at the Hewlett-Packard Property in 1982 for seven months, then restarting the groundwater extraction and treatment system in 1987. Hewlett-Packard then expanded the groundwater system in 1988 and again between 1992 and 1996. Groundwater contamination from the Hewlett-Packard Property commingled with similar contaminant releases from the following two neighboring properties: a former Hewlett-Packard facility at 395 Page Mill Road Property, and a former Varian Medical Systems, Inc. facility at 601 California Avenue.

## 1.2. Physical Characteristics

The Site, which includes the 10-acre Hewlett-Packard Property and the off-property area, is located in Palo Alto, California (Figure 1). The Site is south of Highway 101 near the corner of Page Mill Road and El Camino Real and near the southeastern campus boundary of Stanford University. The off-Property area is comprised of the COE Study Area and the Perimeter Area, excluding the 601 California Avenue Property and 395 Page Mill Road Property. The COE Study Area is bounded by California Avenue to the west, Olive Avenue to the east, Emerson Avenue to the north, and the southernmost extent of the Hewlett Packard Property to the south (Figure 2). The Perimeter Area is located immediately east of the COE Study Area and is bounded by Emerson Street to the north, Fernando Avenue to the east, and State Highway 82 and Hansen Way to the south.

The City of Palo Alto is on the west side of Silicon Valley in Santa Clara County and is part of the San Francisco Bay metropolitan region. The population of Palo Alto, as of 2018, is approximately 67,000. The Property is located within a mixed-use commercial/residential area that is supplied with municipal water. A groundwater use restriction was placed on the Hewlett Packard Property in 2003 and remains in place. No environmentally sensitive areas are located near the Site.

## 1.3. Hydrology

Three water-bearing zones or aquifers underly the Site (the A, B, and C Zones). The A Zone and B Zones are comprised of alluvial fan deposits from ancestral San Francisquito Creek and Matadero Creek and are the primary saturated zones. The saturated portion of the A Zone spans from 13 to 55 feet below ground surface (bgs) while the B Zone spans from approximately 60 to 120 feet bgs. The third aquifer, the C Zone, is separated from the B Zone by an aquitard (low permeability zone) and underlies the Site below 150 feet bgs.

The A Zone is subdivided into the A1 Upper (A1U) Zone, A1, A2, and A2 Deeper (A2D) Zones based on the presence of aquitards, which vary from 1 to 22 feet thick and by substantially different contaminant levels in each zone. The B Zone is subdivided into the B1 and B2 Zones that are separated by a 20-feet thick aquitard. The A Zone water-bearing zones retain a degree of hydraulic connection where the aquitards are thinner.

The course-grained sediments of the A1U Zone extend from approximately 10 to 30 feet bgs and are unsaturated in the southwestern portion of the Site. The A1 Zone and the A2 Zone respectively from approximately 30 and 40 feet bgs and 40 and 55 feet bgs. A single A1/A2 Zone exists in the western portion of the Site, where the A1 and A2 Zones are in direct contact. The A2D Zone comprises sandy lenses within the upper portion of the aquitard between the A and B Zones. The A/B aquitard spans from 5 to 23 feet bgs.

The regional groundwater flow direction is generally to the northeast from the hills to the San Francisco Bay. Local variations in the distribution of coarse- and fine-grained deposits created preferential pathways for chemicals in groundwater. Groundwater extraction also appears to cause localized refraction of groundwater flow. Shallow groundwater is not currently used as a source of potable water within the area of the groundwater plume

Approximately 1,500 feet northeast of the Property, the Oregon Expressway Underpass subdrain system captures the majority of the Site's plume beneath the Southern Pacific Railroad tracks, along Page Mill Road that becomes Oregon Expressway. The Oregon Expressway Underpass subdrain extends approximately 24 feet bgs into the A1U Zone to prevent flooding and existed before the remedy was implemented. While not included as a part of the remedy, the subdrain system effectively prevents further migration of the groundwater plume.


**Figure 1. Location Map**

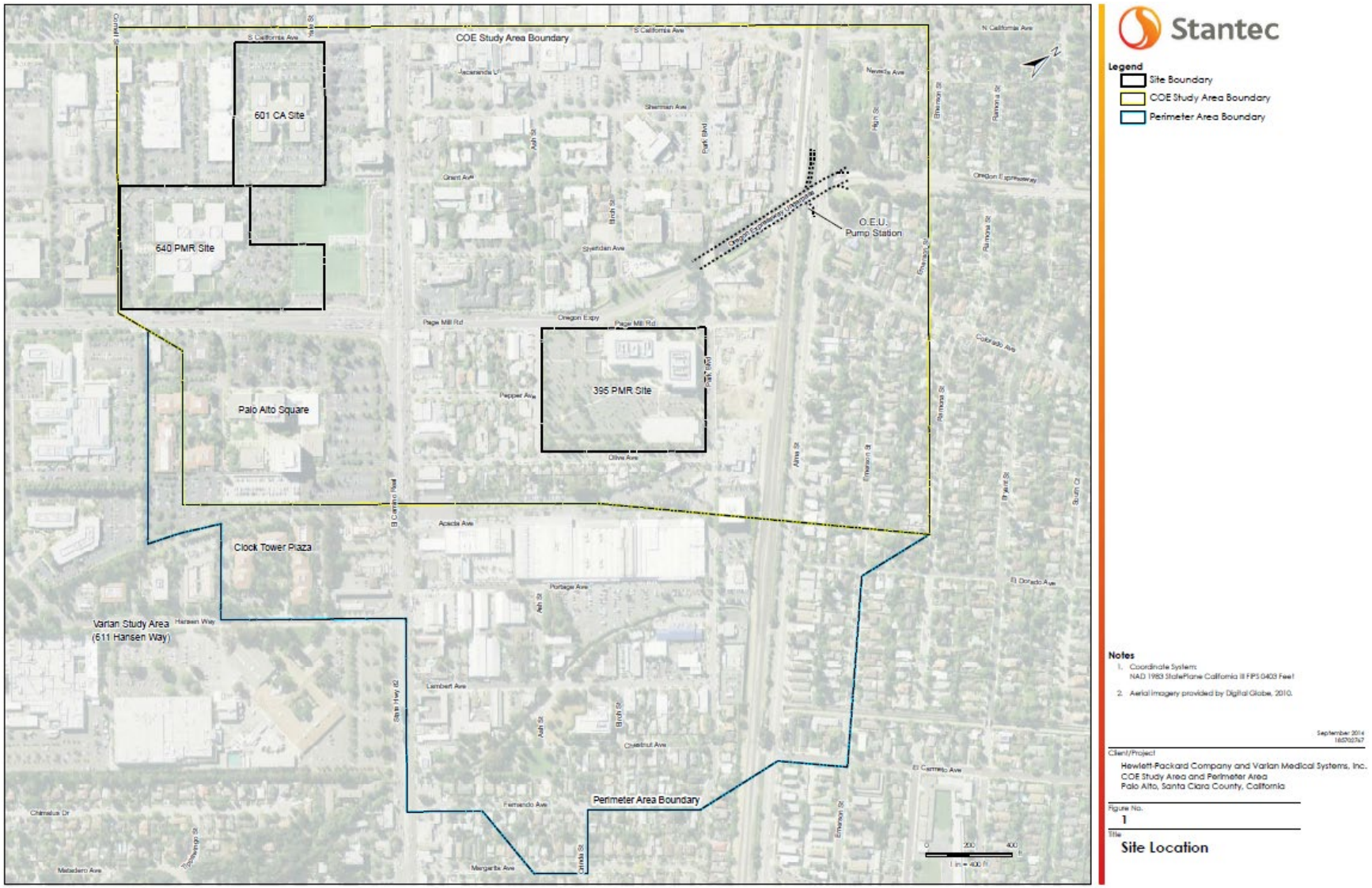



**Figure 2. Detailed Map**

# 2. Remedial Actions Summary

## 2.1. Basis for Taking Action

Volatile contaminants in soil and groundwater were identified in the Record of Decision (ROD) as the primary contaminants of concern at the Site. Exposure through touching contaminated soil or drinking contaminated groundwater were the primary reasons behind taking action.

EPA's 1992 Baseline Public Health Evaluation further evaluated current and future residential exposure scenarios and commercial/industrial worker exposure scenarios based on potential exposure to groundwater contaminants. The three most significant potential exposures under future use scenarios were as follows:

- Ingestion of groundwater containing chemicals of potential concern
- Inhalation of volatile contaminant vapors from the groundwater during showering and/or other domestic uses
- Inhalation of volatile contaminant vapors inside buildings resulting from volatilization from groundwater

## 2.2. Remedy Selection

The RWQCB adopted Final Site Cleanup Requirements Order No. 94-130 in September 1994 and EPA issued the ROD in March 1995. While no Remedial Action Objectives were stated in the ROD, the following Remedial Action Objectives are inferred:

- Prevent soil contamination from adversely impacting groundwater.
- Restore groundwater to beneficial use as a source of drinking water.
- Limit human exposure to contaminants in groundwater.
- Mitigate migration of contaminated groundwater.

The components of the final cleanup remedy selected in the ROD for the Site consisted of the following:

- Continued operation of the existing 15-well soil vapor extraction and treatment system at the Site until final cleanup standards are achieved.
- Expansion and continued operation of the existing groundwater extraction system until final cleanup standards are achieved.
- Long-term groundwater monitoring.
- A deed restriction for the Property prohibiting use of on-Property groundwater for drinking water until final cleanup standards are achieved.

Although not an official component of the remedy, the remedy did rely on the Oregon Expressway Underpass dewatering subdrain that captures shallow groundwater to keep the underpass area free of standing water and prevents flooding. The groundwater remedy considered the Oregon Expressway Underpass subdrain because the subdrain also captures groundwater from the surrounding areas and limits plume migration.

The ROD selected cleanup standards for both soil and groundwater as defined in the RWQCB's Site Cleanup Requirements Order. For soil, the cleanup standards selected in the ROD are 1.0 milligram per kilogram (mg/kg) for total volatile contaminants and 25 mg/kg for acetone (Table 2). The RWQCB set the 1 mg/kg total volatile contaminant standard based on guidance within the 1992 Ground Water Basin Plan Amendments and set the 25 mg/kg acetone standard based on the chemical transport model described in the Remedial Investigation.

**Table 2. Soil Cleanup Standards Selected in ROD**

| Contaminants of Concern | 1995 ROD Selected Cleanup Level (mg/kg) | Basis |
|---|---|---|
| Total Volatile Organic Compounds | 1 | 1992 Groundwater Basin Plan Amendments |
| Acetone | 25 | 1994 Remedial Investigation transport model |

The groundwater cleanup standards for all contaminants were set to the more stringent value of either the federal or state Maximum Contaminant Levels (MCLs), except for acetone for which no MCL existed (Table 3). For acetone, the cleanup standard was based on the reference dose and hypothetical maximum exposure rate found in the 1992 EPA Health Effects Assessment Summary Tables (USEPA, 1992).

**Table 3. Groundwater Cleanup Standards Selected in ROD**

| Contaminants of Concern | 1995 ROD Selected Cleanup Level (µg/L) | Basis |
|---|---|---|
| Acetone | 3,500 | Risk-based[1] |
| Benzene | 1 | State MCL |
| 1,1-Dichloroethane | 5 | State MCL |
| 1,2-Dichloroethane | 0.5 | State MCL |
| 1,1-Dichloroethene | 6 | State MCL |
| *cis*-1,2-Dichloroethene | 6 | State MCL |
| *trans*-1,2-Dichloroethene | 10 | State MCL |
| Methylene Chloride | 5 | State MCL |
| Tetrachloroethene (PCE) | 5 | Federal MCL |
| 1,1,1-Trichloroethane | 200 | Federal MCL |
| 1,1,2-Trichloroethane | 3 | State MCL |
| Trichloroethene (TCE) | 5 | Federal MCL |
| Freon 113 | 1,200 | State MCL |
| 1,2-Dichlorobenzene | 600 | Federal MCL |
| 1,2,4-Trichlorobenzene | 70 | Federal MCL |

[1]Based on the reference does and hypothetical maximum exposure rate found in the 1992 EPA Health Effects Assessment Summary Tables (USEPA, 1992)

## 2.3. Remedy Implementation

### 2.3.1. Soil Vapor Extraction and Treatment

Hewlett-Packard periodically shut down and re-started the existing soil vapor extraction and treatment system from 1995 until 1997 to allow for volatile contaminant rebound. An effectiveness evaluation in 1997 concluded that the soil vapor extraction and treatment system influent concentrations had decreased by approximately 99 percent and that remediation goals for volatile contaminants and acetone had likely been achieved in the upper zone soil. The lower zone soil vapor extraction and treatment wells could not operate effectively due to re-saturation of soil by rising groundwater levels.

### 2.3.2. Groundwater Extraction and Treatment

Portions of the groundwater extraction and treatment system operating at the time of the ROD continue to operate. However, the location and number of operating extraction wells have been modified. Currently EW-8, EW-10, TW-1 and TW-2 are the only operating extraction wells. Extracted groundwater is pumped through a pipeline from these wells to the northwest corner of the Property where the treatment system is located.

The groundwater is treated using an advanced oxidation process that utilizes hydrogen peroxide and ozone followed by two liquid-phase granular activated carbon tanks. Following treatment, treated groundwater discharges into Matadero Creek via the City of Palo Alto storm drain.

Hewlett-Packard submitted Annual National Pollutant Discharge Elimination System (NPDES) Permit Reports for 2015 to 2019 that indicate there have been no unacceptable effluent exceedances of permit requirements to receiving waters over that period. However, 1,4-dioxane was reported in the effluent sampling at concentrations above the RWQCB Environmental Screening Level of 0.38 ug/L and EPA regional screening level of 0.46 ug/L. There is no 1,4-dioxane effluent standard set in the NPDES permit for the Property.

An addendum to the Site NPDES permit was issued on December 18, 2018, which modified the effluent sampling requirements. As part of this modification, 1,4-dioxane was removed from the effluent sampling list because there are no water quality standards for 1,4-dioxane promulgated by EPA through its MCLs or State Water Resources Control Board. This chemical was historically was reported in the effluent sampling during the first and third quarter of the year. The presence of 1,4-dioxane in the groundwater extraction and treatment system effluent was an issue noted in the 2015 Five-Year Review and supplemental groundwater sampling for 1,4-dioxane was conducted during the Second Quarter 2016.

The Oregon Expressway Underpass dewatering subdrain was considered when designing the groundwater remedy because it captures groundwater from the surrounding areas and limits plume migration. Volatile contaminant-impacted groundwater collected at the Oregon Expressway Underpass pump was historically discharged to the sanitary sewer system under permit. During high-flow times, contaminated groundwater was pumped to a box culvert that discharges to Matadero Creek. In 2002, the current treatment system was installed and consists of vacuum air stripping that discharges to the box culvert.

As part of the groundwater extraction and treatment system expansion in 1996, three additional wells were installed in the Perimeter Area, EW-12, EW-13, and EW-14. These wells were connected to a

treatment system at 611 Hanson Way within the Perimeter Area, which operated from 1996 until 2006 when the system was damaged by flooding. EW-14 was decommissioned in July 2006, after an in-situ chemical oxidation treatment. RWQCB approved a request to decommission EW-12 and EW-13 in September 2017. EW-13 was decommissioned in December 2018 and well destruction was deferred to a future date (Stantec, 2018b).

#### 2.3.3. Institutional Controls

Stanford Management Company owns the Property and recorded a covenant and environmental restriction (Deed Restriction) that became effective May 28, 2003. The Deed Restriction prohibits constructing a well for the purpose of extracting contaminated water for any use, unless expressly permitted in writing by the RWQCB.

### *2.4. Operation and Maintenance (O&M)*

The system at the Property is monitored remotely and personnel inspect and maintain the system at least once per week. Updates to the O&M procedures were completed when the groundwater extraction and treatment system was updated in 2013.

# 3. Progress Since the Last Five-Year Review

### *3.1. Previous Five-Year Review Protectiveness Statement and Issues*

The protectiveness statement from the 2015 Five-Year Review for the Site stated the following:

> *The remedy at the Hewlett-Packard 620-640 Page Mill Road Site currently protects human health and the environment because there are no current exposure pathways for groundwater consumption, and the vapor intrusion study has not detected vapor intrusion in currently occupied living or workspaces above levels of concern. However, to be protective in the long-term, a new cleanup level for 1,2,4-trichlorobenzene considering the new state MCL should be evaluated, an evaluation of the need for a remedy which considers the potential for future vapor intrusion exposures should be completed, and 1,4 dioxane should be analyzed in future site sampling to determine its distribution and whether it should be considered a site Contaminant of Concern.*

**Table 4: Status of Recommendations from the 2015 Five-Year Review**

| Issue | Recommendations | Current Status | Current Implementation Status Description | Completion Date (if applicable) |
|---|---|---|---|---|
| Recent vapor intrusion investigations have demonstrated that a complete pathway does exist in subgrade structures. However, there have not been unacceptable exposure or exceedances of the risk range in currently occupied locations. | Evaluate the need for revisions to the current remedy to address potential future unacceptable vapor intrusion | Completed | Additional vapor intrusion sampling was completed for selected properties in 2015. The RWQCB issued No Further Action (NFA) for vapor intrusion in 2016. The RWQCB established a protocol with the City of Palo Alto to notify the RWQCB when any new construction is planned within the COE plume. | 10/6/2016 |
| The California MCL for 1,2,4-trichlorobenzene has decreased since the signing of the ROD and is more stringent than the current ROD cleanup level. | Evaluate whether the cleanup level for 1,2,4-trichlorobenzene should be changed to the new state MCL and include in a decision document modification as necessary. | Considered But Not Implemented | The ROD cleanup level for 1,2,4-trichlorobenzene is still within EPA's protective range for excess cancer risk of 10-4 to 10-6. 1,2,4-trichlorobenzene is present only in the source area of the Property and will be addressed by the remedy along with other Site contaminants. | 1/28/2020 |
| The Annual NPDES reports show that 1,4-dioxane is analyzed for and detected in the treatment system effluent. 1,4-Dioxane was commonly used as a stabilizer for chlorinated solvents, particularly 1,1,1-Trichloroethane (Mohr, 2001), which is a property contaminant. The detection of 1,4-dioxane in the system effluent suggests its presence in the aquifer, but there is no information regarding its distribution in the subsurface | Analyze for 1,4-dioxane in a future sampling event to determine subsurface 1,4-dioxane concentration and to assess whether 1,4-dioxane should be considered as a property contaminant | Ongoing | 1,4-dioxane groundwater samples were collected as part of the Second Quarter 2016 sampling event. 1,4-dioxane was reported in the subsurface with a maximum concentration of 11 ppb. The extent of 1,4-dioxane remains undefined and does not appear to have substantial overlap with other Site contaminants. Additional sampling is recommended to determine the extent and distribution in the subsurface, and evaluation of 1,4,-dioxane as a potential Site contaminant is recommended after the additional sampling. | 9/30/2023 |

## 3.2. Work Completed at the Site During this Five-Year Review Period

Hewlett-Packard completed one additional round of vapor intrusion assessment in response to the January 8, 2015 RWQCB letter (Stantec 2015b). Hewlett-Packard and EPA evaluated buildings with subgrade structures within the footprint of the 5 micrograms per liter (µg/L) TCE plume for air sampling and completed additional outreach within the Initial Vapor Intrusion Study Area. Air samples were collected from 55 locations and three samples had detections of Site contaminants. None of the samples were above the screening values and indicated that there is no risk from vapor intrusion in the existing structures that were sampled. However, the risk for vapor intrusion remains due to the elevated concentrations of volatile contaminants in shallow groundwater especially for buildings with subgrade structures.

Hewlett-Packard installed an air purifier in the electrical meter room in the subgrade garage of Commercial Building 23 to address the completed vapor intrusion pathway (Stantec 2016a). The air purifier operated from April 27, 2015 until March 24, 2017 when it was removed prior to building demolition (Stantec 2017b).

Hewlett Packard used 1,4-dioxane as a solvent stabilizer (Mohr 2001). The presence of 1,4-dioxane in the groundwater extraction and treatment effluent water was identified as an issue in the 2015 Five-Year Review and groundwater sampling was recommended. 1,4-Dioxane analysis was included for selected monitoring wells during the Second Quarter 2016 to assess its presence and distribution in the subsurface. The maximum groundwater concentration observed during the Second Quarter 2016 groundwater sampling event was 11 µg/L in well F40A. This concentration exceeds both the EPA regional screening level and the RWQCB Environmental Screening Level for tap water. No Site contaminants were reported above cleanup levels in F40A. However, public utilities provide water to occupants within the Site.

Hewlett-Packard conducted a groundwater tracer study on the Property in accordance with the previously submitted Hewlett-Packard *Enhanced In Situ Bioremediation Pilot Study Work Plan* that was approved by the RWQCB in 2012 (Stantec 2019d). Fluorescing dyes were injected into existing A1 and A2 zone wells in the basement parking garage to assess the feasibility of injecting and distributing substrates for enhanced in situ bioremediation via extraction wells TW-1 and TW-2. Based on the successful tracer study, the RWQCB requested Hewlett Packard to submit a revised *Enhanced In Situ Bioremediation Pilot Study Work Plan* by December 31, 2020.

Hewlett-Packard decommissioned multiple extraction and monitoring wells in 2017 and 2018 with RWQCB approval (Table 5). All of these wells were located in the COE Study Area (Stantec 2018b, Stantec 2018c, and Stantec 2018d).

**Table 5. Extraction and Monitoring Wells Decommissioned Since 2015**

| Well ID | Date |
|---|---|
| EW-13, OB12-2, OB12-2 | December 2017 |
| F38A, F101B, V-11A1U | April 2018 |
| F36A, P2-1, P2-2, P2-3, P2-4 | June 2018 |

# 4. Five-Year Review Process

## 4.1. Community Notification and Site Interviews

EPA published a public notice of the Five-Year Review in the *West Valley View News* on February 19, 2020 and invited the public to submit any comments (Appendix F). The results of the review and the report will be made available at the Site information repository located at Building 3 of the U.S. Geological Survey Library located at 345 Middlefield Road, Menlo Park, California.

During the Five-Year Review process, interviews were conducted to document any perceived problems or successes with the remedy that has been implemented to date (Appendix G). The results of these interviews are summarized below.

Several Stantec employees provided a group response to the interview questions via email. The group response noted that there were no concerns with remedy progress and/or O&M activities. The groundwater extraction and treatment system was optimized in 2014 to further contain the plume and continues to remove volatile contaminant mass. A new NPDES permit was issued in 2019, which modified the monitoring frequency and parameters.

Amy French, Chief Planning Official, and Jodie Gerhardt, Manager of Current Planning, both with the City of Palo Alto, were also interviewed by USACE and Roger Papler of the RWQCB via telephone on April 1, 2010. The focus of the interview was the new construction noted in the COE Study Area during the Site inspection and how the City Planning Office interacts with the RWQCB to evaluate potential risks for new construction.

The City Planning Office indicated that they were aware of the Site and had previously interacted with the RWQCB on planned developments. They also indicated that proposed construction plans are submitted to the State Clearinghouse, which should forward them on to other state agencies for review. Mr. Papler, indicated that due to the number of submissions to the State Clearinghouse that he was oftentimes not notified in a timely manner of planned construction and asked that he be copied when the City submits the proposed plans to the State Clearinghouse. The City Planners indicated that he would be copied on future submittals. They further requested additional training on how to identify which areas were of specific concern. Mr. Papler indicated the process of putting on a formal training would be labor intensive but agreed to provide procedures through an informal call with the larger Planning Office staff.

## 4.2. Data Review

The data review indicates Site contamination remains aerially extensive and at concentrations significantly above cleanup levels. However, the groundwater extraction and treatment system continues to remove contamination and prevent migration into less contaminated areas. The ROD estimated that cleanup levels would be reached in approximately 30 years. After approximately 25 years, 65 wells out of the 117 wells sampled, exceed cleanup standard for Site contaminants with a maximum concentration of TCE of 2,800 ug/L that exceeds the cleanup level 5 ug/L. The number of wells exceeding cleanup standards and the high concentrations demonstrate the extensive size and concentration of the remaining plume. While the furthest downgradient wells all remain non-detect indicating the plume is not migrating off Site, there is little evidence that the remedy will reach cleanup standards in the near future.

The plume has remained stable over the past five years based on Mann-Kendall analysis included as Appendix C. The Mann-Kendall analysis shows no trend or a stable trend for approximately 60 percent of the wells. Mann-Kendall analyses were completed on 31 wells and only four of the wells had increasing concentrations. The increasing concentrations were near extraction wells and likely due to the extraction wells pulling contaminated water towards the wells. However, only 30 percent of the wells were decreasing and indicates that the remedy has not provided a significant reduction in contaminant concentrations. Nor is it likely to achieve cleanup standards in a timely manner, as envisioned in the ROD.

The highest concentrations of Site contaminants beyond the Property were near the Oregon Expressway Underpass (Figure 4). The underdrain system at the Oregon Expressway Underpass acts as an extraction well by capturing downgradient contamination. The concentrations at the wells near the Oregon Expressway Underpass remained stable with TCE ranging from 49 to 120 ug/L during the previous five years and wells downgradient of the Oregon Expressway Underpass were at non-detectable concentrations.

Contamination in the distal portions of the plume was detected above cleanup levels at five wells in the perimeter area. The concentrations were significantly lower than the main portion of the plume with a maximum of 68 ug/L for TCE and downgradient wells remained at non-detectable concentrations.

In 2016, sampling for 1,4-dioxane was completed at 24 wells based on the recommendation of the last Five-Year Review. The ROD did not list 1,4-dioxane as a Site contaminant. However, it was commonly used as a solvent stabilizer and 1,4-dioxane does not degrade as quickly as other volatile contaminants and can remain after cleanup of other volatile contaminants is complete. Out of the 24 wells sampled for 1,4-dioxane, 16 had detections of 1,4-dioxane and indicated that widespread and additional sampling should be completed to better characterize the extent in the subsurface. (Appendix C).

The pump and treat system at the Site continued to pump, averaged between 46 and 53 gallons per minute, and removed 254 to 590 pounds of volatile contaminants per year.

EPA and the RWQCB issued a January 2016 public information memo entitled "*California-Olive-Emerson Study Area" Cleanup Update* to address vapor intrusion concerns in the community. The RWQCB approved the previous vapor intrusion investigation and granted "No Further Action" for vapor intrusion in October 2016 and there is no risk from vapor intrusion in the current structures. However, the vapor intrusion risk for future subgrade structures remains due to the high volatile contaminant concentrations in shallow groundwater at the Site and within the COE Study Area (Figure 4).

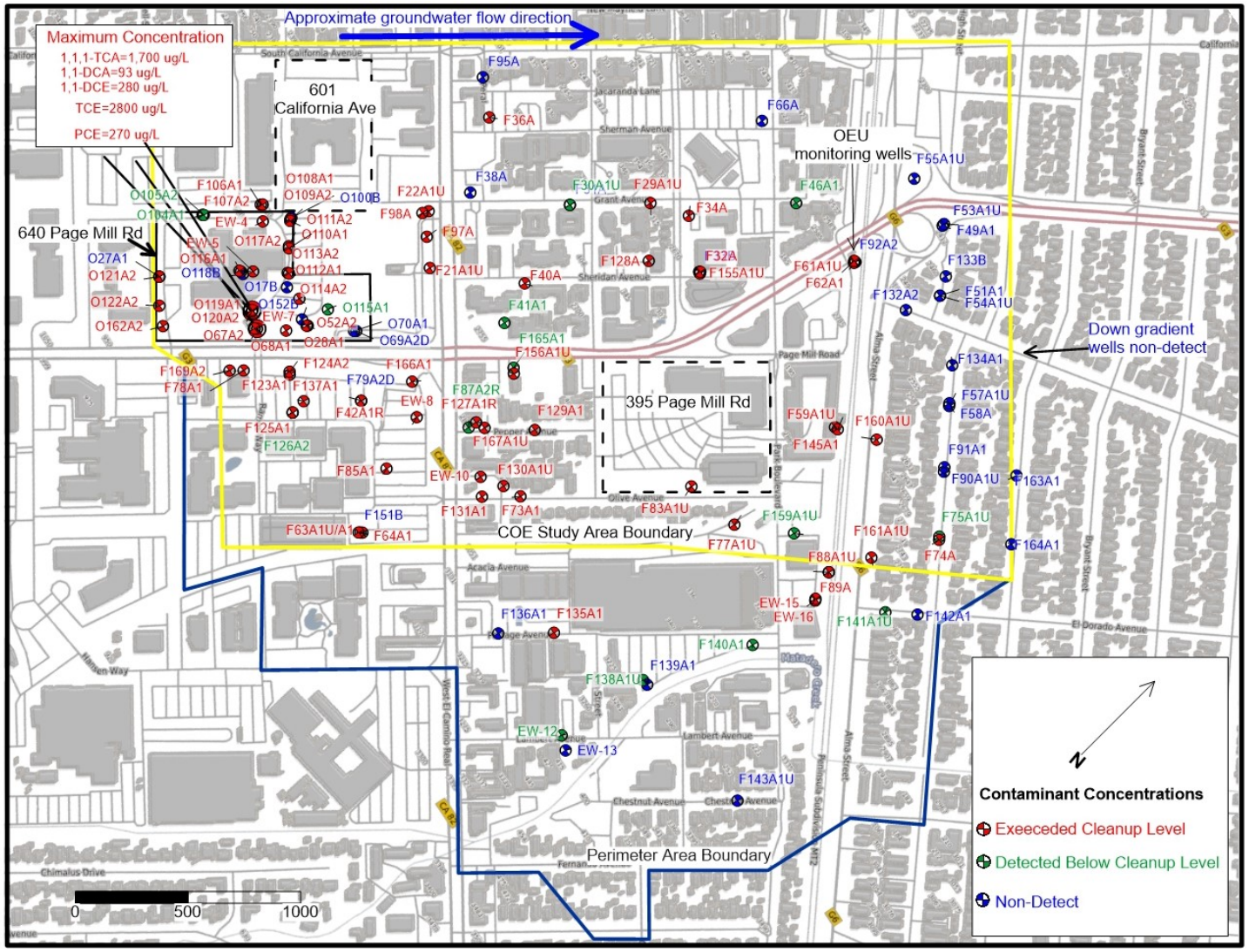



**Figure 3. Summary of Sampling from 2015 to 2019**

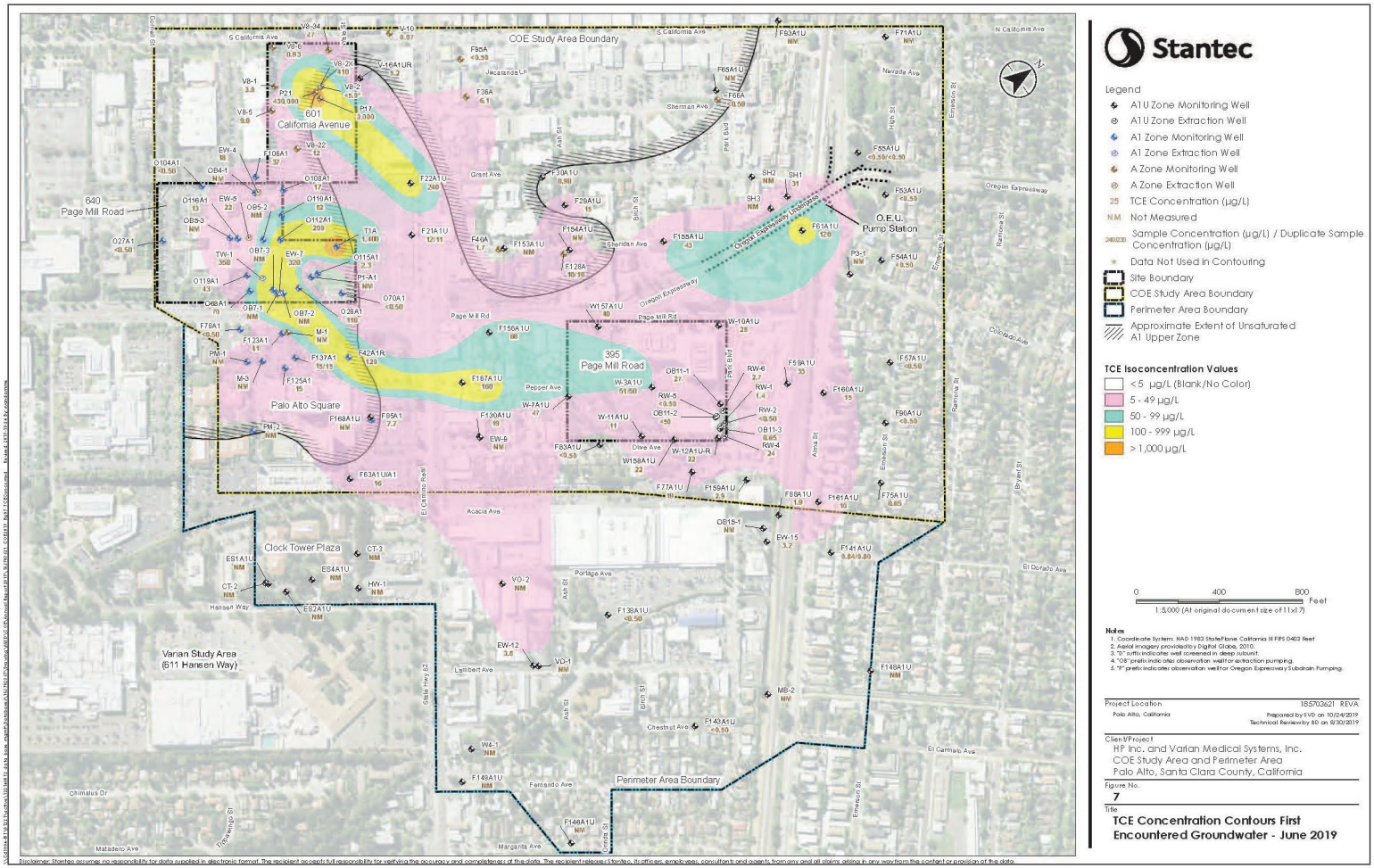



Figure 4. 2019 TCE Concentrations in First Encountered Groundwater

## 4.3. Site Inspection

EPA, USACE and the RWQCB inspected the Site February 25, 2020 (Appendix H). In attendance were Brian Milton, EPA; Roger Papler, RWQCB; Justin McNabb, USACE; Mark Becker, Pete Cornish, Brittany Demmer, and Angus McGrath, Stantec; and Chris Dirschel, Hewlett-Packard. The purpose of the inspection was to assess remedy protectiveness. The existing monitoring well network and groundwater extraction and treatment system were in good condition with all existing wells locked and the groundwater extraction and treatment system operating.

Prior to the inspection, the USACE representative walked the COE Study Area to identify new construction since completion of the vapor intrusion investigation. New construction was observed on several properties within the COE Study Area. A map showing the location of the properties with ongoing construction is included with the Site inspection report (Appendix H).

# 5. Technical Assessment

## 5.1. Question A: Is the remedy functioning as intended by the decision documents?

The remedy is functioning as intended. Soil cleanup goals were met in 1997. Institutional controls prohibit installation of groundwater extraction wells for any purpose unless permitted by the RWQCB; this prevents exposure to contaminated groundwater. Groundwater extraction continues to remove contaminant mass and the contaminant plume is not migrating. However, while the treatment plant is successfully removing Site contaminants to below the effluent or receiving water limitations, elevated contaminant concentrations remain.

The ROD estimated that cleanup levels would be reached in approximately thirty years. After about twenty-five years of operation, 65 wells, out of the 117 wells sampled, exceed cleanup standard for Site contaminants. There was no trend or a stable trend in contaminant concentrations for approximately 60 percent of the approximately 31 wells evaluated for trends. Based on these observations the current remedy is not likely to achieve cleanup standards in a timely manner, as envisioned in the ROD.

Evidence of new construction activities was noted at several properties within the COE Study Area. Internal RWQCB consultation regarding the new construction revealed that staff were overseeing the new construction properties for vapor intrusion potential.

## 5.2. Question B: Are the exposure assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

In the original Baseline Public Health Evaluation, EPA determined that current exposure pathways only included vapor intrusion; however, future pathways may also include domestic use of groundwater if drinking water wells were to be placed within the plume area. Currently, there are no drinking water wells in the area, which is provided with municipal water. The RWQCB also prohibits installing such wells. The continued operation of the Oregon Expressway Underpass dewatering subdrain also continues to prevent migration of the groundwater plume. Therefore, the exposure assumptions in the ROD are still valid.

The ROD selected the cleanup standards based on either federal MCL or the California MCL at the time of the ROD, whichever was more stringent. Since the ROD was signed, California adopted an MCL for 1,2,4-trichlorobenzene more stringent than the ROD cleanup level and the federal MCL. However, the ROD cleanup level for 1,2,4-trichlorobenzene is still within EPA's protective range for excess cancer risk of $10^{-4}$ to $10^{-6}$. The solvent stabilizer 1,4-dioxane is not a Site contaminant of concern. However, the presence of 1,4-dioxane in the subsurface at the Site was confirmed by the Second Quarter 2016 groundwater sampling event.

## 5.3. Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

The Site is located in an area expected to be at increased risk for floods associated with climate change (GAO 2019). Previous flooding damaged extraction well, EW-12, and the groundwater extraction and treatment system at 611 Hanson Way in the Perimeter Area. This groundwater extraction and treatment system was removed and an in-situ chemical oxidation injection completed. The increased risk of flooding due to climate change may impact the groundwater extraction and treatment system operating at the Property.

# 6. Issues/Recommendations

**Table 6. Issues and Recommendations Identified in the Five-Year Review**

| OU(s): N/A | Issue Category: Changed Site Conditions | | | |
|---|---|---|---|---|
| | **Issue:** The nature and extent of 1,4-dioxane in groundwater remains undefined. | | | |
| | **Recommendation:** Conduct additional groundwater sampling to define the extent of 1,4-dioxane relative to Site contaminants and area of remedy implementation | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Party Responsible** | **Oversight Party** | **Milestone Date** |
| No | Yes | PRP | State | 9/30/2023 |

| | | | | |
|---|---|---|---|---|
| OU(s): N/A | Issue Category: Remedy Performance | | | |
| | **Issue:** The remedy has been operating for approximately 25 years. The initial timeframe for reaching groundwater cleanup standards in the ROD was 30 years. Evidence suggests that the current remedial strategy for groundwater will not achieve cleanup standards for decades. | | | |
| | **Recommendation:** Conduct an evaluation for remedy optimization or possibly remedy alternatives to decrease the time to reach cleanup. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Party Responsible** | **Oversight Party** | **Milestone Date** |
| No | Yes | PRP | EPA/State | 9/30/2023 |

# 7. Protectiveness Statement

**Table 7. Protectiveness Statement**

| Property-wide Protectiveness Statement |
|---|
| *Protectiveness Determination:*<br><br>Short-term Protective |
| *Protectiveness Statement:* The remedy at the Hewlett-Packard Superfund Site currently protects human health and the environment because there are no current exposure pathways for groundwater consumption since 1) the institutional control prohibits installation of wells on the Property, 2) the footprint of the groundwater plume is not migrating, and 3) the vapor intrusion study has not detected vapor intrusion in currently occupied living or work spaces above levels of concern. However, to be protective in the long-term, the extent of 1,4-dioxane should be delineated in groundwater, and an evaluation should be conducted for remedy optimization or possibly remedy alternatives to decrease the time to reach cleanup. |

# 8. Next Review

The next five-year review report for the Hewlett Packard Site is required five years from the completion date of this review.

# Appendix A: List of Documents Reviewed

ENVIRON. (1993). *Remedial Investigation Report (Revised),* California-Olive-Emerson (COE) Study Area and Perimeter Area, Palo Alto, California. Prepared on behalf of Hewlett-Packard Company & Varian Associates, Inc. 24 June 1993.

ENVIRON. (1994). *Remedial Investigation Report (Revised),* California-Olive-Emerson (COE) Study Area and Perimeter Area, Palo Alto, California. Prepared on behalf of Hewlett-Packard Company and Varian Associates, Inc. 2 May 1994.

EPA. (1992). Health Effects Assessment Summary Tables, Annual, FY 1992. March 1992.

EPA. (1995). Record of Decision; Hewlet Packard (620-640 Page Mill Road), EPA ID: CAD980884209, OU 01, Palo Alto, CA. 24 March 1995.

EPA. (2011). Acetone (CASRN 67-64-1). Retrieved January 7, 2020, from Health Effects Assessment Summary Tables (HEAST): https://epa-heast.ornl.gov/heast.php

EPA and SFBRWQCB. (2016) "California-Olive-Emerson Study Area" Cleanup Update. Hewlett-Packard (620-640 Page Mill Road) Superfund Property and former Varian 601 California Avenue Property, former Hewlett-Packard 395 Page Mill Road Property, and "Off-Property" Areas. January.

GAO. (2019). Hewlett-Packard 620-640 Page Mill Road. Retrieved February 6, 2020 from Interactive Graphic: Superfund Property and Climate Change: https://www.gao.gov/multimedia/GAO-20-73/interactive/

Hewlett-Packard Inc. (2016). Fourth Quarter/Annual 2015 Self-Monitoring Report, National Pollutant Discharge Elimination System General Permit, Groundwater Extraction and Treatment System, Hewlett-Packard Inc, 640 Page Mill Road, Palo Alto, Santa Clara County, CA 94304. 12 February 2016.

ICF Technology Incorporated. (1992). *Baseline Public Health Evaluation, Hewlett-Packard*, 640 Page Mill Road Superfund Property. Prepared for USEPA, Region IX. September 1992.

Mohr, T.K.G. 2001. 1,4-Dioxane and other Solvent Stabilizers. Santa Clara Valley Water District White Paper. 14 June 2001.

SFBRWQCB. (2000). Five-Year Review, Hewlett-Packard Company, 640 Page Mil Road, Palo Alto, California. 9 September 2000.

SFBRWQCB. (2005). Second Five-Year Review, Hewlett-Packard 620-640 Page Mill Road, Palo Alto, Santa Clara County, California. 30 September 2005.

SFBRWQCB. (2010). Third Five-Year Review, Hewlett-Packard (620-640 Page Mil Road) Superfund Property, Palo Alto, Santa Clara County, California. 30 September 2010.

SFBRWQCB. (2015). Fourth Five-Year Review, Hewlett-Packard (620-640 Page Mil Road) Superfund Property, Palo Alto, Santa Clara County, California. 05 October 2015.

Stanford Management Company. (2003). Covenant and Environmental Restriction on Property. Recorded 25 June 2003 in the Official Recrods of Santa Clara County. Document No. 17136710.

Stantec. (2014). *Trial Shutdown Evaluation Report for California-Olive-Emerson (COE) Perimeter Area Groundwater Extraction Wells EW-15 and EW-16*. Prepared on behalf of Hewlett-Packard Company and Varian Medical Systems, Inc. 18 December 2014.

Stantec. (2015a). *Five-Year Remedial Action Status and Effectiness Evaluation Report*, California-Olive-Emerson (COE) Study Area and Permiter Area, Palo Alto, California.. Prepared on behalf of Hewelett-Packard Company and Varian Medical Systems, Inc. 30 January 2015.

Stantec. (2015b). Additional Vapor Intrusion Assessment, California-Olive-Emerson (COE) Study Area, Palo Alto, California. Prepared on behalf of Hewlett Packard Company and Varian Medical Systems, Inc. 29 July 2015.

Stantec. (2015c). *Annual Groundwater Self-Monitoring Report for 2015 California-Olive-Emerson (COE) Study Area and Perimeter Area*. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems, Inc. 30 September 2015.

Stantec. (2016a). 2015 *Annual Building 23 Air Purifier Operation Report*, COE Study Area, Palo Alto, California. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems Inc. 25 March 2016.

Stantec. (2016b). *Annual Groundwater Self-Monitoring Report for 2015 California-Olive-Emerson (COE) Study Area and Perimeter Area*. Prepared on behalf of Hewlett-Packard Inc. 30 September 2016.

Stantec. (2017a). *Fourth Quarter/Annual 2016 Self-Monitoring Report, National Pollutant Discharge Elimination System General Permit, Groundwater Extraction and Treatment System*, Hewlett-Packard Inc, 640 Page Mill Road, Palo Alto, Santa Clara County, CA 94304. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems, Inc. 14 February 2017.

Stantec (2017b). *Final Annual Building 23 Air Purifier Operation Report, COE Study Area*, Palo Alto, California. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems, Inc. 12 April 2017.

Stantec. (2017b). *Annual Groundwater Self-Monitoring Report for 2017 California-Olive-Emerson (COE) Study Area and Perimeter Area*, Palo Alto, California. Prepared for Hewlett-Packard Inc. and Varian Medical Systems, Inc. 29 September 2017.

Stantec. (2018a). *Fourth Quarter/Annual 2017 Self-Monitoring Report, National Pollutant Discharge Elimination System General Permit, Groundwater Extraction and Treatment System*, Hewlett-Packard Inc, 640 Page Mill Road, Palo Alto, Santa Clara County, CA 94304. Prepared on behalf of Hewlett-Packard Inc. 14 February 2018.

Stantec. (2018b). *Well Destruction Report – COE Area Wells EW-13, OB12-1, and OB12-2 at 415-425 Lambert Ave, Palo Alto, California*. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems. 26 February 2018.

Stantec. (2018c). *Well Destruction Report – COE Area Wells F38A, F101B, and V-11A1U at 2585 El Camino Real, Palo Alto, California*. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems. 01 May 2018

Stantec. (2018d). *Well Destruction Report – COE Area Wells F37A in City Parking Lot C-7, and Wells P2-1, P2-2, P2-3, and P2-4 at 2747 Park Blvd., Palo Alto, California*. Prepared on behalf of Hewlett-Packard Inc. and Varian Medical Systems. 26 July 2018

Stantec. (2018e). *Annual Groundwater Self-Monitoring Report for 2018 California-Olive-Emerson (COE) Study Area and Perimeter Area, Palo Alto, California*. Prepared for Hewlett-Packard Inc. and Varian Medical Systems, Inc. 28 September 2018.

Stantec. (2019a). *Fourth Quarter/Annual 2018 Self-Monitoring Report, National Pollutant Discharge Elimination System General Permit, Groundwater Extraction and Treatment System*, Hewlett-Packard Inc, 640 Page Mill Road, Palo Alto, Santa Clara County, CA 94304. Prepared on behalf of Hewlett-Packard Inc. 14 February 2019.

Stantec. (2019b). *Annual Groundwater Self-Monitoring Report for 2019 California-Olive-Emerson (COE) Study Area and Perimeter Area*, Palo Alto, California. Prepared for Hewlett-Packard Inc. and Varian Medical Systems, Inc. 30 September 2019.

Stantec. (2019c). *Transmittal of 2019 Self-Monitoring Report, National Pollutant Discharge Elimination System General Permit, Groundwater Extraction and Treatment System*, Hewlett-Packard Inc, 640 Page Mill Road, Palo Alto, Santa Clara County, CA 94304. Prepared on behalf of Hewlett-Packard Inc. 15 August 2019.

Stantec (2019d) *Groundwater Tracer Study Report, Hewlett-Packard Inc. 640 Page Mill Road Property*, Palo Alto. Prepared on behalf of Hewlett-Packard Inc. 25 November 2019.

# Appendix B: Property Chronology

| Event | Date |
|---|---|
| Hewlett-Packard began soil and groundwater investigation after discovery of a leaking underground solvent storage tank | 1981 |
| Hewlett-Packard began initial groundwater remediation | 1982 |
| Hewlett-Packard conducted soil excavations | 1987-1992 |
| Hewlett-Packard expanded groundwater remediation | 1988 |
| The Hewlett-Packard 620-640 Page Mill Road Property (Hewlett-Packard 620-640 PMR Property) and off-Property Area (together, the Property) was listed on the National Priorities List. | 1990 |
| Additional soil excavation was conducted | 1994 |
| Hewlett-Packard began soil vapor extraction | 1994 |
| San Francisco Bay Regional Water Quality Control Board (RWQCB) Order 94-130 approved remedies that include soil vapor extraction and treatment and groundwater extraction and treatment and discharge to sanitary sewer and surface water under National Pollutant Discharge Elimination System (NPDES) permit | 1994 |
| EPA issued a Record of Decision (ROD) for the Property | 1995 |
| The soil vapor extraction and treatment system at the Hewlett-Packard 620-640 PMR Property was abandoned due to rising groundwater levels | 1997 |
| RWQCB and EPA completed the first Five-Year Review. | 2000 |
| RWQCB approved a work plan for chemical oxidation and decommissioning groundwater monitoring and extraction wells at the former Mayfield School property and northeast end of the Hewlett-Packard 620-640 PMR Property | 2005 |
| Hewlett-Packard conducted chemical oxidation treatment in the combined A1/A2 zone in the area south and southwest of well F44A and permanently decommissioned extraction wells EW-1, EW-2 and EW-6 | 2005 |
| RWQCB and EPA completed the second Five-Year Review | 2005 |
| Stanford University completed redevelopment of the former Mayfield School property and northeast portion of Hewlett-Packard 620-640 PMR Property as the Stanford/Palo Alto Community Playing Fields soccer complex | 2006 |
| Hewlett-Packard completed a one-time chemical oxidation treatment in extraction well EW-14; the well was then permanently decommissioned | 2006 |
| Hewlett-Packard decommissioned extraction well EW-9, permanently shut down extraction well EW-12, and shut down (on a trial basis) well EW-13 | 2007 |
| Hewlett-Packard shut down extraction wells EW-4, EW-5 and EW-10 for approved hydraulic testing | 2007 |
| Hewlett-Packard conducted a preliminary assessment of in-situ remedial technologies, and conducted additional characterization investigations of the A Zones using high-resolution technologies | 2007-2008 |
| Hewlett-Packard conducted soil gas sampling in the off-property down-gradient area | 2008 |
| RWQCB approved permanent shut-off of wells EW-4 and EW-5 | 2008 |
| RWQCB and EPA completed the third Five-Year Review | 2010 |
| Hewlett-Packard submitted findings of 2010 extraction well EW-10 study; recommended continued operation of EW-10 | May 2011 |

| Event | Date |
|---|---|
| Hewlett-Packard completed an investigation in the COE Study Area to define the lateral extent of volatile organic compounds (volatile contaminants) in groundwater and study trichloroethene (TCE) concentrations in first-encountered groundwater to support vapor intrusion studies | Oct 2011 |
| Hewlett-Packard completed a study to evaluate remedial options for chlorinated hydrocarbons | Nov 2011 |
| Hewlett-Packard upgraded the 620-640 PMR Property groundwater extraction and treatment system: New extraction wells TW-1 and TW-2 replaced EW-7 and were respectively installed in the A1 and A2 Zones. The treatment system was upgraded to increase capacity and add additional treatment methods and equipment | 2013 |
| Hewlett-Packard completed a vapor intrusion study in the off-Property COE Study Area. No contaminants attributable to vapor intrusion were found in the breathing zone, but the RWQCB required additional assessment based on some elevated pathway and sub-grade sample results. | Sept 2014 |
| Hewlett-Packard completed trial shutdown of extraction wells EW-15 and EW-16; the final report recommended continued shutdown | Dec 2014 |
| Hewlett-Packard completed additional vapor intrusion sampling at four residences and two commercial buildings within the off-Property COE Study Area. No contaminants attributable to vapor intrusion were found above screening values in the breathing zone. | 2015 |
| Hewlett-Packard installed and began operating an air purifier in the Building 23 subgrade garage meter room | Apr 2015 |
| RWQCB and the EPA completed the fourth Five-Year Review | Sept 2015 |
| RWQCB and the EPA issued a Cleanup Update on vapor intrusion testing within the off-Property COE Study Area | Jan 2016 |
| RWQCB approved the Additional Vapor Intrusion Assessment and granted No Further Action on vapor intrusion | Oct 2016 |
| Hewlett-Packard removed the air purifier in the Building 23 subgrade garage meter room in anticipation of building demolition | Mar 2017 |
| Hewlett-Packard decommissioned extraction well E-13 and monitoring wells OB12-1 and OB12-2 | Dec 2017 |
| Hewlett-Packard decommissioned monitoring wells F38A, F101B, and V-11A1U | Apr 2018 |
| Hewlett-Packard decommissioned monitoring wells F37A, P2-1, P2-3, and P2-4 | June 2018 |
| F41A1 decommissioned prior to property redevelopment by property owner's consultant | June 2019 |
| Hewlett-Packard completed a groundwater tracer study for extraction wells TW-1 and TW-2 | July 2019 |

# Appendix C: Data Review

## Groundwater

Contaminant Concentrations

Volatile contaminant data collected from 116 A-zone wells was used to evaluate the contaminant trends and distribution at the property. The wells and maximum concentrations of the five most common volatile contaminants that exceeded the MCLs are listed (Table C-1). TCE was the most prevalent contaminant with concentrations exceeding the MCL in 65 wells during the previous five years.

Trend Analysis

Mann-Kendall analyses were completed using the volatile contaminant data collected from monitoring wells during the previous five years (Table C-3). Approximately 60 percent of the Mann-Kendall results were stable or had no trend, 30 percent were decreasing, and 10 percent were increasing. The wells with increasing trends included TW-1 and TW-2 which is likely due to the extraction wells pulling contaminant mass into the wells. The other two wells with increasing trends included F166A1 and O108A1. However, these wells had relatively low concentrations with small increases and do not indicate contamination is moving beyond the current extent. Overall, the Mann-Kendall trends indicate pump and treat is reducing contamination; however, a majority of the property has not had a significant reduction in contaminant concentrations.

Pump and Treat System

The pump and treat system has continued to operate during the previous five years with four extraction wells EW-8, EW-10, TW-1 and TW-2. The flow rates and mass of volatile contaminants removed from the extraction system during the previous five years are summarized (Table C-2). The mass of volatile contaminants removed per year decreased from 594 pounds in 2015 to 254 pounds in 2019. Extraction wells TW-1 and TW-2 started pumping in 2014. Extraction wells tend to have the greatest mass removal shortly after startup and decline to asymptotic levels over time. More data will need to be collected to determine when the mass removal has reached asymptotic levels.

Groundwater Contours

Groundwater contour maps indicate the groundwater flow direction is to the northeast with a groundwater depression near TW-1 and TW-2 and a relatively flat gradient beyond the groundwater depression. There is not enough information from the groundwater contour maps to determine capture across the plume. The relatively stable contaminant concentrations in the surrounding monitoring wells indicate the extraction wells are achieving containment.

Tracer Study

A tracer study completed at the property in 2019 as part of an in-situ evaluation demonstrated tracer injected west of TW-1 and TW-2 near the highest groundwater contamination would be pulled to TW-1 and TW-2. The results indicate TW-1 and TW-2 are achieving capture across the area with the highest concentrations.

1,4-Dioxane Sampling

During 2016 groundwater samples from 24 wells were analyzed for 1,4-dioxane to evaluate the concentration and distribution across the Site (Table C-4). The ROD does not list 1,4-dioxane as a contaminant, so it is not regularly sampled for at the property. Groundwater monitoring detected 1,4-dioxane in 16 of the 24 wells at relatively low concentrations of 11 to 0.26 ug/L. There is no MCL for 1,4-dioxane; however, EPA and the state of California have respective notification levels of 0.46 and 0.38 ug/L. California also has a notification level of 1 ug/L and response level of 35 ug/L for public water supply users. Eight of the samples were above the notification level and none of the samples were above the response level. 1,4-dioxane was detected across the property and extends beyond the extent of the plumes for the other contaminants. The current pump and treat system will likely not remove all of the 1,4-dioxane based on the distribution and low mobility of 1,4-dioxane. Additional sampling at the property for 1,4-dioxane would provide data for trend analysis and better delineation of the distribution.

## Vapor Intrusion

Vapor monitoring at the property during the previous five years has included one round of sampling for indoor and outdoor air sampling in 2015. The locations of the air sampling are shown (Figure C-31) and the results are presented. Air samples were collected from 55 locations and only three samples had detections of contaminants and none of the samples were above the screening values. The results indicated there is no risk from vapor intrusion in the current structures. The risk for vapor intrusion in future structures is addressed via a process wherein the City of Palo Alto submits proposed construction plans to the RWQCB for review to evaluate whether engineering or other controls are necessary. remains due to the elevated concentrations of volatile contaminants in shallow groundwater.

| | PCE | | TCE | | 1,1,1-TCA | | 1,1-DCA | | 1,1-DCE | |
|---|---|---|---|---|---|---|---|---|---|---|
| MCL (ug/L) | 5 | | 5 | | 200 | | 6 | | 5 | |
| | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc |
| EW-10 | - | - | *28* | 4 | - | - | - | - | - | - |
| EW-15 | - | - | *39* | 5 | - | - | - | - | - | - |
| EW-16 | *17* | 5 | *9.3* | 4 | - | - | - | - | - | - |
| EW-4 | *49* | 5 | *48* | 5 | - | - | *7.3* | 2 | *74* | 5 |
| EW-5 | - | - | *22* | 3 | - | - | - | - | *6.6* | 1 |
| EW-7 | *140* | 5 | *2000* | 5 | *1000* | 2 | *26* | 1 | *77* | 5 |
| EW-8 | *16* | 8 | *660* | 11 | *350* | 3 | *16* | 5 | *46* | 11 |
| F106A1 | *77* | 5 | *68* | 5 | - | - | *5.3* | 1 | *65* | 5 |
| F107A2 | - | - | - | - | - | - | *5.9* | 2 | *24* | 3 |
| F123A1 | - | - | *55* | 5 | - | - | - | - | - | - |
| F124A2 | - | - | *520* | 6 | - | - | *50* | 6 | *49* | 6 |
| F125A1 | *11* | 3 | *23* | 3 | - | - | - | - | - | - |
| F127A1R | - | - | *450* | 6 | - | - | *26* | 6 | *88* | 6 |
| F128A | - | - | *10* | 1 | - | - | - | - | - | - |
| F129A1 | - | - | - | - | - | - | *35* | 4 | *36* | 4 |
| F130A1U | - | - | *24* | 4 | - | - | - | - | - | - |
| F131A1 | - | - | *22* | 4 | - | - | - | - | - | - |
| F135A1 | - | - | *65* | 2 | - | - | - | - | - | - |
| F137A1 | *5.7* | 1 | *24* | 5 | - | - | - | - | - | - |
| F145A1 | - | - | *130* | 5 | - | - | - | - | *10* | 5 |
| F155A1U | - | - | *52* | 6 | - | - | - | - | - | - |
| F156A1U | - | - | *86* | 8 | - | - | - | - | - | - |
| F160A1U | *61* | 3 | *22* | 3 | - | - | - | - | - | - |
| F161A1U | - | - | *18* | 7 | - | - | - | - | - | - |
| F166A1 | - | - | *180* | 4 | - | - | *7.6* | 3 | *8.2* | 4 |
| F167A1U | - | - | *270* | 8 | - | - | *9.1* | 2 | *25* | 8 |
| F169A2 | - | - | *34* | 1 | - | - | - | - | - | - |
| F21A1U | - | - | *71* | 12 | - | - | - | - | - | - |
| F22A1U | - | - | *290* | 8 | - | - | - | - | - | - |
| F29A1U | - | - | *36* | 7 | - | - | - | - | - | - |
| F32A | - | - | *150* | 4 | - | - | - | - | - | - |
| F34A | - | - | *50* | 9 | - | - | - | - | - | - |
| F36A | - | - | *7.7* | 4 | - | - | - | - | - | - |
| F40A | - | - | *9.4* | 1 | - | - | - | - | - | - |
| F42A1R | *14* | 6 | *410* | 6 | - | - | - | - | *23* | 5 |
| F59A1U | *240* | 8 | *56* | 8 | - | - | - | - | - | - |
| F61A1U | - | - | *120* | 6 | - | - | - | - | - | - |
| F62A1 | - | - | *100* | 9 | - | - | - | - | - | - |
| F63A1U/A1 | - | - | *16* | 4 | - | - | - | - | - | - |
| F64A1 | - | - | *25* | 6 | - | - | - | - | - | - |
| F73A1 | - | - | - | - | - | - | *13* | 2 | - | - |
| F74A | - | - | *38* | 8 | - | - | - | - | - | - |
| F77A1U | - | - | *26* | 4 | - | - | - | - | - | - |
| F78A1 | - | - | *5.5* | 1 | - | - | - | - | - | - |
| F83A1U | - | - | *70* | 6 | - | - | - | - | - | - |
| F85A1 | - | - | *7.7* | 4 | - | - | - | - | - | - |
| F88A1U | *68* | 11 | *11* | 3 | - | - | - | - | - | - |
| F89A | - | - | *13* | 7 | - | - | - | - | - | - |
| F97A | - | - | *480* | 11 | - | - | *18* | 11 | *22* | 11 |
| F98A | - | - | *970* | 5 | - | - | *14* | 5 | *9.3* | 4 |
| O108A1 | - | - | *19* | 4 | - | - | - | - | *18* | 2 |
| O109A2 | - | - | *24* | 2 | - | - | *5.9* | 1 | *14* | 2 |
| O110A1 | - | - | *140* | 4 | - | - | - | - | *16* | 2 |
| O111A2 | - | - | *160* | 4 | - | - | *11* | 4 | *26* | 4 |
| O112A1 | - | - | *590* | 4 | - | - | - | - | *6.2* | 2 |
| O113A2 | - | - | *210* | 3 | - | - | *7.8* | 3 | *26* | 3 |
| O114A2 | - | - | *300* | 5 | - | - | *8.5* | 5 | *15* | 5 |
| O116A1 | - | - | *19* | 3 | - | - | - | - | - | - |

| | PCE | | TCE | | 1,1,1-TCA | | 1,1-DCA | | 1,1-DCE | |
|---|---|---|---|---|---|---|---|---|---|---|
| MCL (ug/L) | 5 | | 5 | | 200 | | 6 | | 5 | |
| | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc | *Max Conc (ug/L)* | Num of Exc |
| O117A2 | - | - | *50* | 3 | - | - | *20* | 3 | *25* | 3 |
| O119A1 | *84* | 5 | *680* | 5 | *1700* | 2 | *93* | 4 | *280* | 4 |
| O120A2 | *60* | 5 | *2800* | 5 | *870* | 3 | *52* | 4 | *68* | 5 |
| O121A2 | - | - | *35* | 4 | - | - | - | - | *9.8* | 3 |
| O122A2 | *9* | 3 | *8.1* | 2 | - | - | - | - | - | - |
| O162A2 | *19* | 3 | *23* | 3 | - | - | - | - | - | - |
| O28A1 | - | - | *110* | 4 | - | - | - | - | *6.1* | 1 |
| O52A2 | - | - | *290* | 5 | - | - | *14* | 5 | *31* | 5 |
| O67A2 | *270* | 2 | *170* | 2 | - | - | - | - | - | - |
| O68A1 | *130* | 5 | *450* | 6 | *330* | 2 | - | - | *35* | 3 |
| TW-1 | *74* | 10 | *690* | 10 | *680* | 8 | *30* | 10 | *100* | 10 |
| TW-2 | *72* | 10 | *1300* | 10 | *710* | 10 | *41* | 10 | *94* | 10 |

Max Conc = maximum concentration between 2015 and 2019

Num of Exc = number of samples that exceeded cleanup levels between 2015 and 2019

**Table C-1. Summary of Max Concentrations of Contaminants at Wells**

| Treatment System Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Average Groundwater Extraction Rate (gallons per minute) | | | | | Volume of Water Treated (gallons) (gallons | volatile contaminant Removed (pounds) |
| | EW08 | EW10 | TW-1 | TW-2 | Combined | | |
| 2015 | 9 | 8 | 6 | 21 | 47 | 24,824,190 | 590 |
| 2016 | 8 | 7 | 6 | 21 | 47 | 22,347,310 | 364 |
| 2017 | 12 | 6 | 6 | 22 | 53 | 25,583,530 | 395 |
| 2018 | 16 | 5 | 4 | 17 | 46 | 21,749,150 | 328 |
| 2019 | 18 | 5 | 4 | 19 | 46 | 22,656,980 | 254 |
| **Total** | | | | | | **117,161,160** | **1,932** |

**Table C-2. Summary of Treatment System**

Summary of Mann-Kendall Results

| Well ID | PCE | TCE | c-1,2-DCE | 1,1,1-TCA | 1,1-DCA | 1,2,4-TCB | 1,2-DCB | 1,1-DCE |
|---|---|---|---|---|---|---|---|---|
| EW-4 | NA | NA | Stable | Stable | Stable | NA | NA | Stable |
| EW-5 | Stable | Stable | NA | NA | NA | NA | NA | NA |
| EW-7 | NA | NA | **Decreasing** | NA | NA | NA | **Prob. Decreasing** | **Decreasing** |
| O108A1 | NA | NA | **Increasing** | No Trend | **Increasing** | NA | NA | **Increasing** |
| O109A2 | NA | NA | Stable | Stable | Stable | NA | NA | Stable |
| O110A1 | NA | NA | Stable | NA | Stable | NA | NA | No Trend |
| O111A2 | NA | NA | **Decreasing** | **Decreasing** | Stable | NA | NA | No Trend |
| O112A1 | NA | NA | NA | NA | NA | NA | NA | NA |
| O114A2 | NA | NA | NA | **Prob. Decreasing** | Stable | NA | NA | Stable |
| O115A1 | NA | NA | NA | NA | NA | NA | NA | NA |
| O119A1 | Stable | Stable | No Trend | No Trend | No Trend | **Stable** | **Decreasing** | No Trend |
| O120A2 | **Decreasing** | **Decreasing** | Stable | Stable | Stable | **Stable** | Stable | Stable |
| O121A2 | No Trend | NA | NA | NA | **Decreasing** | NA | NA | **Decreasing** |
| O28A1 | NA | NA | No Trend | NA | Stable | NA | NA | No Trend |
| O52A2 | NA | NA | **Decreasing** | **Decreasing** | Stable | NA | NA | Stable |
| O67A2 | No Trend | NA | Stable | NA | NA | No Trend | No Trend | NA |
| O68A1 | Stable | Stable | **Decreasing** | **Decreasing** | NA | NA | NA | NA |
| P3-A2 | NA | NA | **Prob. Decreasing** | NA | Stable | NA | NA | No Trend |
| P5-A2 | NA | NA | Stable | **Decreasing** | Stable | NA | NA | No Trend |
| TW-1 | No Trend | No Trend | **Increasing** | **Increasing** | **Increasing** | **Increasing** | **Prob. Decreasing** | No Trend |
| TW-2 | No Trend | No Trend | **Prob. Increasing** | **Prob. Increasing** | **Prob. Decreasing** | **Increasing** | Stable | **Prob. Decreasing** |
| EW10 | NA | Stable | **Decreasing** | **Decreasing** | NA | NA | NA | **Decreasing** |
| EW8 | **Decreasing** | **Decreasing** | **Decreasing** | **Decreasing** | **Decreasing** | NA | NA | **Decreasing** |
| F123A1 | No Trend | **Decreasing** | **Decreasing** | **Decreasing** | Stable | NA | NA | Stable |
| F124A2 | NA | Stable | Stable | No Trend | **Decreasing** | NA | NA | No trend |
| F127A1R | NA | No Trend | Stable | **Decreasing** | Stable | NA | NA | No Trend |
| F129A1 | NA | NA | Stable | Stable | Stable | NA | NA | NA |
| F130A1U | NA | No Trend | NA | NA | NA | NA | NA | Stable |
| F137A1 | NA | Stable | Stable | **Decreasing** | Stable | NA | NA | Stable |
| F166A1 | NA | No Trend | No Trend | No Trend | NA | NA | NA | **Increasing** |
| F42A1R | **Prob. Decreasing** | **Decreasing** | Stable | **Decreasing** | NA | NA | NA | Stable |
| F63A1U/A1 | NA | Stable | NA | NA | NA | NA | NA | NA |
| F85A1 | NA | No Trend | NA | NA | NA | NA | NA | Stable |
| Number of wells with Mann-Kendall | 11 | 17 | 25 | 21 | 21 | 5 | 6 | 24 |
| Stable or No trend | 9 | 13 | 15 | 8 | 15 | 3 | 3 | 17 |
| Decreasing | 2 | 4 | 8 | 11 | 4 | 0 | 3 | 5 |
| Increasing | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 |

**Table C-3. Summary of Mann-Kendall Results**

| Well ID | Groundwater Zone(s) | 1,4-Dioxane (µg/L) |
|---|---|---|
| EW-8 | A1 | 0.63J |
| EW-10 | A1 | 0.57J |
| EW-16 | A1 | 2.0 |
| F22A1U | A1U / FEG | 1.3 |
| F32A | A1, A2 (A) | ND(<0.26) |
| F36A | A1, A2 / FEG (A) | ND(<0.26) |
| F40A | A1, A2 (A) | 11 |
| F42A1R | A1 / FEG | 0.96J |
| F46A1 | A1 | ND(<0.25) |
| F74A | A1, A2 (A) | 1.5 |
| F92A2 | A2 | ND(<0.25) |
| F98A | A1, A2 (A) | 2.7 |
| F135A1 | A1 | 1.3 |
| F138A1U | A1U / FEG | ND(<0.24) |
| F141A1U | A1U / FEG | ND(<0.25) |
| F145A1 | A1 | 0.84J |
| F155A1U | A1U / FEG | 0.27J |
| F160A1U (Dup5) | A1U / FEG | 0.64J)/0.86J |
| SH1 | A1U / FEG | ND(<0.26) |
| T1A | A1 / FEG | ND(<0.26) |
| TW-1 (Dup4) | A1 / FEG | 0.73J)/0.93J |
| TW-2 | A2 | 1.1 |
| V8-2 | A1, A2 / FEG (A) | 3.4 |
| W-3A1U | A1U / FEG | 0.69J |
| **Screening Values** | | |
| RWQCB ESL | --- | 0.38 |
| USEPA RSL | --- | 0.46 |
| Notification Level | --- | 1 |
| Response Level | --- | 35 |

Notes

µg/L: Micrograms per liter

ND(<1.0): Not detected at or above the indicated method detection limit

-RWQCB: San Francisco Bay Regional Water Quality Control Board

-ESL: RWQCB Environmental Screening Level

-USEPA RSL: USEPA Region 9 Regional Screening Level for tap water

-Notification Level: California State Water Resources Control Board Division of Drinking Water (SWRCB) health-based advisory level

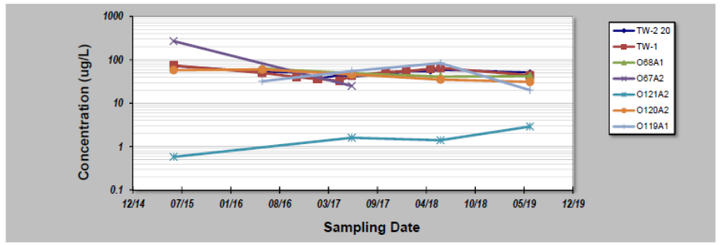
-Response Level: SWRCB's recommended level at which a water source should not be supplied to a consumer

**Table C-4. 1,4-Dioxane Results**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: PCE
Concentration Units: ug/L

| Sampling Point ID: | TW-2 | TW-1 | O68A1 | O67A2 | O121A2 | O120A2 | O119A1 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | PCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 11-Jun-15 | 72 | 74 | 0 | 270 | 0.58 | 58 | |
| 2 | 8-Jun-16 | 53 | 50 | 63 | 0 | | 60 | 32 |
| 3 | 27-Oct-16 | 51 | 40 | | | | | |
| 4 | 20-Jan-17 | 37 | 36 | | | | | |
| 5 | 20-Apr-17 | 44 | 33 | | | | | |
| 6 | 9-Jun-17 | 41 | 43 | 49 | 25 | 1.6 | 46 | 55 |
| 7 | 26-Oct-17 | 46 | 52 | | | | | |
| 8 | 18-Jan-18 | 54 | 55 | | | | | |
| 9 | 27-Apr-18 | 54 | 62 | | | | | |
| 10 | 7-Jun-18 | 59 | 65 | 41 | 0 | 1.4 | 35 | 84 |
| 11 | 8-Jun-19 | 51 | 44 | 42 | 0 | 2.9 | 31 | 20 |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.19 | 0.25 | 0.60 | 2.01 | 0.59 | 0.28 | 0.59 |
| Mann-Kendall Statistic (S): | | 5 | 11 | 0 | -5 | 4 | -8 | 0 |
| Confidence Factor: | | 61.9% | 77.7% | 40.8% | 82.1% | 83.3% | 95.8% | 37.5% |
| Concentration Trend: | | No Trend | No Trend | Stable | No Trend | No Trend | Decreasing | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

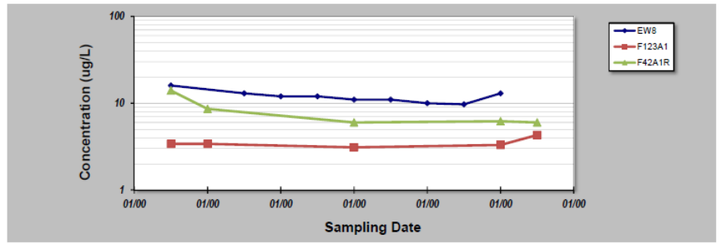


**Figure C-1. Mann-Kendall PCE pg 1**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date:
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: PCE
Concentration Units: ug/L

| Sampling Point ID: | EW8 | F123A1 | F42A1R | | | |
|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | PCE CONCENTRATION (ug/L) | | | | | |
| 1 | 6/9/2015 | 16 | 3.4 | 14 | | | |
| 2 | 6/8/2016 | | 3.4 | 8.6 | | | |
| 3 | 10/27/2016 | 13 | | | | | |
| 4 | 1/20/2017 | 12 | | | | | |
| 5 | 4/20/2017 | 12 | | | | | |
| 6 | 6/9/2017 | 11 | 3.1 | 6 | | | |
| 7 | 10/26/2017 | 11 | | | | | |
| 8 | 1/18/2018 | 10 | | | | | |
| 9 | 4/27/2018 | 9.7 | | | | | |
| 10 | 6/21/2018 | 13 | 3.3 | 6.2 | | | |
| 11 | 6/7/2019 | | 4.3 | 6 | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.16 | 0.13 | 0.42 | | | |
| Mann-Kendall Statistic (S): | | -21 | 1 | -7 | | | |
| Confidence Factor: | | 98.3% | 50.0% | 92.1% | | | |
| Concentration Trend: | | Decreasing | No Trend | Prob. Decreasing | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

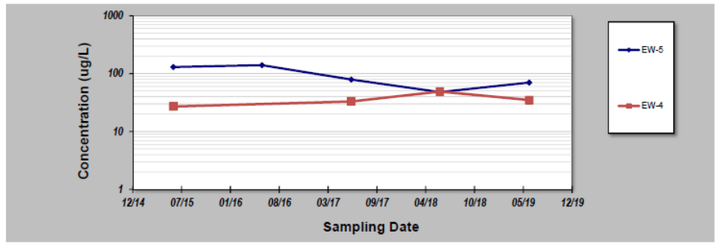


**Figure C-2. Mann-Kendall PCE pg 2**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: PCE
Concentration Units: ug/L

| Sampling Point ID: | EW-5 | EW-4 | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | PCE CONCENTRATION (ug/L) | | | | | |
| 1 | 11-Jun-15 | 130 | 27 | | | | |
| 2 | 8-Jun-16 | 140 | | | | | |
| 3 | 27-Oct-16 | | | | | | |
| 4 | 20-Jan-17 | | | | | | |
| 5 | 20-Apr-17 | | | | | | |
| 6 | 9-Jun-17 | 79 | 33 | | | | |
| 7 | 26-Oct-17 | | | | | | |
| 8 | 18-Jan-18 | | | | | | |
| 9 | 27-Apr-18 | | | | | | |
| 10 | 7-Jun-18 | 48 | 49 | | | | |
| 11 | 8-Jun-19 | 70 | 35 | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.43 | 0.26 | | | | |
| Mann-Kendall Statistic (S): | | -6 | 4 | | | | |
| Confidence Factor: | | 88.3% | 83.3% | | | | |
| Concentration Trend: | | Stable | No Trend | | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

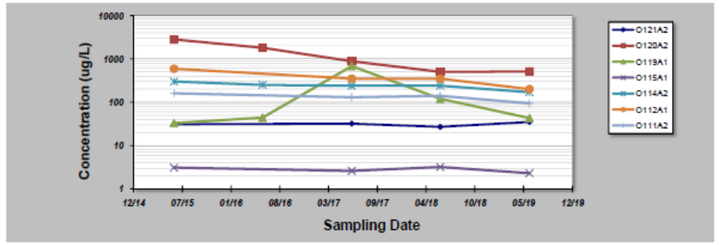


**Figure C-3. Mann-Kendall PCE pg 3**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: TCE
Concentration Units: ug/L

| Sampling Point ID: | O121A2 | O120A2 | O119A1 | O115A1 | O114A2 | O112A1 | O111A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 11-Jun-15 | 31 | 2800 | 33 | 3.1 | 300 | 590 | 160 |
| 2 | 8-Jun-16 | | 1800 | 44 | | 250 | | |
| 3 | 27-Oct-16 | | | | | | | |
| 4 | 20-Jan-17 | | | | | | | |
| 5 | 20-Apr-17 | | | | | | | |
| 6 | 9-Jun-17 | 32 | 880 | 680 | 2.6 | 240 | 350 | 130 |
| 7 | 26-Oct-17 | | | | | | | |
| 8 | 18-Jan-18 | | | | | | | |
| 9 | 27-Apr-18 | | | | | | | |
| 10 | 7-Jun-18 | 27 | 500 | 120 | 3.2 | 240 | 350 | 140 |
| 11 | 8-Jun-19 | 35 | 510 | 43 | 2.3 | 170 | 200 | 94 |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.11 | 0.76 | 1.52 | 0.15 | 0.19 | 0.43 | 0.21 |
| Mann-Kendall Statistic (S): | | 2 | -8 | 2 | -2 | -9 | -5 | -4 |
| Confidence Factor: | | 62.5% | 95.8% | 59.2% | 62.5% | 97.5% | 89.6% | 83.3% |
| Concentration Trend: | | No Trend | Decreasing | No Trend | Stable | Decreasing | Stable | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

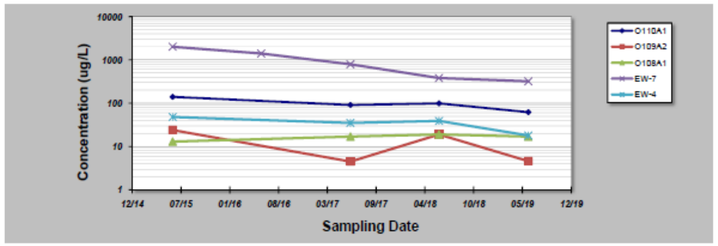


**Figure C-4. Mann-Kendall TCE pg 1**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: TCE
Concentration Units: ug/L

| Sampling Point ID: | O110A1 | O109A2 | O108A1 | EW-7 | EW-4 | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 11-Jun-15 | 140 | 24 | 13 | 2000 | 48 | | |
| 2 | 8-Jun-16 | | | | 1400 | | | |
| 3 | 27-Oct-16 | | | | | | | |
| 4 | 20-Jan-17 | | | | | | | |
| 5 | 20-Apr-17 | | | | | | | |
| 6 | 9-Jun-17 | 91 | 4.5 | 17 | 790 | 35 | | |
| 7 | 26-Oct-17 | | | | | | | |
| 8 | 18-Jan-18 | | | | | | | |
| 9 | 27-Apr-18 | | | | | | | |
| 10 | 7-Jun-18 | 99 | 19 | 19 | 380 | 39 | | |
| 11 | 8-Jun-19 | 62 | 4.6 | 17 | 320 | 18 | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.33 | 0.77 | 0.15 | 0.73 | 0.36 | | |
| Mann-Kendall Statistic (S): | | -4 | -2 | 3 | -10 | -4 | | |
| Confidence Factor: | | 83.3% | 62.5% | 72.9% | 99.2% | 83.3% | | |
| Concentration Trend: | | Stable | Stable | No Trend | Decreasing | Stable | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-5. Mann-Kendall TCE pg 2**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: TCE
Concentration Units: ug/L

| Sampling Point ID: | EW10 | EW8 | F123A1 | F124A2 | F127A1R | F130A1U | F137A1 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/9/2015 | 28 | 660 | 55 | 410 | 450 | 13 | 24 |
| 2 | 6/8/2016 | | 500 | 48 | 320 | 320 | | 20 |
| 3 | 10/27/2016 | | 600 | | | | | |
| 4 | 1/20/2017 | | 430 | | | | | |
| 5 | 4/20/2017 | | 520 | | | | | |
| 6 | 6/9/2017 | 18 | 530 | 45 | 520 | 380 | 21 | |
| 7 | 10/26/2017 | | 500 | | | | | |
| 8 | 1/18/2018 | | 390 | | | | | |
| 9 | 4/27/2018 | | 390 | | | | | |
| 10 | 6/21/2018 | 18 | 490 | 37 | 320 | 410 | 24 | 13 |
| 11 | 6/7/2019 | 17 | 310 | 41 | 360 | 420 | 19 | 15 |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
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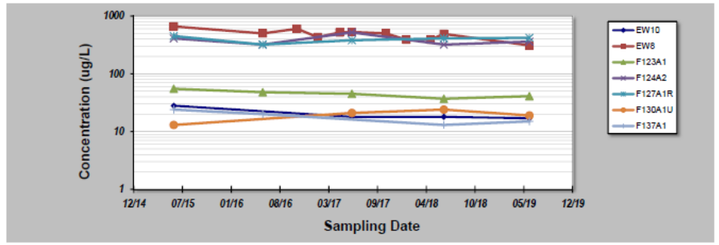
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.26 | 0.21 | 0.15 | 0.22 | 0.12 | 0.24 | 0.28 |
| Mann-Kendall Statistic (S): | | -5 | -33 | -8 | -1 | 2 | 2 | -4 |
| Confidence Factor: | | 89.6% | 99.5% | 95.8% | 50.0% | 59.2% | 62.5% | 83.3% |
| Concentration Trend: | | Stable | Decreasing | Decreasing | Stable | No Trend | No Trend | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-6. Mann-Kendall TCE pg 3**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: TCE
Concentration Units: ug/L

| Sampling Point ID: | F166A1 | F42A1R | F63A1U/A1 | F85A1 | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/9/2015 | 110 | 410 | 16 | 1.6 | | | |
| 2 | 6/8/2016 | | 240 | | | | | |
| 3 | 6/9/2017 | 150 | 210 | 16 | 6.7 | | | |
| 4 | 6/21/2018 | 180 | 190 | 14 | 6.7 | | | |
| 5 | 6/7/2019 | 150 | 120 | 16 | 7.7 | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
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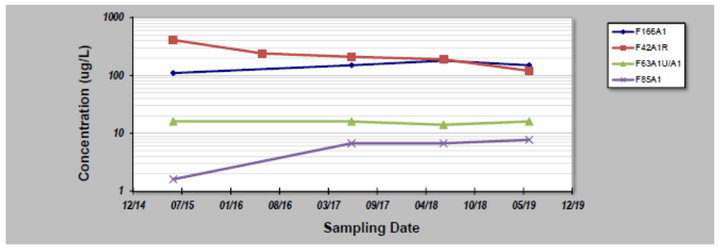
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.19 | 0.46 | 0.06 | 0.49 | | | |
| Mann-Kendall Statistic (S): | | 3 | -10 | -1 | 5 | | | |
| Confidence Factor: | | 72.9% | 99.2% | 50.0% | 89.6% | | | |
| Concentration Trend: | | No Trend | Decreasing | Stable | No Trend | | | |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-7. Mann-Kendall TCE pg 4**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: TCE
Concentration Units: ug/L

| Sampling Point ID: | P5-A2 | TW-2 | TW-1 | P3-A2 | O68A1 | O52A2 | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 11-Jun-15 | 140 | 1300 | 400 | 160 | 420 | 290 | |
| 2 | 8-Jun-16 | 120 | 910 | 290 | 160 | 170 | 250 | |
| 3 | 27-Oct-16 | | 910 | 290 | | | | |
| 4 | 20-Jan-17 | | 810 | 470 | | | | |
| 5 | 20-Apr-17 | | 1000 | 600 | | | | |
| 6 | 9-Jun-17 | 120 | 1200 | 530 | 150 | 140 | 240 | |
| 7 | 26-Oct-17 | | 900 | 540 | | | | |
| 8 | 18-Jan-18 | | 1100 | 520 | | | | |
| 9 | 27-Apr-18 | | 1000 | 590 | | | | |
| 10 | 7-Jun-18 | 150 | 1200 | 690 | 150 | 120 | 210 | |
| 11 | 6-Jun-19 | 110 | 800 | 350 | 160 | 70 | 180 | |
| 12 | | | | | | | | |
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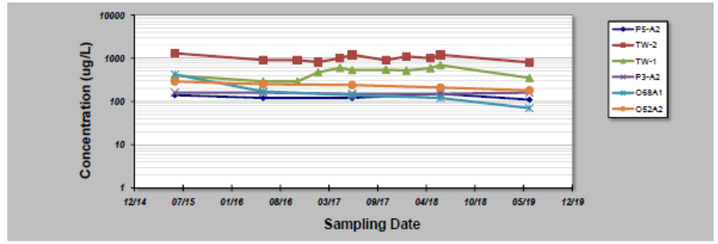
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.13 | 0.17 | 0.28 | 0.04 | 0.74 | 0.18 | |
| Mann-Kendall Statistic (S): | | -3 | -4 | 22 | -2 | -10 | -10 | |
| Confidence Factor: | | 67.5% | 59.0% | 94.9% | 39.2% | 99.2% | 99.2% | |
| Concentration Trend: | | Stable | Stable | Prob. Increasing | Stable | Decreasing | Decreasing | |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

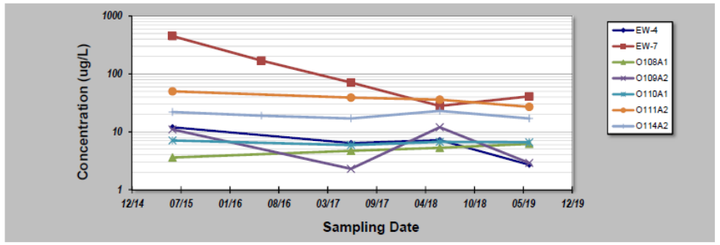


**Figure C-8. Mann-Kendall TCE pg 5**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20 | Job ID:
Facility Name: HP (620 to 640 Page Rd) | Constituent: c-1,2-DCE
Conducted By: Jeffrey Weiss | Concentration Units: ug/L

| Sampling Point ID: | EW-4 | EW-7 | O108A1 | O109A2 | O110A1 | O111A2 | O114A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | C-1,2-DCE CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 12 | 450 | 3.6 | 11 | 7.1 | 50 | 22 |
| 2 | 6/8/2016 | | 170 | | | | | 19 |
| 3 | 6/9/2017 | 6.4 | 71 | 4.7 | 2.3 | 5.9 | 39 | 17 |
| 4 | 6/7/2018 | 7.2 | 28 | 5.3 | 12 | 6.7 | 36 | 23 |
| 5 | 6/8/2019 | 2.7 | 41 | 6.2 | 2.9 | 6.6 | 27 | 17 |
| Coefficient of Variation: | | 0.54 | 1.16 | 0.22 | 0.73 | 0.08 | 0.25 | 0.14 |
| Mann-Kendall Statistic (S): | | -4 | -8 | 6 | 0 | -2 | -6 | -3 |
| Confidence Factor: | | 83.3% | 95.8% | 95.8% | 37.5% | 62.5% | 95.8% | 67.5% |
| Concentration Trend: | | Stable | Decreasing | Increasing | Stable | Stable | Decreasing | Stable |




**Notes:**

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing: < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

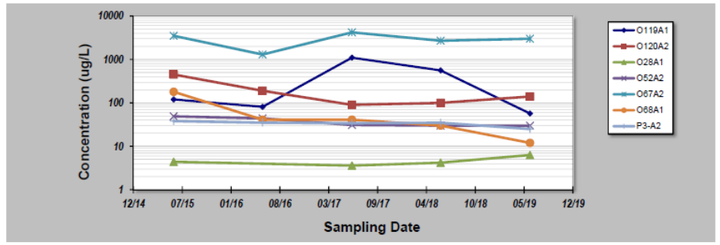


**Figure C-9. Mann-Kendall c-1,2-DCE pg 1**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20 | Job ID:
Facility Name: HP (620 to 640 Page Rd) | Constituent: c-1,2-DCE
Conducted By: Jeffrey Weiss | Concentration Units: ug/L

| Sampling Point ID: | O119A1 | O120A2 | O28A1 | O52A2 | O67A2 | O68A1 | P3-A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | C-1,2-DCE CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 120 | 450 | 4.4 | 49 | 3500 | 180 | 38 |
| 2 | 6/8/2016 | 81 | 190 | | 44 | 1300 | 41 | 35 |
| 3 | 6/9/2017 | 1100 | 90 | 3.6 | 31 | 4200 | 41 | 34 |
| 4 | 6/7/2018 | 560 | 100 | 4.2 | 30 | 2700 | 30 | 35 |
| 5 | 6/8/2019 | 57 | 140 | 6.3 | 30 | 3000 | 12 | 25 |
| Coefficient of Variation: | | 1.17 | 0.77 | 0.25 | 0.25 | 0.37 | 1.11 | 0.15 |
| Mann-Kendall Statistic (S): | | -2 | -4 | 2 | -9 | 0 | -9 | -7 |
| Confidence Factor: | | 59.2% | 75.8% | 62.5% | 97.5% | 40.8% | 97.5% | 92.1% |
| Concentration Trend: | | No Trend | Stable | No Trend | Decreasing | Stable | Decreasing | Prob. Decreasing |




**Notes:**

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing: < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

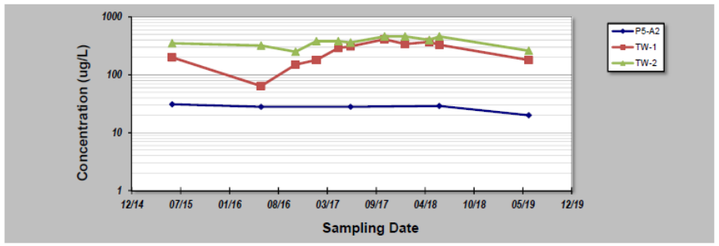


**Figure C-10. Mann-Kendall c-1,2-DCE pg 2**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: c-1,2-DCE
Concentration Units: ug/L

| Sampling Point ID: | P5-A2 | TW-1 | TW-2 | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | C-1,2-DCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/10/2015 | 31 | 200 | 350 | | | | |
| 2 | 6/8/2016 | 28 | 64 | 320 | | | | |
| 3 | 10/27/2016 | | 150 | 250 | | | | |
| 4 | 1/20/2017 | | 180 | 380 | | | | |
| 5 | 4/20/2017 | | 290 | 380 | | | | |
| 6 | 6/9/2017 | 28 | 310 | 360 | | | | |
| 7 | 10/26/2017 | | 410 | 460 | | | | |
| 8 | 1/18/2018 | | 340 | 460 | | | | |
| 9 | 4/27/2018 | | 370 | 400 | | | | |
| 10 | 6/7/2018 | 29 | 330 | 460 | | | | |
| 11 | 6/6/2019 | 20 | 180 | 260 | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.15 | 0.42 | 0.20 | | | | |
| Mann-Kendall Statistic (S): | | -5 | 24 | 19 | | | | |
| Confidence Factor: | | 82.1% | 96.4% | 91.8% | | | | |
| Concentration Trend: | | Stable | Increasing | Prob. Increasing | | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

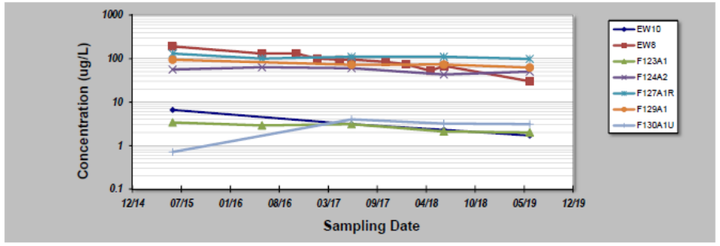


**Figure C-11. Mann-Kendall c-1,2-DCE pg 3**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: cis-DCE
Concentration Units: ug/L

| Sampling Point ID: | EW10 | EW8 | F123A1 | F124A2 | F127A1R | F129A1 | F130A1U |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | CIS-DCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/9/2015 | 6.6 | 190 | 3.4 | 56 | 130 | 94 | 0.71 |
| 2 | 6/8/2016 | | 130 | 2.9 | 63 | 100 | | |
| 3 | 10/27/2016 | | 130 | | | | | |
| 4 | 1/20/2017 | | 100 | | | | | |
| 5 | 4/20/2017 | | 94 | | | | | |
| 6 | 6/9/2017 | 3.1 | 95 | 3.1 | 60 | 110 | 72 | 4 |
| 7 | 10/26/2017 | | 84 | | | | | |
| 8 | 1/18/2018 | | 74 | | | | | |
| 9 | 4/27/2018 | | 52 | | | | | |
| 10 | 6/21/2018 | 2.3 | 68 | 2.1 | 43 | 110 | 73 | 3.2 |
| 11 | 6/7/2019 | 1.7 | 30 | 2 | 50 | 98 | 62 | 3.1 |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.64 | 0.46 | 0.23 | 0.15 | 0.12 | 0.18 | 0.52 |
| Mann-Kendall Statistic (S): | | -6 | -50 | -8 | -4 | -5 | -4 | 0 |
| Confidence Factor: | | 95.8% | >99.9% | 95.8% | 75.8% | 82.1% | 83.3% | 37.5% |
| Concentration Trend: | | Decreasing | Decreasing | Decreasing | Stable | Stable | Stable | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-12. Mann-Kendall c-1,2-DCE pg 4**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: cis-DCE
Concentration Units: ug/L

| Sampling Point ID: | F137A1 | F166A1 | F42A1R | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | CIS-DCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/9/2015 | 5.6 | 9.9 | 45 | | | | |
| 2 | 6/8/2016 | 2.6 | | 21 | | | | |
| 3 | 6/9/2017 | | 11 | 23 | | | | |
| 4 | 6/21/2018 | 1.5 | 11 | 22 | | | | |
| 5 | 6/7/2019 | 2.9 | 13 | 10 | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
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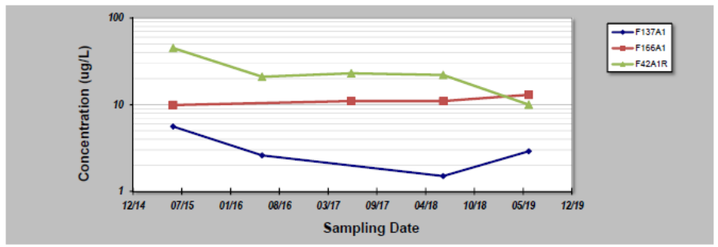
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.55 | 0.12 | 0.53 | | | | |
| Mann-Kendall Statistic (S): | | -2 | 5 | -6 | | | | |
| Confidence Factor: | | 62.5% | 89.6% | 88.3% | | | | |
| Concentration Trend: | | Stable | No Trend | Stable | | | | |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-13. Mann-Kendall c-1,2-DCE pg 5**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1,1-TCA
Concentration Units: ug/L

| Sampling Point ID: | EW-4 | O108A1 | O109A2 | O111A2 | O114A2 | O119A1 | O120A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1,1-TCA CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/10/2015 | 3 | 1.5 | 4.5 | 62 | 17 | 37 | 870 |
| 2 | 6/8/2016 | | | | | 14 | 28 | 410 |
| 3 | 6/9/2017 | 1.9 | 1.6 | 0.63 | 46 | 13 | 1700 | 170 |
| 4 | 6/7/2018 | 2.2 | 1.7 | 4.7 | 33 | 14 | 640 | 93 |
| 5 | 6/6/2019 | 2.1 | 1.5 | 0.58 | 20 | 10 | 47 | 220 |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
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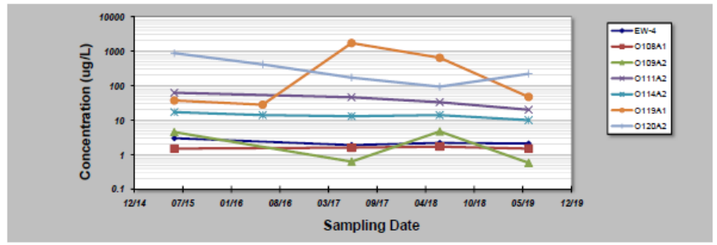
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.21 | 0.06 | 0.89 | 0.45 | 0.18 | 1.48 | 0.88 |
| Mann-Kendall Statistic (S): | | -2 | 1 | -2 | -6 | -7 | 2 | -6 |
| Confidence Factor: | | 62.5% | 50.0% | 62.5% | 95.8% | 92.1% | 59.2% | 88.3% |
| Concentration Trend: | | Stable | No Trend | Stable | Decreasing | Prob. Decreasing | No Trend | Stable |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-14. Mann-Kendall 1,1,1-TCA pg 1**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1,1-TCA
Concentration Units: ug/L

| Sampling Point ID: | F166A1 | F42A1R | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1,1-TCA CONCENTRATION (ug/L) | | | | | |
| 1 | 6/9/2015 | 7.4 | 130 | | | | |
| 2 | 6/8/2016 | | 43 | | | | |
| 3 | 6/9/2017 | 8 | 31 | | | | |
| 4 | 6/6/2018 | 8.7 | | | | | |
| 5 | 6/7/2019 | 8.1 | 13 | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
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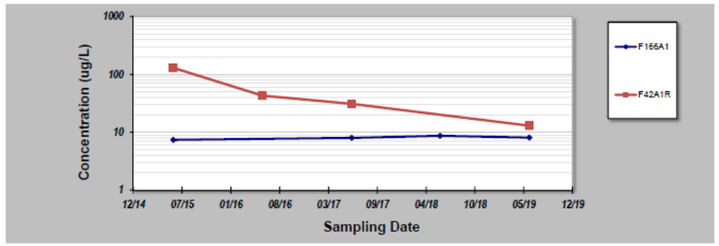
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.07 | 0.96 | | | | |
| Mann-Kendall Statistic (S): | | 4 | -6 | | | | |
| Confidence Factor: | | 83.3% | 95.8% | | | | |
| Concentration Trend: | | No Trend | Decreasing | | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

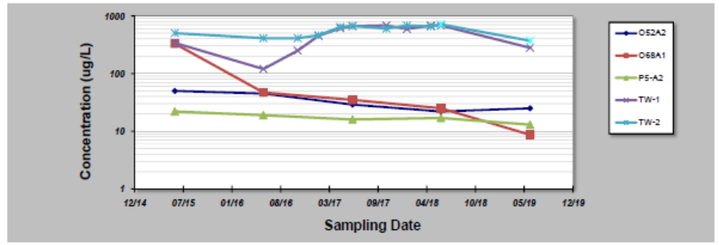


**Figure C-15. Mann-Kendall 1,1,1-TCA pg 2**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1,1-TCA
Concentration Units: ug/L

| Sampling Point ID: | O52A2 | O68A1 | P5-A2 | TW-1 | TW-2 | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1,1-TCA CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 50 | 330 | 22 | 340 | 500 | |
| 2 | 6/8/2016 | 45 | 47 | 19 | 120 | 410 | |
| 3 | 10/27/2016 | | | | 250 | 410 | |
| 4 | 1/20/2017 | | | | 450 | 460 | |
| 5 | 4/20/2017 | | | | 510 | 540 | |
| 6 | 6/8/2017 | 29 | 35 | 16 | 560 | 670 | |
| 7 | 10/26/2017 | | | | 680 | 600 | |
| 8 | 1/18/2018 | | | | 590 | 680 | |
| 9 | 4/27/2018 | | | | 680 | 650 | |
| 10 | 6/7/2018 | 22 | 25 | 17 | 680 | 710 | |
| 11 | 6/6/2019 | 25 | 8.7 | 13 | 280 | 370 | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.37 | 1.52 | 0.19 | 0.42 | 0.23 | |
| Mann-Kendall Statistic (S): | | -8 | -10 | -8 | 26 | 20 | |
| Confidence Factor: | | 95.8% | 99.2% | 95.8% | 97.5% | 92.9% | |
| Concentration Trend: | | Decreasing | Decreasing | Decreasing | Increasing | Prob. Increasing | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-16. Mann-Kendall 1,1,1-TCA pg 3**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCA
Concentration Units: ug/L

| Sampling Point ID: | EW-4 | O108A1 | O109A2 | O110A1 | O111A2 | O114A2 | O119A1 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCA CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/10/2015 | 7.3 | 2 | 4.5 | 4.5 | 11 | 6.5 | 6.4 |
| 2 | 6/8/2016 | | | | | | 6 | |
| 3 | 6/9/2017 | 4.7 | 2.9 | 0.83 | 3.2 | 9.7 | 5.8 | 93 |
| 4 | 6/7/2018 | 4.8 | 3.3 | 5.9 | 3.8 | 11 | 8.5 | 58 |
| 5 | 6/8/2019 | 1.9 | 3.4 | 1.3 | 4.1 | 8.2 | 6.2 | 6.3 |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
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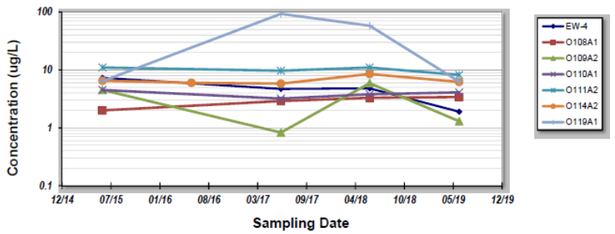
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.47 | 0.22 | 0.79 | 0.14 | 0.13 | 0.17 | 1.04 |
| Mann-Kendall Statistic (S): | | -4 | 6 | 0 | 0 | -3 | 0 | -2 |
| Confidence Factor: | | 83.3% | 95.8% | 37.5% | 37.5% | 72.9% | 40.8% | 62.5% |
| Concentration Trend: | | Stable | Increasing | Stable | Stable | Stable | Stable | No Trend |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



**Figure C-17. Mann-Kendall 1,1-DCA pg 1**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCA
Concentration Units: ug/L

| Sampling Point ID: | O120A2 | O121A2 | O28A1 | O52A2 | P3-A2 | P5-A2 |
|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCA CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 52 | 3.6 | 14 | 0 | 13 | 12 |
| 2 | 6/8/2016 | 24 | | | 12 | 13 | 11 |
| 3 | 6/9/2017 | 0 | 2.5 | 2.2 | 11 | 14 | 13 |
| 4 | 6/7/2018 | 7.5 | 1.9 | 2.9 | 11 | 13 | 12 |
| 5 | 6/8/2019 | 33 | 1.8 | 3.7 | 10 | 10 | 8.8 |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
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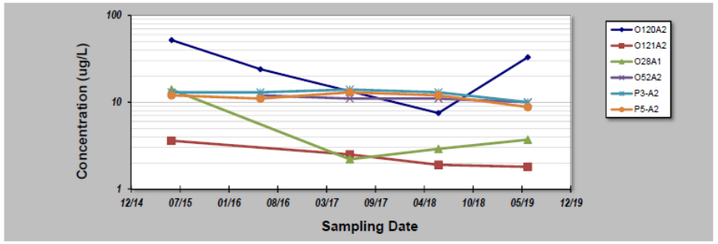
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.89 | 0.34 | 0.98 | 0.56 | 0.12 | 0.14 |
| Mann-Kendall Statistic (S): | | -2 | -6 | 0 | -1 | -3 | -3 |
| Confidence Factor: | | 59.2% | 95.8% | 37.5% | 50.0% | 67.5% | 67.5% |
| Concentration Trend: | | Stable | Decreasing | Stable | Stable | Stable | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

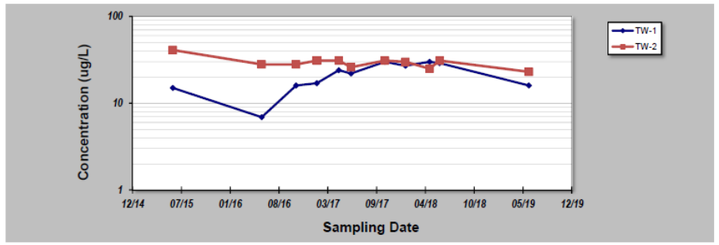


**Figure C-18. Mann-Kendall 1,1-DCA pg 2**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20 | Job ID:
Facility Name: HP (620 to 640 Page Rd) | Constituent: 1,1-DCA
Conducted By: Jeffrey Weiss | Concentration Units: ug/L

| Sampling Point ID: | TW-1 | TW-2 | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCA CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 15 | 41 | | | | |
| 2 | 6/8/2016 | 6.9 | 28 | | | | |
| 3 | 10/27/2016 | 16 | 28 | | | | |
| 4 | 1/20/2017 | 17 | 31 | | | | |
| 5 | 4/20/2017 | 24 | 31 | | | | |
| 6 | 6/9/2017 | 22 | 26 | | | | |
| 7 | 10/26/2017 | 30 | 31 | | | | |
| 8 | 1/18/2018 | 27 | 30 | | | | |
| 9 | 4/27/2018 | 30 | 25 | | | | |
| 10 | 6/7/2018 | 29 | 31 | | | | |
| 11 | 6/6/2019 | 16 | 23 | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.36 | 0.16 | | | | |
| Mann-Kendall Statistic (S): | | 29 | -18 | | | | |
| Confidence Factor: | | 98.7% | 90.5% | | | | |
| Concentration Trend: | | Increasing | Prob. Decreasing | | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

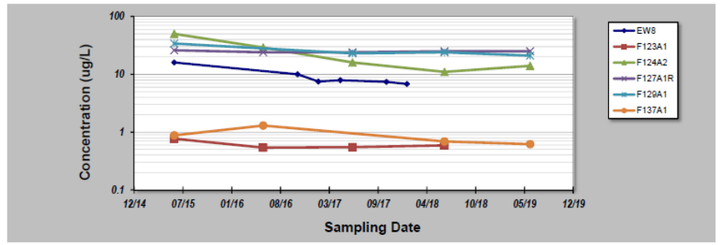


**Figure C-19. Mann-Kendall 1,1-DCA pg 3**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20 | Job ID:
Facility Name: HP (620 to 640 Page Rd) | Constituent: 1,1-DCA
Conducted By: Jeffrey Weiss | Concentration Units: ug/L

| Sampling Point ID: | EW8 | F123A1 | F124A2 | F127A1R | F129A1 | F137A1 | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCA CONCENTRATION (ug/L) | | | | | |
| 1 | 6/9/2015 | 16 | 0.77 | 50 | 26 | 34 | 0.88 |
| 2 | 6/8/2016 | | 0.54 | 29 | 24 | | 1.3 |
| 3 | 10/27/2016 | 10 | | | | | |
| 4 | 1/20/2017 | 7.5 | | | | | |
| 5 | 4/20/2017 | 7.9 | | | | | |
| 6 | 6/9/2017 | | 0.55 | 16 | 24 | 23 | |
| 7 | 10/26/2017 | 7.4 | | | | | |
| 8 | 1/18/2018 | 6.8 | | | | | |
| 9 | 6/21/2018 | | 0.59 | 11 | 25 | 24 | 0.69 |
| 10 | 6/7/2019 | | | 14 | 25 | 21 | 0.62 |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.38 | 0.18 | 0.67 | 0.03 | 0.23 | 0.35 |
| Mann-Kendall Statistic (S): | | -13 | 0 | -8 | 0 | -4 | -4 |
| Confidence Factor: | | 99.2% | 37.5% | 95.8% | 40.8% | 83.3% | 83.3% |
| Concentration Trend: | | Decreasing | Stable | Decreasing | Stable | Stable | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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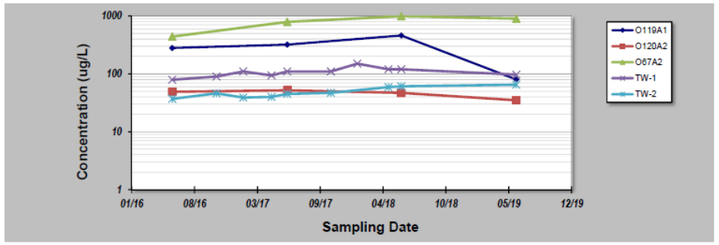
**Figure C-20. Mann-Kendall 1,1-DCA pg 4**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,2,4-TCB
Concentration Units: ug/L

Sampling Point ID: O119A1 | O120A2 | O67A2 | TW-1 | TW-2

| Sampling Event | Sampling Date | 1,2,4-TCB CONCENTRATION (ug/L) | | | | |
|---|---|---|---|---|---|---|
| 1 | 6/8/2016 | 280 | 49 | 440 | 79 | 37 |
| 2 | 10/27/2016 | | | | 90 | 46 |
| 3 | 1/20/2017 | | | | 110 | 39 |
| 4 | 4/20/2017 | | | | 94 | 40 |
| 5 | 6/9/2017 | 320 | 52 | 790 | 110 | 45 |
| 6 | 10/26/2017 | | | | 110 | 47 |
| 7 | 1/18/2018 | | | | 150 | 0 |
| 8 | 4/27/2018 | | | | 120 | 59 |
| 9 | 6/7/2018 | 460 | 47 | 990 | 120 | 61 |
| 10 | 6/8/2019 | 80 | 35 | 900 | 97 | 65 |
| 11 | | | | | | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | | | | | | |
| 15 | | | | | | |
| 16 | | | | | | |
| 17 | | | | | | |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | | | | | | |
| Coefficient of Variation: | | 0.55 | 0.16 | 0.31 | 0.18 | 0.42 |
| Mann-Kendall Statistic (S): | | 0 | -4 | 4 | 23 | 27 |
| Confidence Factor: | | 37.5% | 83.3% | 83.3% | 97.7% | 99.2% |
| Concentration Trend: | | Stable | Stable | No Trend | Increasing | Increasing |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



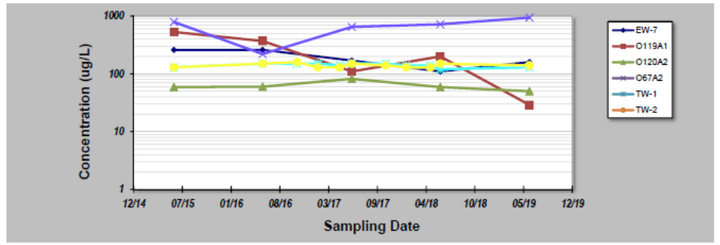
**Figure C-21. Mann-Kendall 1,2,4-TCB**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,2-DCB
Concentration Units: ug/L

Sampling Point ID: EW-7 | O119A1 | O120A2 | O67A2 | TW-1 | TW-2

| Sampling Event | Sampling Date | 1,2-DCB CONCENTRATION (ug/L) | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 6/10/2015 | 260 | 530 | 59 | 790 | 130 | 130 |
| 2 | 6/8/2016 | 260 | 370 | 60 | 220 | 150 | 150 |
| 3 | 10/27/2016 | | | | | 150 | 160 |
| 4 | 1/20/2017 | | | | | 150 | 130 |
| 5 | 4/20/2017 | | | | | 140 | 130 |
| 6 | 6/9/2017 | 170 | 110 | 82 | 650 | 150 | 150 |
| 7 | 10/26/2017 | | | | | 150 | 140 |
| 8 | 1/18/2018 | | | | | 140 | 130 |
| 9 | 4/27/2018 | | | | | 140 | 130 |
| 10 | 6/7/2018 | 110 | 200 | 59 | 720 | 120 | 150 |
| 11 | 6/8/2019 | 160 | 29 | 50 | 940 | 130 | 140 |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| Coefficient of Variation: | | 0.34 | 0.82 | 0.19 | 0.41 | 0.07 | 0.08 |
| Mann-Kendall Statistic (S): | | -7 | -8 | -3 | 4 | -19 | -1 |
| Confidence Factor: | | 92.1% | 95.8% | 67.5% | 75.8% | 91.8% | 50.0% |
| Concentration Trend: | | Prob. Decreasing | Decreasing | Stable | No Trend | Prob. Decreasing | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

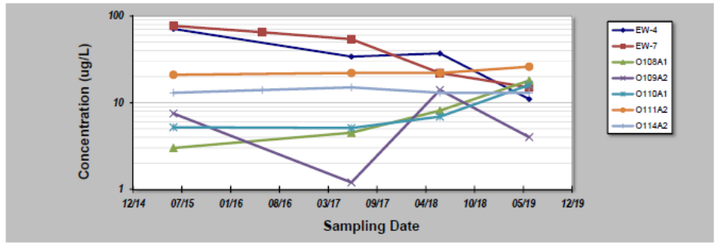


**Figure C-22. Mann-Kendall 1,2-DCB**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

| Sampling Point ID: | EW-4 | EW-7 | O108A1 | O109A2 | O110A1 | O111A2 | O114A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCE CONCENTRATION (ug/L) | | | | | |
| 1 | 6/10/2015 | 71 | 77 | 3 | 7.5 | 5.2 | 21 | 13 |
| 2 | 6/8/2016 | | 65 | | | | | 14 |
| 3 | 6/9/2017 | 34 | 54 | 4.5 | 1.2 | 5.1 | 22 | 15 |
| 4 | 6/7/2018 | 37 | 22 | 8.1 | 14 | 6.9 | 22 | 13 |
| 5 | 6/8/2019 | 11 | 15 | 18 | 4 | 16 | 26 | 13 |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.65 | 0.58 | 0.80 | 0.83 | 0.63 | 0.10 | 0.07 |
| Mann-Kendall Statistic (S): | | -4 | -10 | 6 | 0 | 4 | 5 | -1 |
| Confidence Factor: | | 83.3% | 99.2% | 95.8% | 37.5% | 83.3% | 89.6% | 50.0% |
| Concentration Trend: | | Stable | Decreasing | Increasing | Stable | No Trend | No Trend | Stable |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

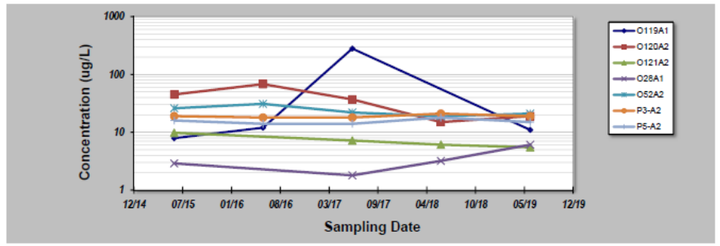


**Figure C-23. Mann-Kendall 1,1-DCE**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

| Sampling Point ID: | O119A1 | O120A2 | O121A2 | O28A1 | O52A2 | P3-A2 | P5-A2 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | | | | | | | |
| 1 | 6/10/2015 | 7.9 | 45 | 9.8 | 2.9 | 26 | 19 | 16 |
| 2 | 6/8/2016 | 12 | 68 | | | 31 | 18 | 14 |
| 3 | 6/9/2017 | 280 | 37 | 7.2 | 1.8 | 22 | 18 | 14 |
| 4 | 6/7/2018 | | 15 | 6.1 | 3.2 | 19 | 21 | 18 |
| 5 | 6/8/2019 | 11 | 19 | 5.5 | 6.1 | 21 | 19 | 15 |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 1.74 | 0.58 | 0.27 | 0.52 | 0.20 | 0.06 | 0.11 |
| Mann-Kendall Statistic (S): | | 2 | -6 | -6 | 4 | -6 | 2 | 1 |
| Confidence Factor: | | 62.5% | 88.3% | 95.8% | 83.3% | 88.3% | 59.2% | 50.0% |
| Concentration Trend: | | No Trend | Stable | Decreasing | No Trend | Stable | No Trend | No Trend |




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

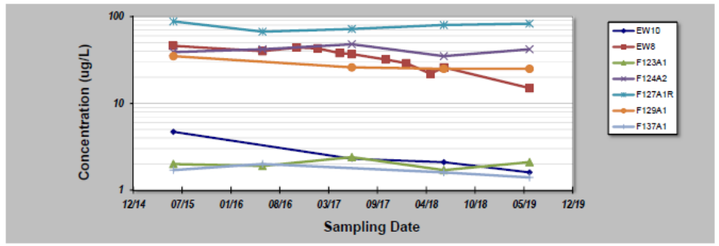


**Figure C-24. Mann-Kendall 1,1-DCE**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

| Sampling Point ID: | EW10 | EW8 | F123A1 | F124A2 | F127A1R | F129A1 | F137A1 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCE CONCENTRATION (ug/L) | | | | | |
| 1 | 6/9/2015 | 4.7 | 46 | 2 | 39 | 88 | 35 | 1.7 |
| 2 | 6/8/2016 | | 40 | 1.9 | 42 | 67 | | 2 |
| 3 | 10/27/2016 | | 44 | | | | | |
| 4 | 1/20/2017 | | 43 | | | | | |
| 5 | 4/20/2017 | | 38 | | | | | |
| 6 | 6/9/2017 | 2.3 | 37 | 2.4 | 48 | 72 | 26 | |
| 7 | 10/26/2017 | | 32 | | | | | |
| 8 | 1/18/2018 | | 29 | | | | | |
| 9 | 4/27/2018 | | 22 | | | | | |
| 10 | 6/21/2018 | 2.1 | 26 | 1.7 | 35 | 80 | 25 | 1.6 |
| 11 | 6/7/2019 | 1.6 | 15 | 2.1 | 42 | 83 | 25 | 1.4 |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.52 | 0.29 | 0.13 | 0.12 | 0.11 | 0.18 | 0.15 |
| Mann-Kendall Statistic (S): | | -6 | -49 | 0 | 1 | 2 | -5 | -4 |
| Confidence Factor: | | 95.8% | >99.9% | 40.8% | 50.0% | 59.2% | 89.6% | 83.3% |
| Concentration Trend: | | Decreasing | Decreasing | Stable | No Trend | No Trend | Stable | Stable |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

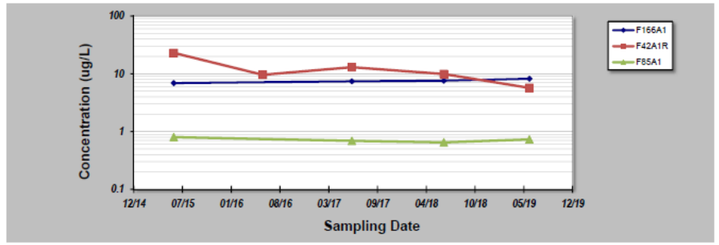


**Figure C-25. Mann-Kendall 1,1-DCE**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

| Sampling Point ID: | F166A1 | F42A1R | F85A1 | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCE CONCENTRATION (ug/L) | | | | | | |
| 1 | 6/9/2015 | 6.9 | 23 | 0.8 | | | | |
| 2 | 6/8/2016 | | 9.6 | | | | | |
| 3 | 6/9/2017 | 7.4 | 13 | 0.69 | | | | |
| 4 | 6/21/2018 | 7.6 | 9.9 | 0.65 | | | | |
| 5 | 6/7/2019 | 8.2 | 5.7 | 0.73 | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.07 | 0.54 | 0.09 | | | | |
| Mann-Kendall Statistic (S): | | 6 | -6 | -2 | | | | |
| Confidence Factor: | | 95.8% | 88.3% | 62.5% | | | | |
| Concentration Trend: | | Increasing | Stable | Stable | | | | |




**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

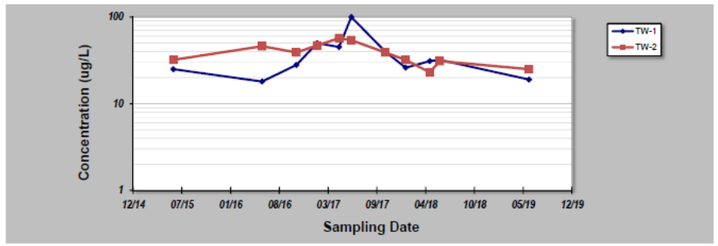


**Figure C-26. Mann-Kendall 1,1-DCE**

## GSI MANN-KENDALL TOOLKIT
### for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

| Sampling Point ID: | TW-1 | TW-2 |
|---|---|---|
| Sampling Event | Sampling Date | 1,1-DCE CONCENTRATION (ug/L) |
| 1 | 6/10/2015 | 25 | 32 |
| 2 | 6/8/2016 | 18 | 46 |
| 3 | 10/27/2016 | 28 | 39 |
| 4 | 1/20/2017 | 50 | 47 |
| 5 | 4/20/2017 | 45 | 57 |
| 6 | 6/6/2017 | 100 | 54 |
| 7 | 10/26/2017 | 40 | 39 |
| 8 | 1/18/2018 | 26 | 32 |
| 9 | 4/27/2018 | 31 | 23 |
| 10 | 6/7/2018 | 32 | 31 |
| 11 | 6/6/2019 | 19 | 25 |
| 12 | | | |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| Coefficient of Variation: | 0.61 | 0.29 |
| Mann-Kendall Statistic (S): | 1 | -21 |
| Confidence Factor: | 50.0% | 94.0% |
| Concentration Trend: | No Trend | Prob. Decreasing |



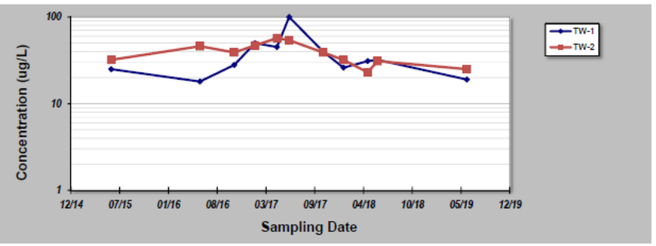

**Notes:**
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.



GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 6-Feb-20
Facility Name: HP (620 to 640 Page Rd)
Conducted By: Jeffrey Weiss
Job ID:
Constituent: 1,1-DCE
Concentration Units: ug/L

Sampling Point ID: TW-1 TW-2
Sampling Event | Sampling Date | 1,1-DCE CONCENTRATION (ug/L)
1 | 6/10/2015 | 25 | 32
2 | 6/8/2016 | 18 | 46
3 | 10/27/2016 | 28 | 39
4 | 1/20/2017 | 50 | 47
5 | 4/20/2017 | 45 | 57
6 | 6/6/2017 | 100 | 54
7 | 10/26/2017 | 40 | 39
8 | 1/18/2018 | 26 | 32
9 | 4/27/2018 | 31 | 23
10 | 6/7/2018 | 32 | 31
11 | 6/6/2019 | 19 | 25
12
13
14
15
16
17
18
19
20
Coefficient of Variation: 0.61 0.29
Mann-Kendall Statistic (S): 1 -21
Confidence Factor: 50.0% 94.0%
Concentration Trend: No Trend Prob. Decreasing




Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI Environmental Inc., www.gsi-net.com

**Figure C-27. Mann-Kendall 1,1-DCE**

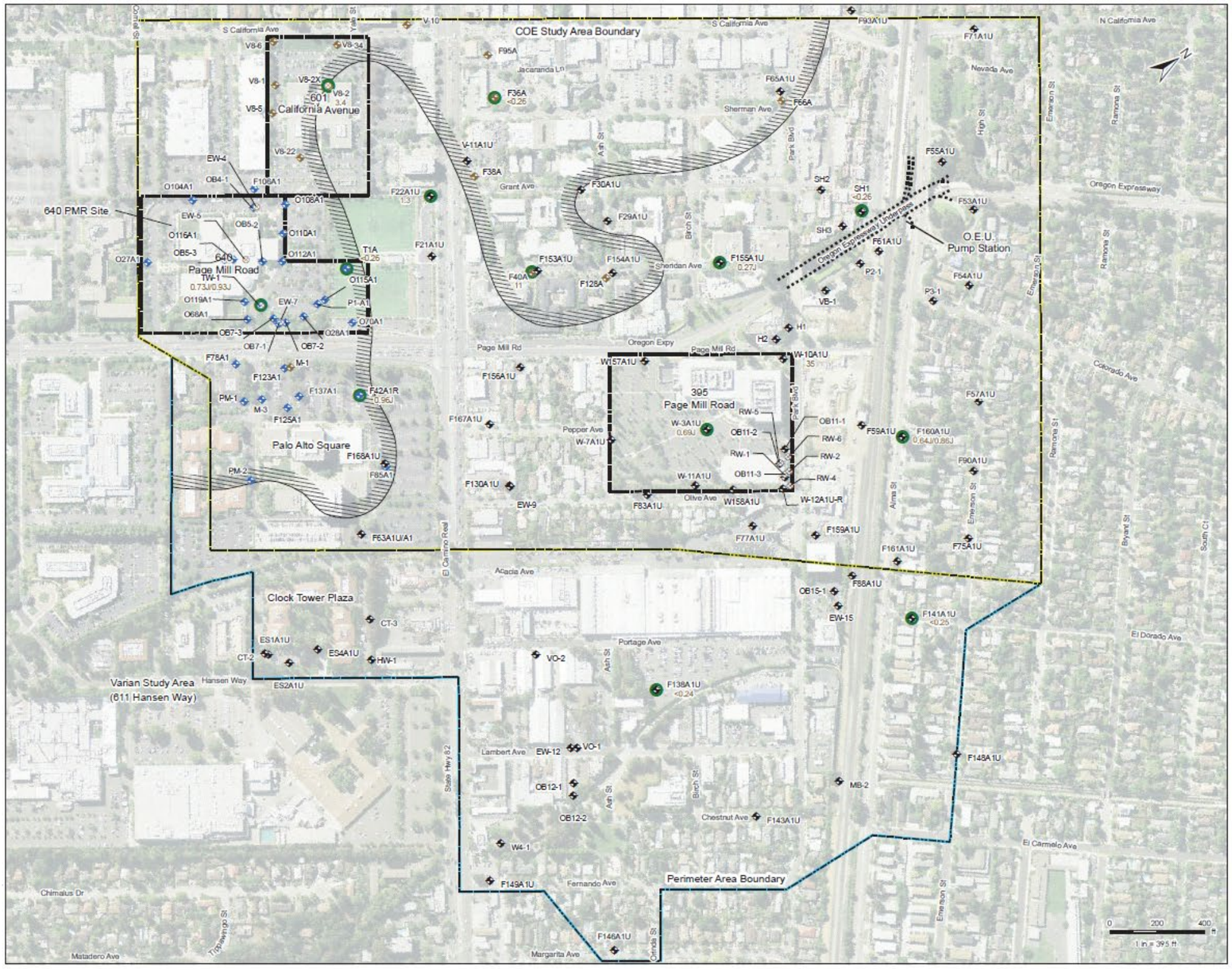
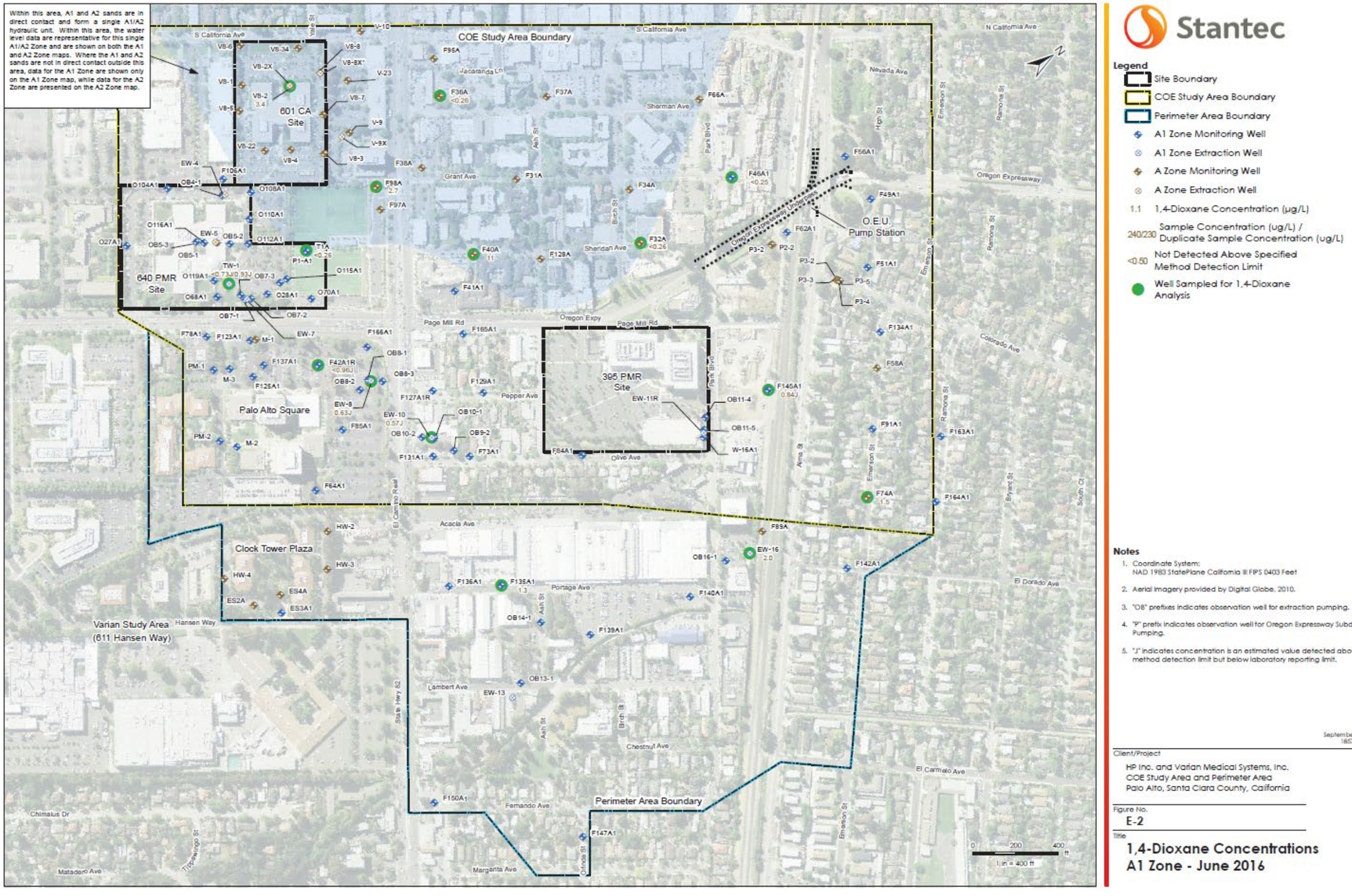



**Figure C-28. 1,4-Dioxane Results, First Encountered Groundwater**




Stantec

**Legend**

- Site Boundary
- COE Study Area Boundary
- Perimeter Area Boundary
- A1 Zone Monitoring Well
- A1 Zone Extraction Well
- A Zone Monitoring Well
- A Zone Extraction Well
- 1.1 — 1,4-Dioxane Concentration (µg/L)
- 240/230 — Sample Concentration (ug/L) / Duplicate Sample Concentration (ug/L)
- <0.50 — Not Detected Above Specified Method Detection Limit
- Well Sampled for 1,4-Dioxane Analysis

**Notes**

1. Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet
2. Aerial imagery provided by Digital Globe, 2010.
3. "OB" prefixes indicates observation well for extraction pumping.
4. "P" prefix indicates observation well for Oregon Expressway Subdrain Pumping.
5. "J" indicates concentration is an estimated value detected above method detection limit but below laboratory reporting limit.

September 2016
1657007a7

Client/Project
HP Inc. and Varian Medical Systems, Inc.
COE Study Area and Perimeter Area
Palo Alto, Santa Clara County, California

Figure No.
E-2

Title
**1,4-Dioxane Concentrations A1 Zone - June 2016**

**Figure C-29. 1,4-Dioxane Results, Groundwater Zone A-1**

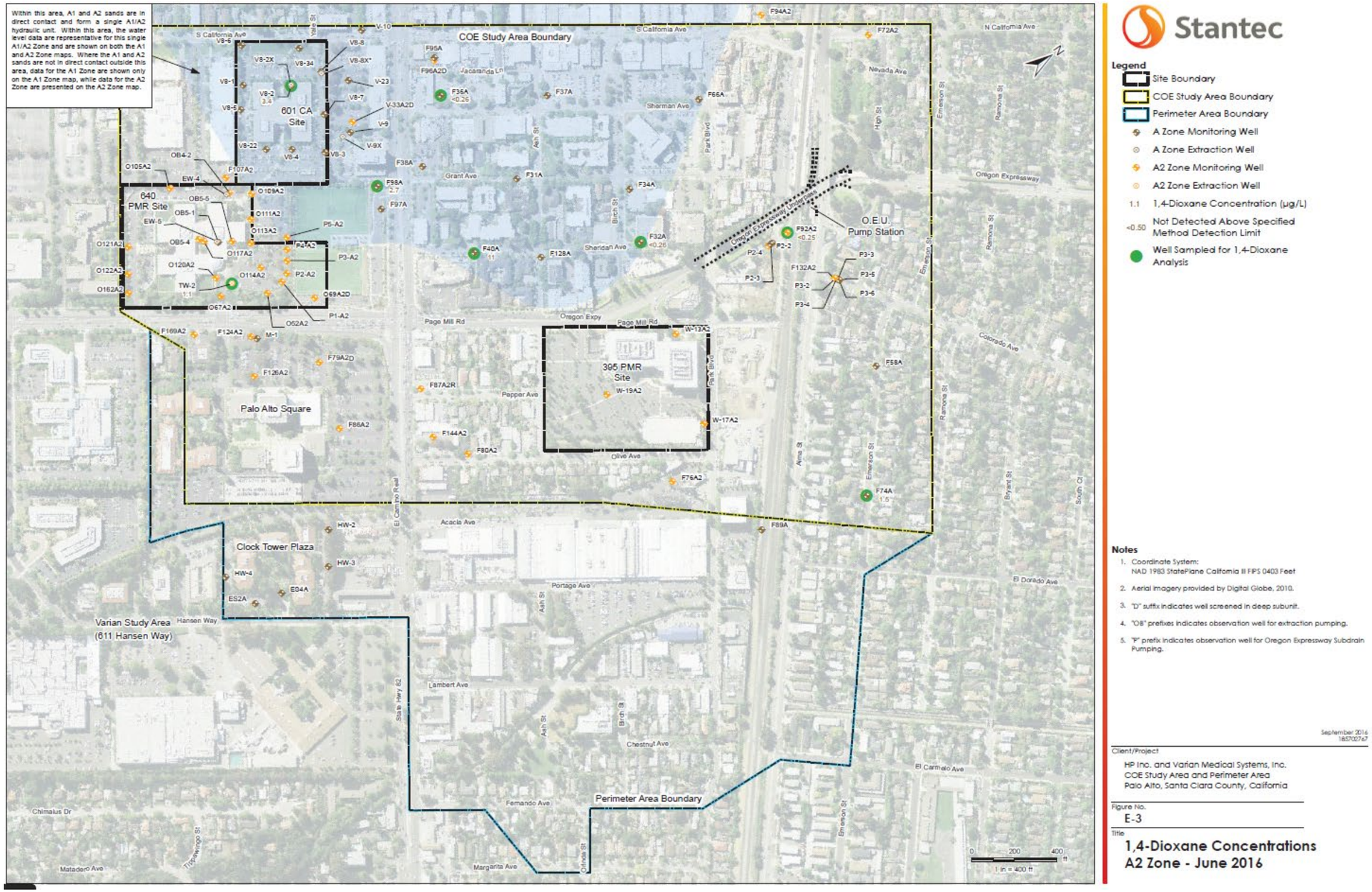
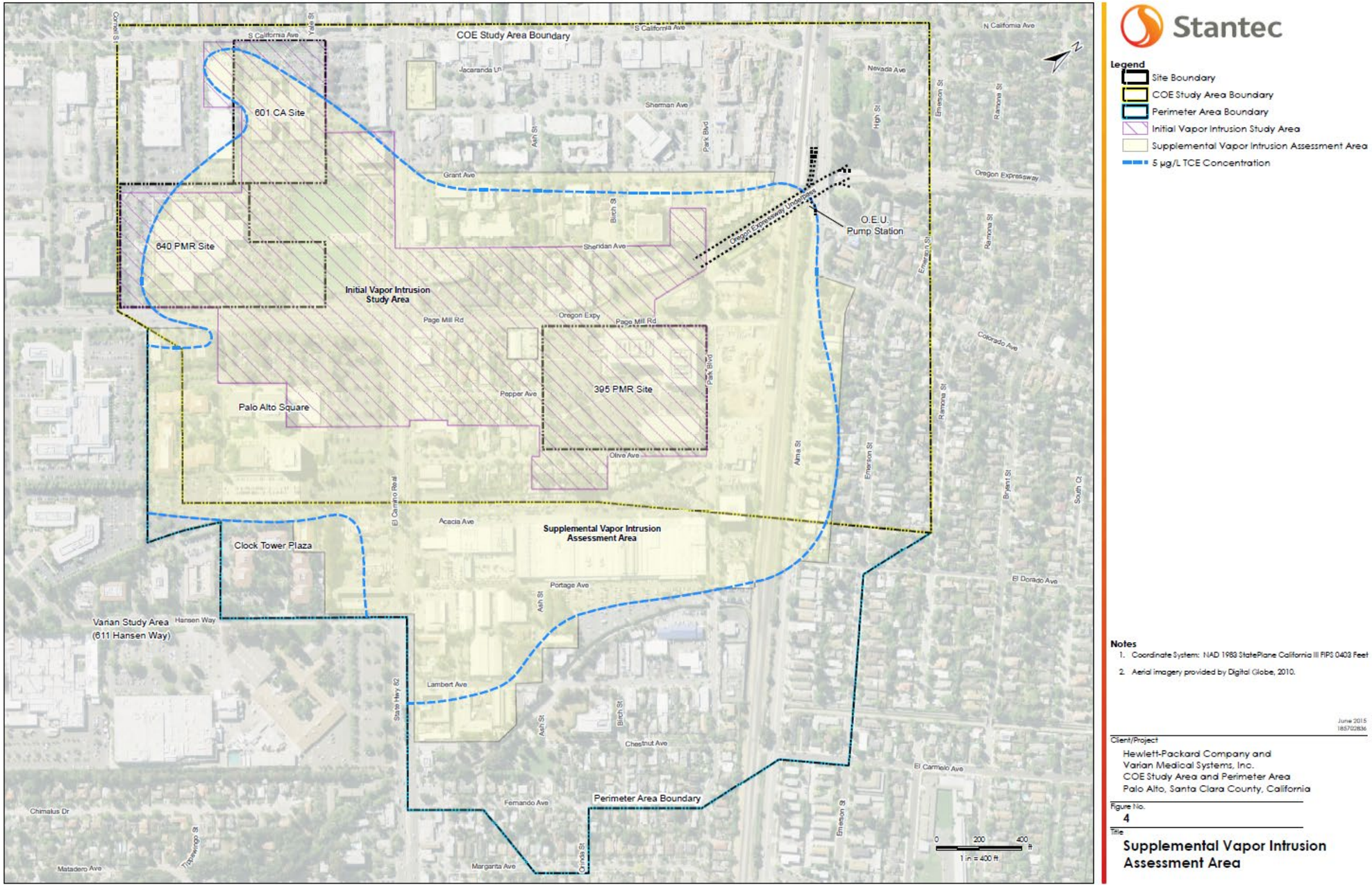



**Figure C-30. 1,4-Dioxane Results, Groundwater Zone A-2**




Stantec

**Legend**

- Site Boundary
- COE Study Area Boundary
- Perimeter Area Boundary
- Initial Vapor Intrusion Study Area
- Supplemental Vapor Intrusion Assessment Area
- 5 µg/L TCE Concentration

**Notes**

1. Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet
2. Aerial imagery provided by Digital Globe, 2010.

June 2015
185702836

Client/Project
Hewlett-Packard Company and
Varian Medical Systems, Inc.
COE Study Area and Perimeter Area
Palo Alto, Santa Clara County, California

Figure No.
4

Title
**Supplemental Vapor Intrusion Assessment Area**

**Figure C-31. Vapor Intrusion Sampling Area**

# Appendix D: Applicable or Relevant and Appropriate Requirements Assessment

Applicable or Relevant and Appropriate Requirements (ARARs). are those standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. Changes (if any) in ARARs are evaluated to determine if the changes affect the protectiveness of the remedy.

Chemical-specific ARARs identified in the selected remedy within the ROD for the groundwater at this Property and considered for this Five-Year Review for continued groundwater treatment and monitoring are listed below (Table D-1). Since the ROD was issued, only one groundwater chemical-specific ARAR has changed; the California MCL for 1,2,4-trichlorobenzene was changed to a more stringent value on June 12, 2003.

**Table D-1. Summary of Groundwater ARAR Changes**

| Contaminants of Concern | 1995 ROD ARARs | Current Regulations | ARARs Changed? |
|---|---|---|---|
| Acetone | 3,500* | -- | No |
| Benzene | 1 | 1† | No |
| 1,1-Dichloroethane (1,1-DCA) | 5 | 5† | No |
| 1,2-Dichloroethane (1,2-DCA) | 0.5 | 0.5† | No |
| 1,1-Dichloroethene (1,1-DCE) | 6 | 6† | No |
| *cis*-1,2-Dichloroethene | 6 | 6† | No |
| *trans*-1,2-Dichloroethene | 10 | 10† | No |
| Methylene Chloride | 5 | 5‡ | No |
| Tetrachloroethene (PCE) | 5 | 5‡ | No |
| 1,1,1-Trichloroethane (1,1,1-TCA) | 200 | 200‡ | No |
| 1,1,2-Trichloroethane (1,1,2-TCA) | 3 | 5‡ | No |
| Trichloroethene (TCE) | 5 | 5‡ | No |
| Freon 113 | 1,200 | 1,200† | No |
| 1,2-Dichlorobenzene | 600 | 600‡ | No |
| 1,2,4-Trichlorobenzene | 70 | 5† | More stringent |

*Derived from EPA *Health Effects Assessment Summary Table* (USEPA, 1992; USEPA, 2011)
†California MCL
‡California and Federal MCL

As stated previously herein, the ROD selected the cleanup standards based on either the federal MCL or the California MCL, whichever is more stringent. Since the ROD was signed, California adopted an MCL for 1,2,4-trichlorobenzene more stringent than the ROD cleanup level and the federal MCL. However, the ROD cleanup level for 1,2,4-trichlorobenzene is still within EPA's protective range for excess cancer risk of $10^{-4}$ to $10^{-6}$. Furthermore, institutional controls prohibit construction of drinking water wells, which prevents exposure to contaminated groundwater.

Federal and state laws and regulations other than the chemical-specific ARARs that have been promulgated or changed since the ROD was signed are described below (Table D-2). ARARs identified in the ROD that are no longer pertinent, now that the response action has transitioned from construction to long-term O&M are not included (e. g. ARARs related to remedial design and construction).

**Table D-2. Applicable or Relevant and Appropriate Requirements (ARAR) Evaluation for 1995 ROD**

| Requirement and Citation | Description | Effect on Protectiveness | Comments | Amendment Date |
|---|---|---|---|---|
| *National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels* 40 C.F.R. §§ 141.60 – 141-66 | These regulations set chemical concentration limits for drinking water for the nation. | Changes to this requirement do not affect protectiveness. | | 12 Oct 2018 |
| *Maximum Contaminant Levels – Organic Chemicals* C.C.R., Title 22, Division 4, Chapter 15, Article 5.5, § 64444 | These regulations set chemical concentration limits for drinking water for the state of California. | Changes to this requirement do not affect protectiveness. | | 14 December 2017 |
| Bay Area Air Quality Management District (BAAQMD) Rules and Regulation. *Air Stripping and Soil Vapor Extraction Operations* Regulation 8, Rule 47 | This rule sets emissions limits of organic compounds from air stripping and soil vapor extraction equipment. | There have been no changes; protectiveness is not affected. | | 15 June 2005 |
| *Identification and Listing of Hazardous Waste Maximum Contaminant Levels – Organic Chemicals* 40 C.F.R. § 261 | This regulation identifies solid wastes that are subject to regulations under 40 C.F.R. Parts 262 through 265, and Part 268. | Changes to this requirement do not affect protectiveness. | This ARAR applies to the disposal of treatment residuals that are classified as hazardous waste. | 07 February 2020 |

| Requirement and Citation | Description | Effect on Protectiveness | Comments | Amendment Date |
|---|---|---|---|---|
| *Standards Applicable to Generators of Hazardous Waste*<br>40 C.F.R. § 262 | This regulation establishes standards for generators of hazardous waste. | Changes to this requirement do not affect protectiveness. | This ARAR applies to the disposal of treatment residuals that are classified as hazardous waste. | 21 August 2019 |
| *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*<br>40 C.F.R. § 264 | This regulation establishes national standards for acceptable management of hazardous waste. | Changes to this requirement do not affect protectiveness. | This ARAR applies to the disposal of treatment residuals that are classified as hazardous waste. | 07 February 2020 |
| *Standards for Owners and Operators of Hazardous Waste Facilities Operating Under a Standardized Permit*<br>40 C.F.R. § 267 | This regulation establishes national standards for acceptable management of hazardous waste under a 40 C.F.R. Part 270, Subpart J standardized permit. | Changes to this requirement do not affect protectiveness. | This ARAR applies to the disposal of treatment residuals that are classified as hazardous waste. | 30 May 2017 |

# Appendix E: Press Notice



Youth

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## District emphasizes letting students follow interests

School Choice: The Littleton Elementary School District invited families to take part in a school-choice event Jan. 27. *(Photo courtesy LESD)*

BY OCTAVIO SERRANO
West Valley View Staff Writer

The Littleton Elementary School District puts the power of choice in the hands of its students.

Roger Freeman, superintendent of the district, said, "The idea is if you choose something that interests you, you're more engaged in learning. And if your interest changes, we accommodate it as well."

The Littleton Elementary School District offers seven schools from which students up to eighth grade can choose depending on their interests. Each school in the district has a different focus. These include arts, leadership, STEM engineering, computer science, health science, service learning and comprehensive program.

Families were invited to the district office Jan. 27, which coincided with National School Choice Week, and learned more about the district's programs. Students were given a registration form to mark their first and second choice of school for next year, with the option for no change.

Over 1,400 students declared their school of choice that day.

Freeman said the district has been around since 1912. The district serves students mainly from Avondale, Tolleson and west Phoenix and currently has about 6,300 students.

Freeman said one of the biggest challenges the district was facing was a shortage of teachers. The district wanted to install a program benefiting the students and its staff.

"Part of our focus was to do something unique and different that would also help improve the community," Freeman. "This is where the idea about student and family choice came into play because we are seeing other places have success with gaining enrollment through school choice."

The Littleton School District is in its fifth year of using this program and, Freeman said, the district gives students a sense of choice while also having security.

The availability of the school is on a first-come-first-serve basis except for the students who are already registered in their first choice. Freeman said the most popular school is the STEM academy.

"We have a selection process where they put their first and second choice," Freeman said. "We don't question the election of their choice."

The Littleton School District implemented a program to put students' interests first and give them the choice to begin developing their careers at an early age. Freeman said the district doesn't believe a student must stick with their initial choice of career, and the district gives students a structure in which they can try an area of focus and change their mind if they want.

"There's this idea of traditional education once you pick your interest or your major, you're going to be doing it for the rest of your life and it's no longer true," Freeman said. "Kids today are preparing for jobs that haven't been created yet."

PUBLIC NOTCE

**U.S. EPA BEGINS FIFTH FIVE-YEAR REVIEW OF COE SUPERFUND SITE CLEANUP**

The California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board) and the U.S. Environmental Protection Agency (EPA) began the fifth Five-Year Review (FYR) of cleanup actions completed at the COE Superfund site (site), also known as the Hewlett-Packard (640 Page Mill Road) site, located in Palo Alto, CA. The review evaluates whether cleanup work at the site continues to protect of human health and the environment.

**FYR Process:**
According to the Superfund law, if a cleanup takes more than five years to complete or hazardous wastes remain on the site, the cleanup will be reviewed every five years. The last Five-Year Review, done in 2015, found the remedy still protected human health and the environment. The 2020 Five-Year Review report will be finished no later than September 30, 2020 and will be available online and at the information repository listed below. The Five-Year Review process continues every five years until the site has been cleaned up to allow unrestricted use. The next Five-Year Review will be done in 2025.

As part of the review, the Regional Water Board and EPA will review:
- the movement and breakdown of remaining contaminants at the site;
- the operation of the groundwater treatment systems;
- the application and monitoring of the deed restrictions; and
- the changes in scientific knowledge about the site contaminants.

**Cleanup Plan (Remedy)**
The original cleanup plan (or "remedy") for the site required:
- building and operating a soil vapor extraction and groundwater treatment system;
- filing a deed restriction to prohibit any use of the groundwater;
- and starting a long-term groundwater monitoring program to ensure more areas did not become polluted.

Since then, an "in-place" biological treatment process has been set up to accelerate and enhance cleanup.

**How to Get Involved**: The Regional Water Board and EPA are interested in hearing from the public through interviews how the cleanup has been working. Please contact Roger Papler, Regional Water Board project manager, at roger.papler@waterboards.ca.gov or 510-622-2435. You may also contact Brian Milton, EPA project manager, at milton.brian@epa.gov or 415-972-3018. Please contact either Mr. Papler or Mr. Milton no later than April 30, 2020.

For a copy of the report and other site documents, please visit the Regional Water Board's website at https://geotracker.waterboards.ca.gov and click on ;Advanced Search', input file number 43S0051, click on 'Search' button at the bottom of the page, click on 'REPORT' on the left side of the 'SEARCH RESULTS' page, click on 'Site Maps / Documents' tab, and then scroll down to 'Site Documents'. Alternatively, you can visit EPA's webpage at www.epa.gov/superfund/hewlett-packard. An information repository that contains the site's Administrative Records, project reports, documents, fact sheets and other reference material is located at:

U.S. Geological Survey Library
345 Middlefield Road, Bldg 3
Menlo Park, CA
(650) 329-5027

*Please call the library for most current hours of operation.*

CNS-3340970#

# Appendix F: Interview Forms

| Five-Year Review Interview Record | | | |
|---|---|---|---|
| **Property:** | Hewlett Packard 620-640 Page Mill Road Superfund Property | **EPA ID No:** | CAD980884209 |

Interview Type: Email
Location of Visit: NA
Date: 2/14/2020
Time: NA

| Interviewers | | |
|---|---|---|
| **Name** | **Title** | **Organization** |
| Justin McNabb | Geologist | USACE |

| Interviewees | | | | |
|---|---|---|---|---|
| **Name** | **Organization** | **Title** | **Telephone** | **Email** |
| Brittany Demmer | Stantec Consulting Services Inc. | Project Engineer | (831) 246-0711 | |
| Pete Cornish | Stantec Consulting Services Inc. | Project Manager | (831) 246-0711 | |
| Mark Becker | Stantec Consulting Services Inc. | Principal Scientist | (831) 246-0711 | |

**Summary of Conversation**

**1) What is your overall impression of the project?**

Good progress is being made on the cleanup. Full time operation of extraction wells TW-1 and TW-2 beginning in 2014 has been effective at containing the plume and removing volatile contaminant mass. On- and downgradient off-property concentrations have declined. Our team does an excellent job on extraction and treatment system O&M. Hewlett-Packard is very supportive, both technically and with financial resources.

**2) Is the remedy functioning as expected? How well is the remedy performing?**

In short, yes. The on-property area where concentration increases were observed after initial implementation of the final remedy was subsequently addressed by high-resolution property characterization and installation and operation of additional extraction wells TW-1 and TW-2. Operation of the newer extraction wells has established good containment and addressed the previous concentration increases. Treatment system efficiency was improved by the addition of advanced oxidation pretreatment. Overall, concentrations have been reduced, the plume is contracting and containment of the distal portion of the plume continues to be maintained by the [Oregon Expressway Underpass] dewatering system.

**3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?**

Overall, concentrations have been reduced, the plume is contracting and containment of the distal portion of the plume continues to be maintained by the [Oregon Expressway Underpass] dewatering system. Many wells have decreasing concentrations trends.

**4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-property presence, describe staff and frequency of property inspections and activities.**

O&M presence is not continuous; however, the extraction and treatment system is equipped with upset condition alarms that call out to the O&M team, and the O&M team can access and manipulate the computer interface remotely. Staff include experienced technicians with expertise in operation and maintenance of remediation systems, and an experienced project manager and assistant project manager with in-depth knowledge of the system O&M and associated permits and reporting requirements. Additional O&M technical support and NPDES and POTW discharge permit support is provided by a Principal level engineer of record. The O&M team provides regular (minimum of weekly) status updates to the Hewlett-Packard Remediation Program Manager. Remote checks of the extraction and treatment system status are made daily. On-property O&M of the treatment system is carried out weekly, at a minimum. Periodic maintenance (weekly, monthly, quarterly, annually) are conducted as prescribed in the O&M manual.

**5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.**

There have been no significant changes in the O&M requirements in the last five years, with the exception of certain monitoring frequencies and analytes suites specified in the requirements of the NPDES permit that went into effect in January 2019.

**6) What are the annual operating costs for your organization's involvement with the property?**

On the order of $200K.

**7) Have there been unexpected O&M difficulties or costs at the property in the last five years? If so, please give details.**

No.

**8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.**

A major optimization of the treatment system was completed in 2014, adding advanced oxidation prior to carbon adsorption. This reduced the carbon change-out frequency by about 65 percent. Looking ahead, implementing EISB at the on-property would improve efficiency and reduce remediation costs over time.

**9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?**

No.

**10) Do you have any comments, suggestions, or recommendations regarding the project?**

No.

| **Additional Property-Specific Questions** |
|---|
| *None* |

| **Five-Year Review Interview Record** | | | |
|---|---|---|---|
| **Property:** | Hewlett Packard 620-640 Page Mill Road Superfund Property | **EPA ID No:** | CAD980884209 |

Interview Type: Telephone
Location of Visit: N/A
Date: April 1, 2020
Time: 1600

| **Interviewers** | | |
|---|---|---|
| **Name** | **Title** | **Organization** |
| Alison Suess | Chemist | USACE |
| Roger Papler: | Engineering Geologist | San Francisco Bay RWQCB |

| **Interviewees** | | | | |
|---|---|---|---|---|
| **Name** | **Organization** | **Title** | **Telephone** | **Email** |
| Amy French | City of Palo Alto | Chief Planning Official | 650.329.2336 | Amy.French@cityofpaloalto.org |
| Jodie Gerhardt | City of Palo Alto | Manager of Current Planning | 650-329-2575 | Jodie.Gerhardt@CityofPaloAlto.org |

**Summary of Conversation**

**1) What is your overall impression of the project?**

Ms. French said that it does not affect her in her current work, and that she has not been out to the Property recently. She said they appreciate Mr. Papler's advice on the Property. Ms. Gerhardt said that she will talk to her staff about working more closely with Mr. Papler when new construction near the Property is evaluated. She said they have project planners on their team who review technical documents produced by environmental consultants.

**2) Have there been routine communications or activities (property visits, inspections, reporting activities, etc.) conducted by your office regarding the property? If so, please give purpose and results.**

Ms. French said that their staff performs environmental reviews for construction in the area of the COE plume. Ms. Gerhardt's team of planners goes to property inspections and stays involved on the way to the final

property inspection. Building inspection and mitigation (such as adding a vapor barrier) measures are monitored as part of the California Environmental Quality Act (CEQA) process. Their staff inspect and review to make sure the measures are installed. They also work with third party reviewers who have scientific and technical expertise.

**3) Have there been any complaints, violations, or other incidents related to the property requiring a response by your office? If so, please give details of the events and results of the responses.**

Ms. French said that the issue that comes to mind is Park Plaza, which is at 195 Page Mill Road and 2865 Park Blvd. The issue was a couple of years ago, around 2018. There was concern related to volatile contaminants that were detected. The source was ultimately determined to be dry cleaning bags in an area where they registered on monitoring equipment, not failure of the vapor barrier, and the issue was resolved. Mr. Papler added that during initial construction, fully loaded forklifts repeatedly drove over and damaged the vapor barrier. Hohbach's consultant oversaw patching and retesting vapor barrier. However, the robust indoor air data set indicates a combination of indoor sources and low-level vapor intrusion at the building.

**4) Do you feel well informed about the property's activities and progress?**

Ms. French said that she was well-informed on Park Plaza, which she oversaw, but not on other projects which she does not oversee. Ms. Gerhardt said that she oversaw other projects and was informed on those. Ms. Gerhard said that she understands the process of the remedy but hasn't received any updates recently on the status of the plume. She said that she has newer staff and could use training about the Property. Ms. French says that tracking of mitigation measures and their staff reaching out to Mr. Papler at key construction moments would be helpful, and that in that way, communication between the City and the RWQCB could be improved.

**5) Do you have any comments, suggestions, or recommendations regarding the property's management or operations?**

Ms. Gerhardt said that it would be helpful to have updates and training for her staff from Mr. Papler, perhaps annually or at another frequency, to hear about the Property and vapor intrusion and mitigation measures needed. Mr. Papler said that formal training needs extensive management review. Ms. Gerhardt said that a format of a 20-minute virtual phone call with her staff and Mr. Papler would be helpful, and Mr. Papler agreed that was possible. Ms. Gerhardt said that she can pull from her experience on Park Plaza to put together a document or PowerPoint on lessons learned, including when they need to reach out to Mr. Papler.

**Additional Property-Specific Questions**

**6) How do you identify new construction projects or permit requests that may require input from the RWQCB? (Note: This question was discussed first in the interview.)**

Ms. French, Ms. Gerhardt, and Mr. Papler discussed that during the Property Inspection, USACE determined that there was new construction at 5 locations that Mr. Papler did not know about (441 Oregon Expressway, 2515 El Camino Real, 2600 El Camino Real, 2755 El Camino Real, and a property on Ramos Way). Ms. French and Ms. Gerhardt said that environmental reviews were done for these properties, and forwarded to the State Clearinghouse, which should then forward them to Mr. Papler. Ms. French said that anytime work is done in the area of the Property, she tells her staff, including Ms. Gerhardt, to work with Mr. Papler, and the property documents are sent to the State Clearinghouse. Her staff does a review for vapor intrusion as part of the process when doing the environmental review for CEQA, which is an environmental review done on every discretionary project. Mr. Papler said that he has found that timely distribution of documents from the State Clearinghouse manner has been problematic, since the State Clearinghouse receives many documents from all over the State. Mr. Papler requested to be copied when things are sent to the State Clearinghouse, and Ms. French and Ms. Gerhardt agreed.

# Appendix G: Property Inspection Report and Photos

1. INTRODUCTION

a. Date of Visit: 05 February 2019

b. Location: Palo Alto, California

c. Purpose: A property visit was conducted to visually inspect and document the conditions of the remedy, the property, and the surrounding area for inclusion into the Five-Year Review Report.

d. Participants: *List all attendees*

| | | |
|---|---|---|
| Brian Milton | USEPA Region 9 Remedial Project Manager (RPM) | (415) 972-3018 |
| Roger Papler | Regional Water Quality Control Board | (510) 622-2435 |
| Justin McNabb | USACE Seattle District Hydrogeologist | (206) 316-3993 |
| Mark Becker | Stantec, Principal Scientist | (831) 246-0711 |
| Pete Cornish | Stantec, Project Manager | (831) 246-0711 |
| Brittany Demmer | Stantec, Project Engineer | (831) 246-0711 |
| Angus McGrath | Stantec, Principal Scientist | (831) 246-0711 |
| Chris Dirscherl | HPE, Environmental Programs Manager | (510) 836-3034 |

2. SUMMARY

A property visit to the Hewlett-Packard Superfund Property including the California-Olive-Emerson Study and Perimeter Area (COE) was conducted on 05 February 2020. All participants met on property for preliminary briefings and health and safety check in. The property is currently a mix of commercial residential with parks and customer parking and active construction. Currently the active remediation is and on property pump and treat system and a bioremediation curtain. Participants toured the property and observed evidence of recent well installations and the remediation compound.

3. DISCUSSION

On 04 February, Justin McNabb flew to San Jose, California to meet with multiple parties for the five-Year Review Property Visit. On 05 February Justin McNabb met the Hewlett-Packard participants at the property. The weather was sunny and warm (temperature approximately 65º F). The property is accessed from California Highway 101 South and Page Mill Road and is located southeast of the Stanford University campus.

Mr. McNabb arrived at the property at 0900 and did a preliminary walk around the property to note the locations of existing wells and identify new construction taking place in the COE study area at the request of the Five-Year Review team. This was before any other participants in the meeting arrived

on property. Addresses for each construction were identified based on Google Maps phone app data if no visible address was seen. The other participants arrived at 1000 and met at the pump and treat system on property. USEPA gave an overview of the objectives of the property visit and a brief background on the property history. Mr. McNabb detailed what groundwater and vapor intrusion data had been reviewed for the Five-Year Review period and verified if any additional pertinent information should be included in the Five-Year Review Report. The participants had no additional data for the report.

After the overview and discussion, the team proceeded through an overview of the groundwater extraction and treatments and inspected numerous well locations that had been installed in the past five years. Existing wells were photographed and documented. The installed wells consisted of both extraction wells and monitoring wells. The current monitoring well network maintains wells in each of the subsurface water-bearing zones but no extraction capabilities. Additionally, a bioremediation curtain to treat a recently identified hotspot of PCE and TCE at the 601 California Avenue property. The current extraction well system is extracting large amounts of contaminants, requiring a three month change out time for the granular activated carbon portion of the extraction system. All existing wells were secured, locked and in good condition.

After viewing the groundwater extraction and treatments compound and the bioremediation curtain wells, the property inspection was concluded and Mr. McNabb left the property by 1230.

4. ACTIONS

The USACE will incorporate information obtained from the property visit into the Five-Year Review report.

Justin McNabb

Geologist/Hydrogeologist

CENWS-ENT-G

| | |
|---|---|
|  |  |
| Extraction system expert manager Pete (L) and SWRCB Roger (R) | New construction at 2755 El Camino Real |


Construction 2600 El Camino Real


Figure G-1. New Construction Activities Observed During Property Inspection