# FOURTH FIVE-YEAR REVIEW REPORT FOR MIDDLEFIELD-ELLIS-WHISMAN (MEW) SUPERFUND STUDY AREA MOUNTAIN VIEW AND MOFFETT FIELD SANTA CLARA COUNTY, CALIFORNIA

Fairchild Semiconductor Corp. – Mountain View Superfund Site
Raytheon Company Superfund Site
Intel Corp. – Mountain View Superfund Site
And portions of NAS Moffett Field Superfund Site

PREPARED BY

**U.S. Environmental Protection Agency**

**Region 9**

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Approved by: Date:

Dana Barton 9/30/19

Dana Barton, Assistant Director
California Site Cleanup and Enforcement Branch
Superfund and Environmental Management Division
U.S. Environmental Protection Agency, Region 9

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# Executive Summary

This is the fourth Five-Year Review of the Middlefield-Ellis-Whisman (MEW) Study Area Superfund Site (Site) located in Mountain View and Moffett Field, 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.

The MEW Site includes three National Priorities List (NPL) or Superfund sites: Fairchild Semiconductor Corp. – Mountain View Superfund site, Raytheon Company Superfund site, and Intel Corp. – Mountain View Superfund site, as well as several other facilities, and portions of the Naval Air Station (NAS) Moffett Field Superfund Site. The individual companies responsible for investigating and cleaning up the soil and groundwater are collectively referred to as the MEW Companies. Because the groundwater contamination at the MEW Site migrates northward and has mixed with contamination from Navy and NASA sources at Moffett Field, the groundwater remedy selected in the MEW Record of Decision (ROD) also applies to the commingled regional groundwater contamination area at Moffett Field. The MEW Site is within a heavily populated, light industrial, commercial, and residential area. The primary contaminants of concern for the MEW Site are trichloroethene (TCE) and other volatile organic compounds (VOCs) in groundwater, soil, soil gas, and indoor air.

In 1989, the U.S. Environmental Protection Agency (EPA) issued a ROD selecting the soil and groundwater cleanup remedies for the MEW Site. EPA issued Explanations of Significant Differences (ESDs) to the ROD in 1990 and 1996 to clarify the remedy. The soil remedy consisted of excavation, with treatment by aeration, and soil vapor extraction, with treatment by vapor-phase granular activated carbon. The soil cleanup was completed in 2001. The groundwater remedy includes slurry walls (barriers beneath the surface) to contain Site contaminants, and extraction and treatment systems to contain and clean up groundwater contamination using granular activated carbon and/or air-stripping systems. Based on TCE and other contaminant concentration trends in the groundwater, the current groundwater remedy is not expected to achieve cleanup levels for many more decades. Groundwater currently is not used for drinking water or other potable uses. Groundwater in the area is, however, a potential future source of drinking water, and therefore groundwater cleanup standards were established.

In 2010, EPA issued a ROD Amendment selecting the vapor intrusion remedy that addresses the potential long-term exposure risks from TCE and other chemicals of concern through the subsurface vapor intrusion pathway. The remedy to address the vapor intrusion pathway consists of the following:

- For existing buildings, the appropriate response action is determined by indoor air sampling and other lines of evidence for each building. If determined necessary, the remedy requires installing, operating, maintaining, and monitoring of an appropriate sub-slab/sub-membrane ventilation system. Alternatively, for existing commercial buildings, using the building's indoor air mechanical ventilation system is acceptable if the property/building owner agrees to use, operate, and monitor the system to meet remedy performance criteria and the remedial action objectives.

- For future (new construction) buildings, the remedy requires installing a vapor barrier and passive sub-slab ventilation system (with the ability to be made active). In addition, implementing

institutional controls and monitoring to ensure the long-term effectiveness of the vapor intrusion remedy is also required.

TCE groundwater concentrations have decreased over the years; and analysis of monitoring data indicates that TCE concentration in the groundwater plume are levelling off at concentrations above the cleanup level. The declining efficiency of the operations of the current groundwater remedy indicates that groundwater cleanup levels will not be achieved in shallow groundwater for many decades. This length of time is inconsistent with the vapor intrusion remedy to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

The groundwater is not currently used for drinking water, and Santa Clara Water Valley Water District has governmental controls in place to prevent the installation of wells in the contaminated aquifer zones.

In the Vapor Intrusion Study Area, all occupied commercial/non-residential buildings have been sampled. In buildings where TCE from subsurface vapor intrusion exceeded the indoor air cleanup levels, mitigation measures have been implemented, or vapor intrusion control systems have been constructed. Vapor intrusion control systems have been installed in all new construction overlying TCE Shallow Zone contamination. Institutional controls are in place requiring the notification to EPA of building improvements that may create a vapor intrusion pathway into the building, interfere with the building foundation or interfere with the existing vapor intrusion remedy.

Exposure assumptions used in the selection of the groundwater and vapor intrusion remedies are still valid. Toxicity data and federal and state maximum contaminant levels (MCLs) used to select groundwater and indoor air cleanup levels have changed since the selection of the remedy, but the changes do not affect the protectiveness of the remedy.

The groundwater and vapor intrusion remedy at the Middlefield-Ellis-Whisman (MEW) Superfund Area is currently protective of human health and the environment because there is no direct exposure to contamination. Governmental controls are in place to prevent access to contaminated groundwater. The vapor intrusion control systems, monitoring program, and institutional controls are in place to minimize exposure risk from vapor intrusion. However, in order for the remedy to be protective in the long-term, alternative groundwater cleanup technologies should be selected in order to accelerate the reduction of the source of vapor intrusion in the Shallow Zone.

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| | |
|---|---|
| ARAR | Applicable or Relevant and Appropriate Requirement |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulation |
| DCA | dichloroethane |
| DCE | dichloroethene |
| EPA | U.S. Environmental Protection Agency |
| ESD | Explanation of Significant Differences |
| GAC | granular activated carbon |
| gpm | gallons per minute |
| HVAC | heating, ventilation, and air conditioning |
| ISCO | in-situ chemical oxidation |
| MCL | maximum contaminant level |
| µg/L | microgram per liter |
| $\mu g/m^3$ | microgram per cubic meter |
| MEW | Middlefield-Ellis-Whisman |
| Moffett Field | Naval Air Station Moffett Field Superfund Site |
| NASA | National Aeronautics and Space Administration |
| NASA Ames | National Aeronautics and Space Administration Ames Research Center |
| NCP | National Contingency Plan |
| NPDES | National Pollutant Discharge Elimination System |
| PCE | tetrachloroethene |
| RAO | remedial action objective |
| RGRP | MEW Regional Groundwater Remediation Program |
| ROD | Record of Decision |
| Site | Middlefield-Ellis-Whisman (MEW) Superfund Study Area |
| TCE | trichloroethene |
| USACE | U.S. Army Corps of Engineers |
| VOC | volatile organic compound |
| WATS | West-Side Aquifers Treatment System |

# 1. Introduction

The purpose of a Five-Year Review is to evaluate the implementation and performance of a Site 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, any issues identified during the review and recommendations to address them are presented in the report.

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

This is the fourth Five-Year Review for the Middlefield-Ellis-Whisman (MEW) Superfund Study Area (Site). The triggering action for this policy review is the completion date of the previous Five-Year Review on September 29, 2014. This Five-Year Review is necessary due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

The MEW Site is located in Mountain View and Moffett Field, California (Figure 1) and is comprised of three National Priorities List sites: Fairchild Semiconductor Corp. – Mountain View Superfund site; Raytheon Company Superfund site; and Intel Corp. – Mountain View Superfund site; several other facilities; and portions of the former Naval Air Station (NAS) Moffett Field Superfund site.

The Navy has issued a separate, draft Five-Year Review Report that includes Site 28 West-side Aquifers Treatment System (WATS) Area in September 2019 and expects to finalize its Five-Year Review Report in February 2020.

The MEW Five-Year Review was led by Alana Lee, EPA Superfund Project Manager, and Cynthia Wetmore, EPA Region 9 Superfund Reporting Coordinator. Technical support was provided by U.S. Army Corps of Engineers (USACE) staff: Alison Suess, Ph.D. Chemist; Justin McNabb, Hydrogeologist; and Benino McKenna, Hydrogeologist. The review began on December 11, 2018.

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

| SITE IDENTIFICATION | | |
|---|---|---|
| **Site Name:** Middlefield-Ellis-Whisman (MEW) Superfund Study Area | | |
| **EPA ID:** (1) Fairchild Semiconductor Corp. – Mountain View – EPA ID: CAD09598778<br>(2) Raytheon Co. – EPA ID: CAD009205097<br>(3) Intel Corp. – Mountain View – EPA ID: CAD061620217 | | |
| **Region:** 9 | **State:** CA | **City/County:** Mountain View and Moffett Field, Santa Clara County |
| **SITE STATUS** | | |
| **NPL Status:** Final | | |
| **Multiple OUs?** Yes | **Has the site achieved construction completion?** No | |
| **REVIEW STATUS** | | |
| **Lead agency:** EPA | | |
| **Author name (Federal or State Project Manager):** Alana Lee, EPA Superfund Project Manager | | |
| **Author affiliation:** EPA Region 9 | | |
| **Review period:** 12/11/2018 - 9/20/2019 | | |
| **Date of EPA Five-Year Review site inspection:** 3/12/2019 | | |
| **Type of review:** Policy | | |
| **Review number:** 4 | | |
| **Triggering action date:** 9/29/2014 | | |
| **Due date *(five years after triggering action date)*:** 9/30/2019 | | |

## 1.1. Background

The individual companies responsible for investigating and cleaning up soil and groundwater at their respective facility-specific source area properties at the Site are collectively referred to as the MEW Companies. The MEW Companies include the following: Fairchild Semiconductor Corp, Raytheon Company, Intel Corp., Schlumberger Technology Corp (Schlumberger), Renesas Electronics America, Inc. (NEC/Renesas), SMI Holding LLC (SMI), Vishay General Semiconductor (Vishay), Sumitomo Mitsubishi Silicon America (SUMCO), National Semiconductor Corporation, Tracor X-Ray, and Union Carbide. National Semiconductor Corporation, Tracor X-Ray, and Union Carbide are not involved with the active investigation and cleanup of the MEW Site.

In the 1960s and 1970s, several industrial companies involved in the semiconductor, electronics, and other manufacturing and research contaminated the soil and groundwater with volatile organic compounds (VOCs), primarily the chemical trichloroethene (TCE). The MEW Companies responsible for the soil and groundwater contamination are investigating and cleaning up the MEW Site but no longer own or operate their former facilities. Current addresses and building configurations at the former MEW facility-specific source area locations south of U.S. Highway 101 are shown on Figure 2.

Some of the MEW Companies have altered their corporate identities through merger, acquisition, and restructuring. Table 2 provides the original MEW Company names, along with the associated current MEW Company identities.

**Table 2. Former and Current MEW Company/Facility Names**

| Former MEW Company/Facility Name | Current MEW Company Name |
|---|---|
| Raytheon Corporation | Raytheon Company |
| Intel Corporation | Intel Corporation |
| Fairchild Semiconductor Corporation | Schlumberger Technology Corporation |
| National Semiconductor Corporation | National Semiconductor Corporation |
| NEC Electronics, Inc. | Renesas Electronics America, Inc. |
| Sobrato Development Companies | SMI Holding LLC |
| Siltec Corporation | SUMCO USA Corporation |
| General Instrument Corporation | Vishay General Semiconductor, Inc. |
| Tracor X-Ray, Inc. | Tracor X-Ray, Inc. |
| Union Carbide Chemicals and Plastics Company | Union Carbide, Inc. |

Note: The former General Instrument Corporation and Siltec facilities are referred to collectively as the Vishay/SUMCO facility.

The former and current MEW facility addresses and EPA site identification numbers for each facility are listed in Table 3. Several addresses have changed to accommodate redevelopment in a different configuration.

**Table 3. Former MEW Facility-Specific and Current Property Addresses**

| Former MEW Facility-Specific Facility Address | Current Property Location Address |
|---|---|
| **Fairchild Semiconductor Corp. – Mountain View (Fairchild/Schlumberger) EPA ID: CAD095980778** | |
| 369/441 North Whisman Road (Building 19, 13 and 23) | 369/379/389/399 North Whisman Road |
| 515/545 North Whisman Road (Buildings 1 and 2) | 515/545 North Whisman Road |
| 313 Fairchild Drive (Buildings 3 and 4) | 313/323 Fairchild Drive |
| 464 Ellis Street (Building 20) | 464/466/468 Ellis Street |
| 401 National Avenue (Building 9) | 600 National Avenue – Parking Lot |
| 644 National Avenue (Building 18) | Parking Lot (of 331 Fairchild Drive) |
| **Raytheon Corp., EPA ID: CAD009205097** | |
| 350 Ellis Street | 350/370/380 Ellis Street |
| 415 E. Middlefield Road (Lots 4 and 5) | 401/415 East Middlefield Road |
| **Intel Corp. – Mountain View, EPA ID: CAD06160217** | |
| 365 East Middlefield Road (Lots 3 and 4) | 355/365 and 401 East Middlefield Road |
| **NEC Electronics America Inc. (Renesas), EPA ID: CAD980883268** | |
| 501 Ellis Street | 501 Ellis Street |
| **SMI Holding LLC (SMI), EPA ID: CAD980638084** | |
| 455, 485/487, 501/505 East Middlefield Road | 455 and 485/487 East Middlefield Road |
| **General Instrument Corp./Siltec Corp. (Vishay/SUMCO), EPA ID: CAD088839105** | |
| 405 National Avenue | 425 National Avenue |

Chemicals used at the former NAS Moffett Field by the Navy and NASA Ames, north of U.S. Highway 101 on Moffett Field, have also been released to the soil and groundwater. The contamination addressed in the MEW Site ROD is both facility-specific and regional. Navy, NASA, and the individual MEW Companies are responsible for investigation, cleanup, and source control for soil and groundwater contamination at their individual facility-specific source area properties. Contaminated groundwater that has bypassed the source control areas and has mixed together with other contaminated groundwater from other source areas is considered part of the regional groundwater contamination plume, or the "regional plume." The regional plume South of 101 is being addressed by the individual MEW Companies and MEW Regional Groundwater Remediation Program (or Regional Program). The regional plume North of 101 is being addressed by the MEW Regional Program, Navy, and NASA. The MEW Site regional TCE shallow groundwater contamination plume, also referred to as the Vapor Intrusion Study Area, is shown on **Error! Reference source not found.**.

## *1.2. Physical Characteristics*

The MEW Site is a heavily populated, light-industrial, commercial, and residential area. Since the 1990s, major redevelopment and reuse has occurred in the MEW Area south of U.S. Highway 101. New tenants and companies own and occupy office buildings. None of these companies were operating at the time of the contaminant releases to the environment. On Moffett Field, the U.S. Navy owned and operated the former Naval Air Station Moffett Field from the 1930s until 1994, then transferred most of the property to the NASA Ames except for the housing areas. Orion Park and Wescoat Housing Areas were transferred

in 1994 to the Air Force and then in 2001 to the Army. Activities by the Navy and NASA, including use of chemicals historically used for dry-cleaning, maintenance, degreasing operations activities, contributed to the soil and groundwater contamination at Moffett Field.

The groundwater beneath and in the vicinity of the MEW Site area is not used as a drinking water source. Drinking water in this area comes from the Hetch Hetchy reservoir in the Sierra Nevada Mountains as well as local sources and is treated to meet all state and federal drinking water standards. Santa Clara Water Valley Water District has governmental controls in place to prevent the installation of wells in the contaminated aquifer zones. Groundwater that is extracted and treated is discharged under a general National Pollutant Discharge Elimination System (NPDES) permit to storm lines to Stevens Creek or under a City of Mountain View industrial wastewater permit to the sanitary sewer.

## 1.3. Hydrology

Groundwater aquifers within the MEW Site consist of shallow and deeper aquifer systems and are separated by a laterally extensive aquitard approximately 40 feet thick. Within the shallow system, four primary hydrogeologic aquifer zones have been identified: the A aquifer zone and the underlying B1, B2, and B3 aquifer zones. The regional B-C aquitard separates the B3 aquifer zone from the C aquifer zone and the deep aquifer system. Current groundwater flow in the shallow aquifer zone is generally to the north, toward San Francisco Bay.

**Table 4. Aquifer Depths by Zone**

| Aquifer Zone | Approximate Depth Interval Below Ground Surface |
|---|---|
| A or A1 or Upper A [(a)] | 0 to 45 feet |
| B1 or A2 or Lower A [(b)] | 50 to 75 feet |
| B2 | 75 to 110 feet |
| B3 | 120 to 160 feet |
| C | 200 to 240 feet |
| Deeper Aquifers | > 200 feet |

[(a)] MEW Companies refer to this aquifer as “A” both south and north of Highway 101. North of Highway 101, NASA refers to it as “A1” and Navy refers to it as “Upper A.”

[(b)] MEW Companies refer to this aquifer as “B1” both south and north of Highway 101. North of Highway 101, NASA refers to it as “A2” and Navy refers to it as “Lower A.”

# 2. Remedial Actions Summary

## 2.1. Basis for Taking Action

The primary contaminants of concern for the MEW Site are TCE, and its degradation products in soil and groundwater. The presence of TCE and other contaminants in soil and groundwater provided the basis for taking action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The TCE shallow A zone aquifer contamination is over 1.5 miles long and 0.5-mile wide and extends from south of E. Middlefield Road northward onto Moffett Field, and mixes with Navy and NASA Ames sources of contamination. EPA determined that there is potential exposure to contaminated groundwater (EPA 1989) and that direct exposure to surface soil contamination was unlikely under current land use conditions. EPA did not perform an ecological risk assessment because no ecological receptors were identified. EPA determined that that greatest public health risk is potential inhalation exposure through the subsurface vapor intrusion pathway (EPA 2010).

## 2.2. Remedy Selection

EPA issued one ROD selecting the soil and groundwater remedy in June 1989, and two Explanations of Significant Differences (ESDs) in 1990 and 1996 to clarify the groundwater remedy. EPA issued a ROD Amendment in August 2010 selecting a remedy for addressing the subsurface vapor intrusion pathway.

### 2.2.1. 1989 Soil and Groundwater Remedy

The selected soil and groundwater remedial action objectives (RAOs) in the 1989 ROD are to:

- Protect the local drinking water supplies.
- Restore the shallow and deep aquifers to meet maximum contaminant levels (MCLs) and a $10^{-6}$ risk level, respectively.
- Control and remediate contamination in subsurface soils.
- Prevent the vertical migration of groundwater contamination into the deeper, underlying aquifers.

The soil cleanup remedy at the MEW Site includes: (1) excavation, with treatment by aeration; and (2) soil vapor extraction, with treatment by vapor phase granular activated carbon (GAC).

The groundwater remedy selected in the 1989 ROD for the MEW Site consists of the following:

- Hydraulic remediation by groundwater extraction and treatment using air-stripping towers plus incorporation of pre-existing liquid-phase granular activated carbon at operating treatment systems.
- Maintaining inward and upward hydraulic gradients by pumping inside the existing slurry walls.
- Identification and sealing of any potential conduit wells.
- Reuse of extracted groundwater to the maximum extent feasible, with 100 percent reuse as a goal.

EPA issued an ESD to the ROD in September 1990, clarifying that the cleanup goals established in the ROD for the MEW Site are the cleanup standards, and TCE is to be used as an indicator compound to

track remediation progress. EPA selected a value of 5 micrograms per liter (µg/L) as the cleanup level for TCE in the shallow aquifer, which was based on the Federal MCL at the time of the ESD. For the C aquifer and deeper aquifer, EPA selected 0.8 µg/L as the cleanup level for TCE, based an excess cancer risk not to exceed 1 x $10^{-6}$.

EPA determined that the ratio of TCE to other chemicals at the site is high enough that when TCE is reduced to its cleanup levels, it is assumed that other chemicals will be reduced to concentrations that meet applicable or relevant and appropriate requirements (ARARs) and do not exceed maximum cumulative risk levels. (See Table 5).

A second ESD, issued in April 1996, provided formal interpretation of the groundwater remedy to include liquid-phase granular activated carbon for groundwater treatment.

**Table 5. Maximum Contaminant Levels at the time of the 1989 ROD for the Chemicals of Concern**

| MEW Site Chemicals of Concern | 1989 Maximum Contaminant Level (µg/L) | | Notes |
|---|---|---|---|
| | Federal | State | |
| Chloroform | 100 | -- | |
| 1,2-Dichlorobenzene | -- | -- | No MCL at the time of the 1989 ROD |
| 1,1-Dichloroethane (1,1-DCA) | -- | -- | No MCL at the time of the 1989 ROD |
| 1,1-Dichloroethene (1,1-DCE) | 7 | 6 | |
| 1,2-Dichloroethene[1] (1,2-DCE) | -- | -- | No MCL at the time of the 1989 ROD |
| Freon-113 | -- | -- | No MCL at the time of the 1989 ROD |
| Phenol | -- | -- | No MCL at the time of the 1989 ROD |
| Tetrachloroethene (PCE) | -- | -- | No MCL at the time of the 1989 ROD |
| 1,1,1-Trichloroethane | 200 | 200 | |
| Trichloroethene (TCE) | 5 | 5 | Shallow Aquifer |
| | 0.8 (Deep Aquifer)[2] | N/A | Deep Aquifer: Excess lifetime cancer risk no greater than 1x $10^{-6}$ |
| Vinyl chloride | 2 | 0.5 | |
| Antimony | -- | -- | No MCL at the time of the 1989 ROD |
| Arsenic | 50 | 50 | |
| Cadmium | 10 | 10 | |
| Lead | 50 | 50 | |

Notes:
1. 1,2-DCE exists as *cis* and *trans* isomers. The more stringent MCL (for *cis*) is used.
2. The TCE cleanup level for the Deep Aquifer is not based on ARARs; but based on toxicity information for TCE at the time of the 1989 ROD.

### 2.2.2. 2010 Vapor Intrusion Remedy

In a 2010 ROD Amendment, EPA selected the vapor intrusion remedy that addresses the potential long-term exposure risks from TCE and other MEW Site chemicals of concern through the subsurface vapor intrusion pathway, which was not addressed in the 1989 ROD. The Vapor Intrusion Study Area is generally defined as the area where the estimated TCE shallow groundwater concentrations exceed 5 µg/L.

The vapor intrusion RAOs for the MEW Site are to:

- Ensure that building occupants (e.g., workers and residents) are protected from Site contamination by preventing subsurface Site contaminants from migrating into indoor air or accumulating in enclosed building spaces exceeding indoor air cleanup levels for long-term exposure.
- Accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

EPA's selected remedy to address the vapor intrusion pathway and ensure protection of human health of building occupants in the vapor intrusion site consists of the following:

- For existing buildings - The appropriate response action is determined by indoor air sampling and other lines of evidence for each building. If necessary, install, operate, maintain, and monitor an appropriate sub-slab/sub-membrane ventilation system, or alternatively, for existing commercial buildings, use building's indoor air mechanical ventilation system if the property/building owner agrees to use, operate, and monitor the system to meet remedy performance criteria and the RAOs.
- For future (new construction) buildings - Installation of a vapor barrier and passive sub-slab ventilation system (with the ability to be made active) is required. In addition, implementation of institutional controls and monitoring to ensure the long-term effectiveness of the vapor intrusion remedy is required.

The risk-based MEW Site-specific indoor air cleanup levels (EPA, 2010) are listed in Table 6.

**Table 6. MEW Site Indoor Air Cleanup Levels**

| MEW Site Chemicals of Concern | Indoor Air Cleanup Level ($\mu g/m^3$) | | Basis |
|---|---|---|---|
| | Residential | Commercial | |
| Trichloroethene (TCE) | 1 | 5 | Representing 1 x $10^{-6}$ lifetime target cancer risk through application of the Cal/EPA toxicity factor and a 1 x $10^{-4}$ lifetime target cancer risk through application of draft 2001 EPA toxicity factor. |
| Tetrachloroethene (PCE) | 0.4 | 2 | Representing 1x $10^{-6}$ lifetime target cancer risk. |
| *cis*-1,2-Dichloroethene (*cis*-1,2-DCE) | 60 | 210 | Based on *trans*-1,2-DCE Non-cancer Hazard Index of 1. |
| *trans*-1,2-Dichloroethene (trans-1,2-DCE) | 60 | 210 | Representing Non-cancer Hazard Index of 1. |

| MEW Site Chemicals of Concern | Indoor Air Cleanup Level ($\mu g/m^3$) | | Basis |
|---|---|---|---|
| | Residential | Commercial | |
| Vinyl chloride | 0.2 | 2 | Representing 1x $10^{-6}$ lifetime target cancer risk. EPA uses a larger conversion factor from residential to commercial for vinyl chloride because the residential value takes into account child exposure and higher sensitivity earlier in life. |
| 1,1-Dichloroethane (1,1-DCA) | 2 | 6 | Representing 1x $10^{-6}$ lifetime target cancer risk. |
| 1,1-Dichloroethene (1,1-DCE) | 210 | 700 | Representing Non-cancer Hazard Index of 1. |

## 2.3. Remedy Implementation

Each of the MEW Companies operates and maintains individual facility-specific groundwater source control measures to contain and clean up contamination source areas in each area for which the MEW Company is responsible. Seven facility-specific source control groundwater extraction and treatment systems and two regional groundwater extraction treatment systems operated during the Five-Year Review period.

The MEW Companies implemented soil and groundwater cleanup programs that included soil excavation and treatment, installation of four slurry walls, soil vapor extraction and treatment systems, and groundwater extraction and treatment systems. The four slurry walls physically contain the shallow groundwater contamination; three 40-foot-deep walls are located around the former Fairchild facilities and one 100-foot-deep slurry wall is located at the former Raytheon facility.

Fairchild, Raytheon, and Intel implemented source control measures in the 1980s, before the final remedy was selected. In the mid-1990s, Fairchild, Raytheon, Intel, SMI, Vishay/SUMCO, and NEC implemented the soil remedy, excavating approximately 36,000 cubic yards of soil and installing five soil vapor extraction systems within the former source areas. They also began operating or continued to operate the groundwater extraction and treatment systems to control source areas and remove VOCs from the aquifers. The soil cleanup was completed in 2001.

The two MEW Regional Program groundwater extraction and treatment systems south of 101 (MEW Area) and north of U.S. Highway 101 (Moffett Field Area) began operations in 1998 and continues to operate. Navy's and NASA's groundwater extraction and treatment systems began operation in 1998 and 2001, respectively and continues to operate.

Several of the groundwater treatment systems discharge to Stevens Creek under facility-specific NPDES permits.

The MEW Companies, Navy, and NASA provided summary tables that summarize the status of gradients within slurry walls, groundwater treatment systems, and facility-specific optimization studies (Appendix C). The summary tables were reviewed by EPA.

## 2.4. Operations and Maintenance

Operations, maintenance, and monitoring across the facility-specific and regional plume areas are routinely performed in accordance with the long-term groundwater operations, maintenance and monitoring plans and manuals. Table 7 provides a summary of the number of extraction wells by aquifer zone and the average total extraction rate and type of treatment system for each facility between 2014 and 2018.

**Table 7. Groundwater Extraction and Treatment Systems Summary**

| Treatment System Facility | Number of Extraction Wells by Aquifer Zone | | | Total Average Extraction Rate (gpm) | Treatment System |
|---|---|---|---|---|---|
| | A/A1 | B1/A2 | B2 | | |
| Fairchild (Building 19)[1] | 9 | 4 | 2 | 77 | GAC |
| MEW Regional Consolidated S101[1] | 11 | 9 | 5 | 140 | GAC |
| Raytheon | 5 | 1 | 2 | 27 | Oxidation/GAC |
| Intel[2] | N/A | N/A | | N/A | Bioremediation pilot treatability study |
| SMI[2] | 3 | | | 19 | GAC /Bioremediation pilot treatability study |
| NEC/Renesas | 3 | | | 4 | GAC |
| Vishay/SUMCO | 7 | 1 | 1 | 17 | Oxidation/Air stripper |
| MEW Regional Program N101 | 8 | 7 | | 126 | Air stripper/Vapor-phase GAC |
| Navy Site 28 WATS | 6 | 3 | | 50 | Oxidation/GAC |
| NASA Ames | 2 | | | 17 | GAC |
| **Total** | **54** | **25** | **10** | **477** | **9 Treatment Systems** |

Notes:

1. In November 2015, flow from Fairchild Systems 1 and 3 were consolidated to the MEW Regional South of 101 Treatment System. Total groundwater extracted and mass removed from November 2015 through December 2018 are included in the amount reported for the Consolidated South of 101 Treatment System.

2. Groundwater extraction at the Intel facility was suspended in 2005, at the Fairchild/Schlumberger 401 National Avenue facility in 2015 and at the SMI facility in 2019 with EPA approval so that in-situ pilot treatability study tests could be performed and monitored.

The vapor intrusion remedy is currently being implemented, in accordance with the Vapor Intrusion ROD Amendment and EPA-approved work plans, design documents, and long-term operations, maintenance, and monitoring plans, and will be ongoing until shallow subsurface contamination no longer poses a vapor intrusion risk.

# 3. Progress Since the Last Five-Year Review

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

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

> *The vapor intrusion remedy selected in the 2010 ROD Amendment for the MEW Site is expected to be protective of human health when fully implemented. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at the MEW Site. To be protective in the long-term, the vapor intrusion remedy implementation procedures need to be assessed to take into account the impact of the potential TCE short-term exposure risks on current MEW Site remedy operational framework.*
>
> *The groundwater remedy at the MEW Site is currently protective of human health and the environment because exposure to groundwater is being controlled. In order to be protective in the long term, the following recommendations and follow-up actions need to be completed:*
>
> - *Determine the source of the TCE hot spot areas on Evandale Avenue and extent of TCE contamination in the A and B1 aquifer zones;*
> - *Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not necessarily require maintaining inward and upward gradients to control source area contamination;*
> - *Evaluate and implement the current optimization pilot tests and treatability studies of alternative groundwater cleanup technologies at the facility-specific source areas, TCE hot spot areas, and representative areas of the regional groundwater contamination plume to expedite contaminant mass removal and cleanup timeframe; and*
> - *Based on evaluation of the information collected, complete a Feasibility Study to evaluate remedial alternatives that can effectively meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.*

The Third Five-Year Review included six issues and recommendations. Each recommendation and the current status are discussed in Table 8.

**Table 8. Status of Recommendations from the 2014 Third Five-Year Review**

| Issue | Recommendations | Current Status | Current Implementation Status Description | Completion Date (if applicable) |
|---|---|---|---|---|
| New TCE groundwater hot spot areas identified in residential area on Evandale Avenue. | Determine the source of TCE groundwater hot spot areas on Evandale Avenue and the lateral and vertical extent of TCE contamination in residential area. If other TCE hot spot areas are found, evaluate and address contamination by treatment or hydraulic control. | Completed | EPA has determined the source of the TCE groundwater hot spot areas. Accelerated response actions were completed at 277 Fairchild Dr. and 228/236 Evandale Avenue properties. Long-term groundwater extraction and treatment continues. | 2018 |
| Assessment needed of how the current vapor intrusion remedy implementation procedures take into account the impact of the short-term TCE risks on current operational framework. | Complete assessment and determine appropriate MEW Site-specific operational procedures and framework to address short-term TCE concerns. | Completed | EPA has confirmed incorporation into Site-specific operational procedures and framework to ensure short-term TCE protectiveness into ongoing work plans. | 2015 |
| The extent and capture of TCE contamination in the B1 zone and downgradient of the TCE groundwater hotspot areas in the A zone in the residential area on the west has not been fully defined and addressed. | Develop and implement cleanup approach to address contamination in the A and B1 zone areas in the residential area. | Under Discussion | In 2015, EPA designated this new area as Operable Unit 3 of the MEW Site. The extent of contamination in the B1 zone needs to be determined. The cleanup approach for the A zone in this area will be part of EPA's Shallow Zone Focused Feasibility Study currently being prepared. | N/A |
| Declining efficiency and effectiveness of existing groundwater remedy will not achieve groundwater cleanup levels and will not meet the vapor intrusion RAO to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of | Enhance regional groundwater contamination plume capture and groundwater cleanup efforts by implementing facility-specific and regional program optimization plans. Evaluate and implement pilot tests and treatability studies of alternative groundwater cleanup technologies to expedite contaminant mass removal and cleanup timeframe and reduce VOC concentrations in different representative source and regional | Ongoing | Optimizations, pilot tests, and treatability studies have been effective and performance monitoring and evaluations are ongoing. EPA is currently preparing a Shallow Zone Focused Feasibility Study to address the vapor intrusion RAO to accelerate the reduction of the source of vapor intrusion. | N/A |

| Issue | Recommendations | Current Status | Current Implementation Status Description | Completion Date (if applicable) |
|---|---|---|---|---|
| current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary for many decades. | groundwater contamination plume areas. Complete Feasibility Study to evaluate remedial alternatives that can effectively meet the RAO for the vapor intrusion remedy. | | | |
| Inward gradients within slurry walls and upward vertical gradients are not consistently maintained at three of the slurry wells. | Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not require maintaining inward and upward gradients to control facility-specific source area contamination as part of the Feasibility Study process. | Considered But Not Implemented | Maintenance of inward and upward gradients within the high TCE groundwater contamination areas within the slurry wall has been determined to potentially exacerbate the vapor intrusion pathway into overlying buildings, which is counter to the vapor intrusion RAOs. EPA is currently evaluating alternative cleanup strategies for these areas that do not require maintaining an inward and upward gradient as part of the Shallow Zone Focused Feasibility Study. | N/A |
| No institutional controls selected for the groundwater remedy to ensure there is no direct exposure to contaminated groundwater. | Include groundwater institutional controls to ensure there is no direct exposure to contaminated groundwater as part of Feasibility Study, Proposed Plan, and ROD Amendment process. | Considered But Not Implemented | EPA determined that current governmental controls through Santa Clara Water Valley Water District are in place to prevent the installation of wells in the contaminated aquifer zones and adequately prevent access to groundwater for drinking. EPA is considering whether additional institutional controls would strengthen the long-term protectiveness. These institutional controls are currently being evaluated as part of the Shallow Zone Focused Feasibility Study. | N/A |

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

From June 2016 to November 2016, the Navy failed to operate, monitor, and maintain the Site 28 West-Side Aquifers Treatment System (WATS) groundwater remedy and from June 2016 to October 2016 the Navy failed to adequately conduct monitoring and notify the regulatory agencies of the remedy shutdown. EPA and San Francisco Bay Regional Water Quality Control Board subsequently assessed stipulated penalties under the NAS Moffett Field Federal Facility Agreement. The Navy's failure to operate, maintain, monitor, and report on the Site 28 WATS groundwater remedy in compliance with the FFA and the WATS Operations and Maintenance Manual allowed unmitigated migration of contaminated groundwater and created a potential risk to human health, warranting the imposition of stipulated penalties. NASA, as current property owner at Moffett Field and under a memorandum of understanding with the Navy, took over operations, maintenance, and monitoring of the Navy's Site 28 WATS system in October 2016. After conducting significant repair and maintenance work, on November 28, 2016, NASA was able to resume operation of the treatment system and network of nine source control extraction wells with total system flow of approximately 47 gallons per minute (gpm). NASA continued making extensive repairs and replaced many components of the Site 28 groundwater extraction well and treatment system through April 2019.

In the past five years, as part of ongoing optimization efforts, source control and regional extraction wells formerly conveyed and treated by Fairchild/Schlumberger Treatment Systems 1 and 3 are now conveyed to Fairchild/Schlumberger Treatment System 19 or to the Consolidated MEW Regional South of 101 Treatment System. The MEW Regional North of 101 Treatment System, constructed with a bypass valve, continues to allow treated groundwater to be diverted for reuse by NASA when needed. Two new A zone extraction wells were added during this Five-Year Review period, one source control well was added to the shared SUMCO/Vishay/Schlumberger system in 2017 and one regional extraction well was added in 2019 to target high TCE groundwater concentrations on the 277 Fairchild Drive property.

Several in-situ treatment pilot programs have been implemented to target high TCE concentration areas to more efficiently reduce TCE concentrations. Intel injected 46,000 gallons of emulsified soybean oil into the groundwater in 2014 at 365 and 401 E. Middlefield Road; subsequent monitoring results indicate decreasing concentrations of TCE, and in some wells, the production of ethane, which indicates complete dechlorination. Schlumberger is conducting an in-situ chemical oxidation (ISCO) pilot treatability study at the former 401 National Avenue property (now 600 National Avenue). Since 2015, Schlumberger has completed seven events injecting sodium permanganate and sodium persulfate oxidants. In 2019, SMI implemented an abiotic reductive dechlorination pilot treatability study using sulfidated zero valent iron at the 455 and 485/487 E. Middlefield Road properties.

Response actions near a TCE hot spot area were completed at the 277 Fairchild Drive and 228/236 Evandale Avenue properties prior to redevelopment. The response actions included soil vapor extraction and treatment and enhanced anerobic bioremediation (see Section 4.2.1.9).

The Navy completed a treatability study in 2015-2016 to evaluate the effectiveness of combined biotic/abiotic treatment approach for reducing the highest PCE and TCE concentration in the lower portion of the A zone (B1 zone) and B2 zone at the Traffic Island Area. The treatability study report recommended source reduction in the vadose zone and upper A aquifer zone with limited soil excavation

(by dense non aqueous phase liquid removal) near well 28SI-16 and installation of a new A zone source control extraction well within the excavation footprint, and installation of an additional source control extraction well in the lower A/B1 zone for source reduction and control of downward vertical migration of contaminants.

NASA in collaboration with other research partners has been conducting a phytoremediation pilot treatability study test since 2014 within the shallow regional groundwater plume near the baseball fields on Moffett Field. Approximately 1,000 endophyte-assisted hybrid poplars have been planted and 2016-2018 shallow A zone groundwater monitoring data immediately upgradient and downgradient of the phtyobarrier test plots have shown a significant reduction of TCE and the degradation products.

In 2016, EPA conditionally approved a trial reduction in routine groundwater monitoring and sampling frequency across the MEW site. This trial reduction allowed a reduction in water level measurements frequency from semi-annual to annual and a reduction in sampling frequency from annual to biennial sampling conducted in 2016 and 2018.

The MEW Regional Program, NASA, Navy, and private developers/owners performed the following vapor intrusion remedial work during the Five-Year Review period.

- The MEW Regional Program, designed, constructed, and installed a sub-slab depressurization system at the 440 East Middlefield Road building, and confirmation sampling showed commercial indoor air cleanup levels have been met. The sub-slab depressurization system shut down on December 12, 2017 due to a blower failure. While the blowers were being replaced, the building ventilation system fan operated continuously when the building was occupied and provided vapor intrusion mitigation. The sub-slab depressurization system resumed its normal operation on January 3, 2018.
- The MEW Regional Program designed, constructed, and installed a sub-slab depressurization system and vapor barrier at a new commercial office building at 620 National Avenue and started operating in October 2017.
- At the 615 National Avenue building, the MEW Regional Program repaired floor cracks and installed a vapor barrier coating on top of the building foundation slab in 2012. In 2018, the MEW Regional Program designed and installed a sub-slab depressurization system as a preventative vapor intrusion mitigation measure and confirmation sampling confirmed commercial indoor air cleanup levels are being met.
- Building 503 on Moffett Field became fully occupied in March 2017, and in April 2017 the MEW Regional Program implemented vapor intrusion mitigation measures, including sealing cuts in the concrete slab and conduits. Confirmation air sampling showed that commercial indoor air cleanup levels are being met.
- In March 2017, NASA quickly modified the building ventilation system at Building 126 in response to elevated TCE and PCE indoor air results reported during the Navy's annual air sampling in January 2017 exceeding the TCE short-term response action levels and the PCE long-term indoor air cleanup levels. The Navy has implemented or is implementing interim vapor intrusion mitigation measures at potential pathway locations (e.g., sealing trenches, floor drains, floor cracks, penetrations, installing door and wall vents, etc.) in Buildings 3, 10, 45, 126, 239

and N239A in advance of implementation of the required long-term vapor intrusion control system.

- The MEW Regional Program designed passive sub-slab vapor intrusion control systems and vapor barriers that were constructed in 2016 as part of new construction at two private residences. Pre-occupancy indoor air testing confirmed that residential indoor air cleanup levels are being met.
- Passive sub-slab vapor intrusion control systems and vapor barriers were designed and constructed by the developer as part of new construction at two residential developments within MEW Operable Unit 3. Pre-occupancy indoor air testing confirmed that residential indoor air cleanup levels are being net.
- The MEW Regional Program conducted soil vapor assessments at one commercial property and two residential properties to evaluate whether vapor mitigation was warranted for the new commercial and residential buildings constructed. Based on the assessments, EPA concurred pending the pre-occupancy air testing in 2018-2019 that a vapor intrusion control system is not needed or required. The air testing results confirmed that indoor air cleanup levels are met and there is not potential vapor intrusion risk such that a vapor intrusion control system is not needed.

# 4. Five-Year Review Process

## *4.1. Community Notification, Involvement, and Site Interviews*

A public notice was published in the *Mountain View Voice* on December 28, 2018, providing notification of the MEW Site five-year review process and invited the public to submit any comments to EPA. The Final Five-Year Review report will be made available on EPA's webpage at www.epa.gov/superfund/mew-study-area, at the Mountain View public library, and at the EPA Superfund Records Center, 75 Hawthorne Street, 3rd Floor, in San Francisco, CA.

During the Five-Year Review process, interviews were conducted to document any perceived problems or successes with the MEW Site remedies that have been implemented to date**.** Voluntary questionnaires were sent by email correspondence to the MEW Companies, Navy, and NASA. Responses are included in Appendix G.

## *4.2. Data Review*

### 4.2.1. Groundwater

Between 2014 and 2018, approximately 1.3 billion gallons of groundwater were treated at the Site, and groundwater extraction and treatment systems removed an estimated 12,212 pounds of contaminants (Appendix C, Table C-2). In total, approximately 6.8 billion gallons of groundwater have been treated and 116,419 pounds of VOCs have been removed due to Site cleanup operations. Most of the wells monitored across the MEW regional groundwater plume area reported TCE concentrations above the cleanup level of 5 µg/L. Trend analysis of sampling data from the past five years indicates that TCE concentrations have predominantly levelled off throughout the regional groundwater plume at concentrations above the

cleanup levels (Appendix B, Tables B-1 and B-2). The groundwater in the A and B aquifer zones will not meet cleanup levels for decades, based on a regression analysis of the same wells (Appendix B). The negative regression slope is indicative of TCE concentrations decreasing toward cleanup levels. The MEW Companies, Navy, and NASA have performed groundwater remedy optimizations, including pilot/treatability studies to target contaminant mass removal, consolidate treatment systems, modify pumping rates and remove source control extraction wells to enhance overall cleanup effectiveness and efficiency.

The following is a brief description of facility-specific source area within the MEW regional groundwater plume and their effectiveness in addressing the RAOs.

#### 4.2.1.1 Former Fairchild Facilities

##### 515/545 N. Whisman Road and 313/323 Fairchild Drive (Former Fairchild Buildings 1-4)

Schlumberger continued to operate the groundwater treatment system, though inward and upward gradients were not always maintained. There are ten extraction wells. Four well pairs are used to monitor vertical gradients associated with the slurry wall, and seven well pairs monitor the horizontal gradient across the slurry wall. Horizontal gradients have been generally from the south to the north (similar to the regional groundwater flow direction) across the slurry wall. TCE concentrations in most wells across the properties remain above cleanup levels, with maximum concentrations at 1,400 µg/L in the A zone.

##### 401 National Avenue (Former Fairchild Building 9)

The groundwater remedy at the former Fairchild Building 9 facility includes four extraction wells and a slurry wall to provide hydraulic containment. Schlumberger implemented an ISCO pilot treatability study at the 401 National Avenue property (now 600 National Avenue) in 2015, to accelerate contaminant mass removal and groundwater cleanup. The groundwater extraction wells have been shut off for the duration of the treatability study. During the ISCO pilot treatability study, the large volumes of injected oxidant resulted in release of hexavalent chromium at concentrations above NPDES discharge limits potentially impacting nearby extraction wells. This problem was resolved by decreasing the total volume of injected oxidant. Based on the initial results from five different injection events, concentrations of TCE and other VOCs identified in the ROD have significantly decreased. The maximum TCE concentrations in the A-zone reported in 2019 monitoring event is 6000 µg/L. Future injections have been planned and performance monitoring of treatability study will continue and results incorporated into EPA's Shallow Zone Focused Feasibility Study.

##### 369/379/389/399 N. Whisman Road (Former Fairchild Buildings 13, 19, 23)

Schlumberger continued to operate 14 source control extraction wells at former Fairchild Buildings 13, 19, and 23, and performed optimizations to increase extraction rates to enhance contaminant mass removal. Results from monitoring well pairs indicated that inward and upward gradients were not always maintained across the slurry wall in this facility-specific source area. A regional extraction well is downgradient of the northern slurry walls and captures groundwater that flows through the slurry wall. The extraction rate of this well has been increased. Recently reported TCE concentrations in the former Fairchild Building 19 area have a maximum TCE groundwater concentration of 4,000 µg/L in the A zone.

644 National Avenue (Former Fairchild Building 18)

Schlumberger continued to operate one source control extraction well and three regional extraction wells in the former Fairchild Building 18 area. The building at 644 National Avenue has been removed and the wells are currently in the parking lot of the 331 Fairchild property. Downward gradients occurred in monitoring wells, which was attributed to B1 zone regional extraction wells located on the property that pull water down from the A zone aquifer above. The maximum TCE concentration recently reported in the A-zone aquifer is 980 µg/L.

#### 4.2.1.2 350 Ellis Street (Raytheon)

Raytheon continued to operate the groundwater extraction and treatment system. Inward and upward gradients have not been maintained in the slurry wall in the last five years. The slurry wall partially contains high TCE concentrations within the slurry wall exceeding 10,000 µg/L in several locations. However, well pairs along the northern slurry wall are not demonstrating a successful upward and inward gradient. Well pairs R-68B1/R-67A, R-63B1/R-60A, RP-19B/R-60A, and R-67B1/RE-08A exhibit downward gradients during portions of the year. Based on the stability in reported concentrations of TCE, it does not appear that the current remedy is sufficient to reach the RAO in the 2010 ROD Amendment to accelerate the reduction of the source of vapor intrusion such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

#### 4.2.1.3 355/365, 401, and 415 E. Middlefield Rd (Intel/Raytheon)

Intel/Raytheon continued to operate an in-situ remediation pilot test over the last five years, which has accelerated cleanup of VOCs in groundwater. The pilot test began in 2005, and Intel's groundwater extraction and treatment system was shut down at that time. Intel/Raytheon performed the most recent electron donor injection and bioaugmentation injection in 2014. Since 2014, no further injections have taken place, and monitoring indicates that TCE concentrations and the extent of the plume have decreased due to the pilot treatability study. The decrease in the extent of the plume has left some localized areas of residual TCE concentration areas (well IM-18A, 270 µg/L, R52A, 710 µg/L). The property is currently planned for residential redevelopment and new building construction will include the required vapor intrusion control systems. Long-term groundwater remedial infrastructure (e.g., monitoring wells, etc.) will be coordinated and considered as part of the redevelopment plans.

#### 4.2.1.4 501 Ellis Street (NEC/Renesas)

Renesas continued to operate the A-zone groundwater extraction and treatment system and optimized the groundwater remedy by converting an extraction well into a monitoring well. TCE concentrations across the 501 Ellis property are relatively low compared to other portions of the regional TCE groundwater contamination plume though above the TCE cleanup level. The maximum TCE groundwater monitoring result reported in the 2018 annual groundwater report is 83 µg/L. TCE degradation appears to be occurring naturally as the chemical breakdown products are increasing in concentration. Alternatives to the current groundwater remedy, including passive alternatives, are currently being evaluated in the Shallow Zone Focused Feasibility Study.

#### 4.2.1.5 455, 485/487, and 501/505 E. Middlefield Rd (SMI Holding LLC)

SMI continued to operate its A-zone groundwater extraction and treatment system until June 2019 when SMI began implementing a two-year in-situ pilot sulfidated zero valent iron treatability study. The extraction and treatment system will remain off during the treatability study and performance monitoring will be conducted and evaluated to determine the effectiveness of the treatability study.

#### 4.2.1.6 405/425 National Avenue (Vishay/SUMCO)

Vishay/SUMCO is evaluating remedial options to accelerate contaminant mass removal from groundwater at the former 405 National Avenue property. They have done this by collecting additional data, converting an A-zone monitoring well 116A to a source control extraction well, and continuing to operate the groundwater extraction and treatment system. Although VOC concentrations in all wells have decreased since the groundwater extraction and treatment began in 1996, recent data indicate that TCE concentrations have increased in some wells both within and downgradient from the former source area. Data collected in 2016 identified localized VOC mass in the A-zone extending deeper than existing extraction and monitoring wells. In January 2017, monitoring well 116A was converted to shared source control extraction well EX-116A to target high TCE groundwater contamination and optimize contaminant mass removal.

#### 4.2.1.7 NASA Ames

The NASA Ames groundwater treatment system has been optimized to increase well extraction rates in the two operating extraction wells. They phytoremediation pilot treatability study test of endophyte-assisted hybrid poplars have grown to over 1,000 trees in three phytobarrier test plots within the regional plume area just north of Highway 101 on Moffett Field. The upgradient well results in 2016 -2018 has shown significant reduction of TCE (300 μg/L) and cis-1,2-DCE (160 μg/L) compared to the well immediately downgradient of the phytobarrier test plot. Both TCE and cis-1,2-DCE are not detected below the laboratory reporting limit. As performance monitoring of the phytoremediation study continues, other areas overlying the shallow TCE regional plume area are being considered and the phytoremediation technology is being evaluated in EPA's Shallow Zone Focused Feasibility Study.

#### 4.2.1.8 Navy's Site 28 WATS Area

During the Five-Year Review period, the Navy completed a treatability study to evaluate the effectiveness and feasibility of combined biotic/abiotic treatment for reducing the highest concentrations of PCE and TCE in the lower A2/B1 zone and in the B2 aquifer zone at the Traffic Island Area. Baseline VOC concentrations were established in the treatment area and the treatability study was very effective in reducing PCE and TCE concentrations; however, the Navy is not planning on conducting additional in-situ biotic/abiotic work in the Site 28 area. The Navy has prepared a work plan for limited DNAPL soil excavation in the vicinity of well 28SI-16, installation of a new A zone extraction well (EA1-7) within the excavation footprint, and installation of a new extraction well (EA2-4) screened in the lower A2/B1 zone (65 to 80 feet bgs) for source reduction and to control the downward vertical migration of contaminants. In addition, based on the 2018 groundwater monitoring data, the Navy plans to install a new lower A2/B1 extraction well (EA2-5) southeast of Building 6 (near 28SI-04) and downgradient of the former Building 88 source area. Since the start-up of WATS, groundwater extraction from EA1-1 (averaging less than 0.5

gpm) has been significantly less than that of other upper A zone extraction wells. The Navy is proposing a replacement extraction well (EA1-1R) for EA1-1 in a gravelly and sandy channel deposit.

As indicated in Section 3.2, the WATS groundwater extraction and treatment system had considerable operational downtime in 2016 through mid-2019 for repairs, replacement, and maintenance to the primary advanced oxidation process units and granular activated carbon vessels and auxiliary system and extraction well components and remote monitoring.

#### 4.2.1.9 TCE Hot Spot Areas along Evandale Avenue and Leong Drive

In 2012, EPA identified TCE groundwater hot spot areas in a residential area on Evandale Avenue and these hot spots formed the basis of two issues in the previous 2014 Five-Year Review. In the 2014 Five-Year Review, EPA recommended that the source, as well as lateral and vertical extent of contamination, should be determined, and that the cleanup approach to address contamination should be developed and implemented. EPA conducted additional groundwater, soil gas, and vapor intrusion sampling in 2013 and 2014 and since 2013 EPA has also been investigating the source of the TCE hot spot areas found on Evandale Avenue and Leong Drive properties. In 2015 began referring to this area as MEW Operable Unit 3 Vapor Intrusion Evaluation Area and implementing the 2010 ROD Amendment vapor intrusion remedy for new construction and existing residences and commercial buildings within the area (see blue shaded area on Figures 1, 5, and 6).

In 2016, EPA and a developer collected soil gas and shallow groundwater samples at three residential properties at 277 Fairchild Drive and 228/236 Evandale Avenue. In shallow A zone groundwater samples (18 to 24 feet below ground surface [bgs]), TCE was detected at a maximum concentration of 6,000 µg/L. In A zone groundwater samples (28 to 32 feet bgs), TCE was detected at a maximum concentration of 2,800 µg/L. In soil gas samples, maximum TCE soil gas concentrations of 110,000 microgram per cubic meter (µg/$m^3$) at 5 feet bgs, and maximum TCE soil gas concentrations at 410,000 µg/$m^3$ were detected.

As part of a Bonafide Prospective Purchaser Agreement with the developer and EPA, the developer conducted additional response actions to reduce TCE hot spot areas exceeding 20,000 µg/$m^3$ in soil gas and 1,500 µg/L in shallow A zone groundwater. The developer operated a soil vapor extraction and treatment system from October 2017 to June 2018 and performed enhanced anerobic bioremediation at the property by injecting carbon amendments to facilitate reductive dechlorination at 42 injection points. Injections were conducted in September 2017, followed by a second round of injections in the southwestern portion of the property in March 2018. After completion of the accelerated response actions, TCE remains at the property above groundwater cleanup levels, and long-term groundwater and vapor intrusion remedial actions are required and being implemented. Residential construction is ongoing at the property during the Five-Year Review Site Inspection and planned to continue through 2019 (Appendix H).

Remedial actions currently in place are operation of a new regional A-zone groundwater extraction well (GT-1A) in the south-central area of the 277 Fairchild Drive property, continued operation of an existing regional B zone groundwater extraction well (REG-3B1) located near the northwestern corner of the property, and operation of vapor intrusion control systems at the new residential buildings on the property. An additional source control groundwater extraction is needed to address TCE hot spot area on Evandale Avenue.

### 4.2.2. Vapor Intrusion

The Vapor Intrusion Study Area is the area where TCE concentrations in shallow groundwater are greater than 5 µg/L. The MEW Companies, Navy, NASA, and EPA continue to implement the vapor intrusion remedy selected in the 2010 ROD Amendment in the MEW Vapor Intrusion Study Area (Figure 6) and EPA and private parties have been implementing the vapor intrusion remedy in the OU3 Vapor Intrusion Evaluation Area. To date, over 125 commercial/non-residential buildings and over 200 residences have been sampled in both the MEW and OU3 areas. In addition, air sampling is conducted in all new residential and commercial buildings and where tenant improvements/renovations are conducted prior to occupancy to confirm that the indoor air cleanup levels are met and the vapor intrusion remedy is verified and operating and performing as designed (See Section 3.2).

In buildings where TCE from subsurface vapor intrusion exceeded the indoor air cleanup levels, interim mitigation measures have been implemented, or building vapor intrusion control systems have been constructed and are operating. Vapor intrusion mitigation measures may include sealing cracks and penetrations in foundations, floor drains, and conduits, operation of air treatment systems, and modification of the building ventilation systems. Residential buildings in the Vapor Intrusion Study Area and OU3 Vapor Intrusion Evaluation have been sampled where access has been permitted. Vapor intrusion control systems have been installed in all new construction overlying TCE Shallow Zone contamination.

### 4.2.3. Institutional Controls

The vapor intrusion remedy includes ongoing institutional controls to ensure that the remedy is properly implemented over time and that all parties are aware of the remedy's implementation and ongoing requirements. The following three categories of Institutional Controls specifically selected for the vapor intrusion remedy are being implemented. 1) All properties with an implemented vapor intrusion control system have recorded proprietary controls which run with the land that inform future property owners of the ongoing operation of the building vapor intrusion remedy at the property. 2) Governmental controls in the form of City of Mountain View planning and permitting procedures are being implemented. These procedures are intended to inform and allow for EPA to comment when work conducted anywhere overlying the shallow TCE regional groundwater contamination plume may either impact the remedy itself or cause a new pathway for vapors to enter any overlying structure. 3) The institutional controls also include the implementation of informational mechanisms, which are two-fold: use of an information-gathering service that can keep EPA and the MEW Companies informed of property ownership changes in the MEW Site area and provision of information to owners and occupants in the MEW Site area to ensure understanding of the remedy and its requirements. For Moffett Field, the institutional controls selected for the vapor intrusion remedy are those requirements found in NASA's and Planetary Ventures' Environmental Issues Management Plans (EIMP) which applies to the NASA Research Park area and a portion of the Moffett Federal Airfield Leasehold by Planetary Ventures. The EIMP provides a decision framework for the management of residual chemicals in soil, groundwater and existing structures, and describes procedures to address the known remaining environmental conditions as well as contingency actions to be taken in the event that previously unknown environmental conditions are encountered during development. Thus, for the full implementation of the Moffett Field Area institutional controls, NASA

has expanded the applicability of the vapor intrusion remedy requirements to areas of groundwater contamination outside the NASA Research Park.

### 4.3. Site Inspection

The inspection of the Site was conducted on March 12, 2019 by Alana Lee, EPA Project Manager and Benino McKenna, USACE. Representatives from the MEW Companies, Navy, and NASA attended at each of their respective facility-specific areas. The purpose of the inspection was to observe the current remedy.

A summary of the site inspection visits, along with photographs, is included in Appendix H. The Five-Year Review team inspected each of the groundwater treatment systems and selected vapor intrusion treatment systems. The Five-Year Review team inspected properties where pilot/treatability studies have been performed or are ongoing and inspected properties where active and passive vapor intrusion control systems have been installed. The WATS was offline for system repairs, and EPA had been previously notified of the system shutdown.

## 5. Technical Assessment

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

The groundwater remedy is operating as intended by the decision documents; however, the Navy failed to operate, monitor, and maintain the Site 28 West-Side Aquifers Treatment System (WATS) groundwater remedy for several months in 2016. In October 2016, NASA took over the Site 28 WATS groundwater extraction and treatment system and restored operation and implemented a robust maintenance and monitoring schedule. The MEW Companies, Navy, and NASA have performed groundwater remedy optimizations, including pilot/treatability studies to target contaminant mass removal, consolidate treatment systems, modify pumping rates and remove source control extraction wells to enhance overall cleanup effectiveness and efficiency.

Optimization of the existing groundwater extraction and treatment system has improved performance at the Regional Program systems and some of the former Facility-specific areas including Fairchild/Schlumberger, Vishay/SUMCO, Renesas, and NASA. The MEW Companies, Navy, and NASA are currently performing pilot treatability studies of alternate groundwater cleanup technologies. Pilot treatability study tests of in-situ remediation by Fairchild/Schlumberger, Intel/Raytheon, Navy, and SMI; and phytoremediation by NASA are showing promising results in reducing Site contaminant concentrations in groundwater.

TCE groundwater concentrations have decreased over the years; and analysis of monitoring data indicates that TCE concentration in the groundwater plume are levelling off at concentrations above the cleanup level. The declining efficiency of the operations of the current groundwater remedy indicates that groundwater cleanup levels will not be achieved in shallow groundwater for many decades. This prolonged period of time is inconsistent with the vapor intrusion remedy RAO to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that

are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

The groundwater is currently not used for drinking water, and Santa Clara Water Valley Water District has governmental controls in place to prevent the installation of wells in the contaminated aquifer zones.

The vapor intrusion remedy is functioning as intended by the 2010 ROD Amendment. In the Vapor Intrusion Study Area, all occupied commercial/non-residential buildings have been sampled and institutional controls are in place for new building construction and building improvements that may interfere with the vapor intrusion remedy. Residential buildings have been sampled. Vapor intrusion mitigation and control measures have been implemented in affected buildings.

## 5.2. Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

Federal and state maximum contaminant levels (MCLs) identified as ARARs in the decision documents have changed since the selection of the remedy, but the changes do not affect the protectiveness of the remedy. Concentrations of chloroform, 1,2-dichlorobenzene, PCE, antimony, cadmium, and arsenic are below current MCLs, so the changes do not affect protectiveness. Only 1,2-DCE has a change in ARARs and current concentrations of 1,2-DCA exceed the current MCL. However, it is anticipated that concentrations of 1,2-DCA will decrease to levels below its MCL before the remedy has achieved its cleanup level for TCE, the primary chemical of concern and the indicator chemical for contaminant cleanup. In addition, institutional controls are in place to prevent future direct exposure to contaminated groundwater. Other ARARs have changed since the ROD was issued (Appendix D), and these changes are primarily editorial and do not affect the protectiveness of the remedy.

Toxicity data for some contaminants of concern have changed since the time of remedy selection; however, these changes do not affect protectiveness. Changes to toxicity data for TCE since the selection of the groundwater cleanup level have occurred. Protectiveness of the groundwater remedy is not affected by these changes, because the cleanup level remains within EPA's acceptable risk range. Changes to toxicity values since the 2010 ROD amendment for the vapor intrusion pathway also have occurred, and these changes are summarized in Appendix F. The changes fall within EPA's acceptable risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, as discussed in the NCP, so the changes do not affect protectiveness.

Exposure assumptions used in the selection of the groundwater and vapor intrusion remedies are still valid.

Due to declining efficiency and effectiveness, the existing groundwater remedy will not achieve the groundwater remedy RAO to restore aquifers to groundwater cleanup levels, since concentrations of contaminants of concern in the plume are stabilizing at concentrations above cleanup levels. Also, the existing groundwater remedy will not meet the vapor intrusion RAO to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary for many decades. Pilot tests and treatability studies are ongoing to explore alternative groundwater cleanup technologies, in order to expedite contaminant mass removal and cleanup timeframe and reduce VOC concentrations.

## 5.3. *Question C: Has any other information come to light that could call into question the protectiveness of the remedy?*

No, there is no other information that has come to light that could call into question the protectiveness of the remedy.

# 6. Issues/Recommendations

**Table 9. Issues and Recommendations Identified in the Five-Year Review**

| **Issues and Recommendations Identified in the Five-Year Review:** | | | | |
|---|---|---|---|---|
| **OU(s): Site-wide** | **Issue Category: Remedy Performance** | | | |
| | **Issue:** Due to declining efficiency and effectiveness, the existing groundwater remedy will not achieve groundwater cleanup levels for many decades and will not meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary. | | | |
| | **Recommendation:** Evaluate alternative cleanup technologies that will accelerate TCE contaminant reduction and vapor intrusion source reduction in the Shallow Zone (soil gas and A aquifer zone) to address the vapor intrusion source remedial action objectives and prepare Shallow Zone Focused Feasibility Study, Proposed Plan and ROD Amendment to support and change the current remedy. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Party Responsible** | **Oversight Party** | **Milestone Date** |
| No | Yes | EPA | EPA | 12/1/2021 |

## 6.1. *Other Findings*

In addition, the following are recommendations that improve reliability of the remedy but do not affect current and/or future protectiveness were identified during the Five-Year Review.

- Consider groundwater institutional controls in the upcoming Feasibility Study to ensure protection against direct exposure to contaminated groundwater.
- Evaluate alternative cleanup strategies to address contamination inside the slurry walls and implement remedial actions that do not require maintaining inward and upward gradients to control facility-specific source area contamination.
- Conduct water use survey of potential users to determine if treated water at the MEW Site could be reused.

# 7. Protectiveness Statement

**Table 10. Protectiveness Statement**

| Sitewide Protectiveness Statement |
| --- |
| *Protectiveness Determination:*<br>Short-term Protective |
| *Protectiveness Statement:*<br>The groundwater and vapor intrusion remedy at the Middlefield-Ellis-Whisman (MEW) Superfund Area is currently protective of human health and the environment because there is no direct exposure to contamination. Governmental controls are in place to prevent access to contaminated groundwater. The vapor intrusion control systems, monitoring program, and institutional controls are in place to minimize exposure risk from vapor intrusion. However, in order for the remedy to be protective in the long-term, alternative groundwater cleanup technologies should be selected in order to accelerate the reduction of the source of vapor intrusion in the Shallow Zone. |

# 8. Next Review

The next five-year review report for the MEW Superfund Study Area is required five years from the completion date of this review.

# Figures

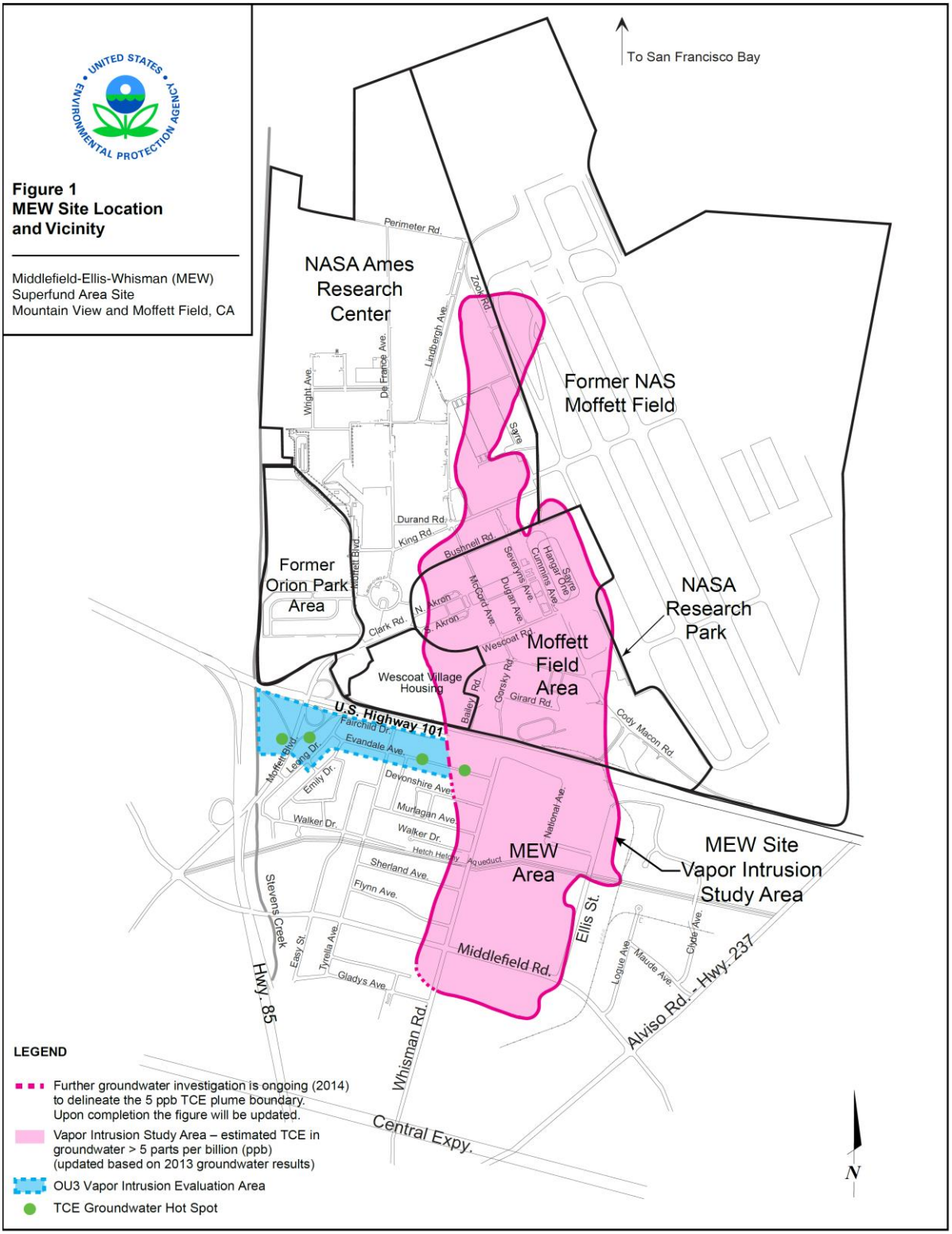


**Figure 1. Location Map for the Middlefield-Ellis-Whisman (MEW) Superfund Study Area Site**

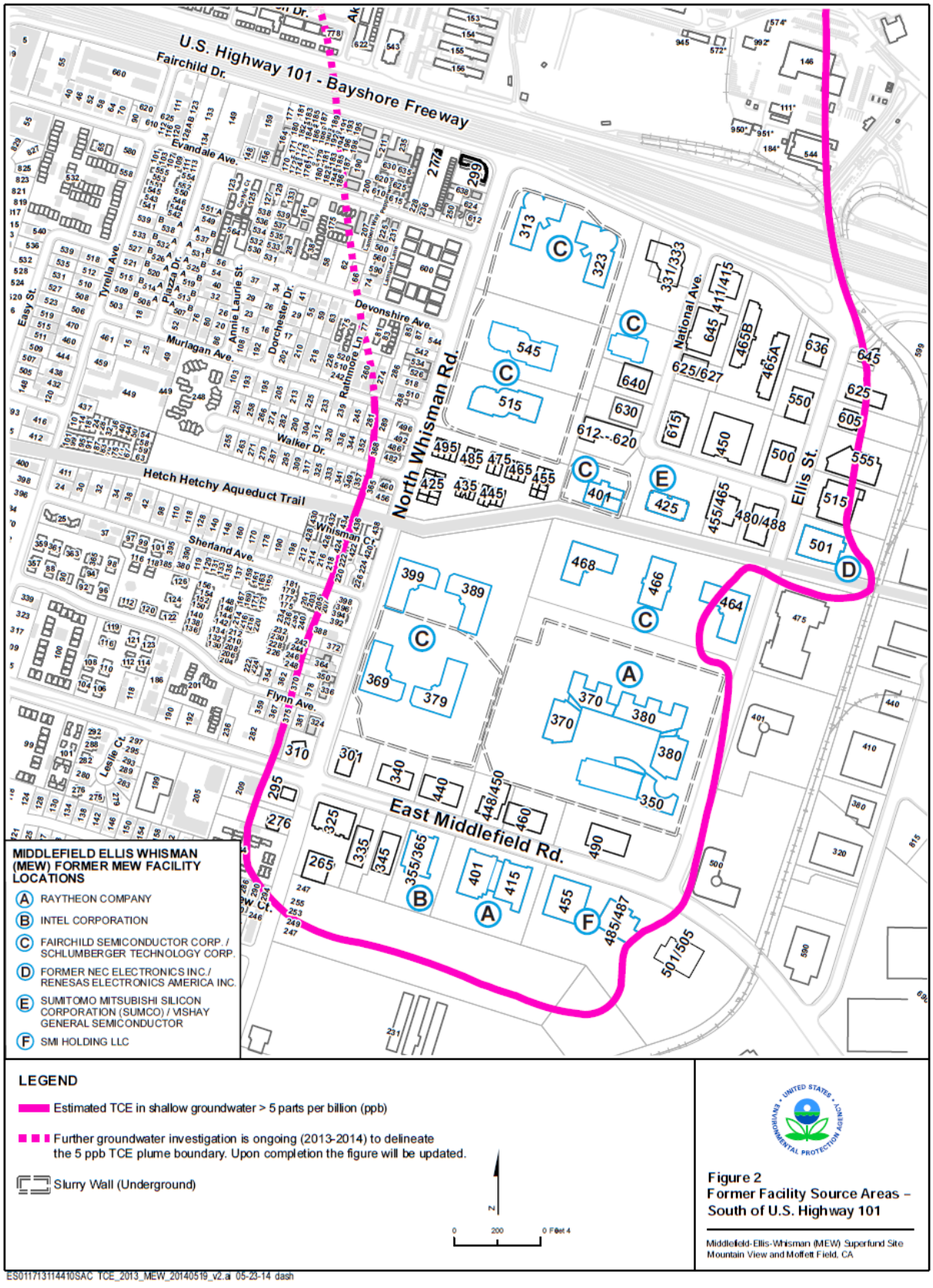


**Figure 2. Location (Current Property Address) of Former MEW Facility-specific Source Areas**

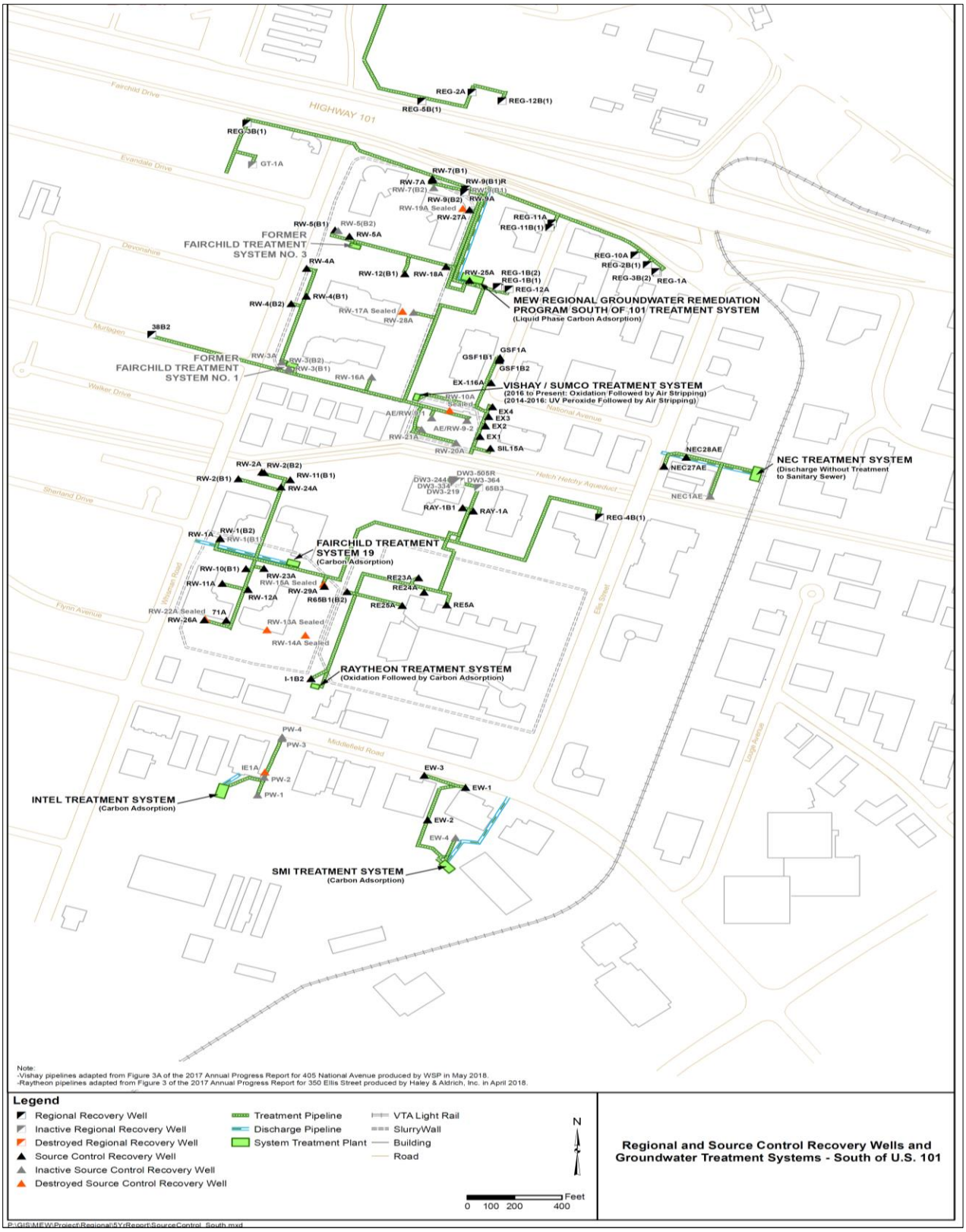


**Figure 3. Regional and Source Control Extraction Wells and Treatment Systems – South of U.S. Highway 101**

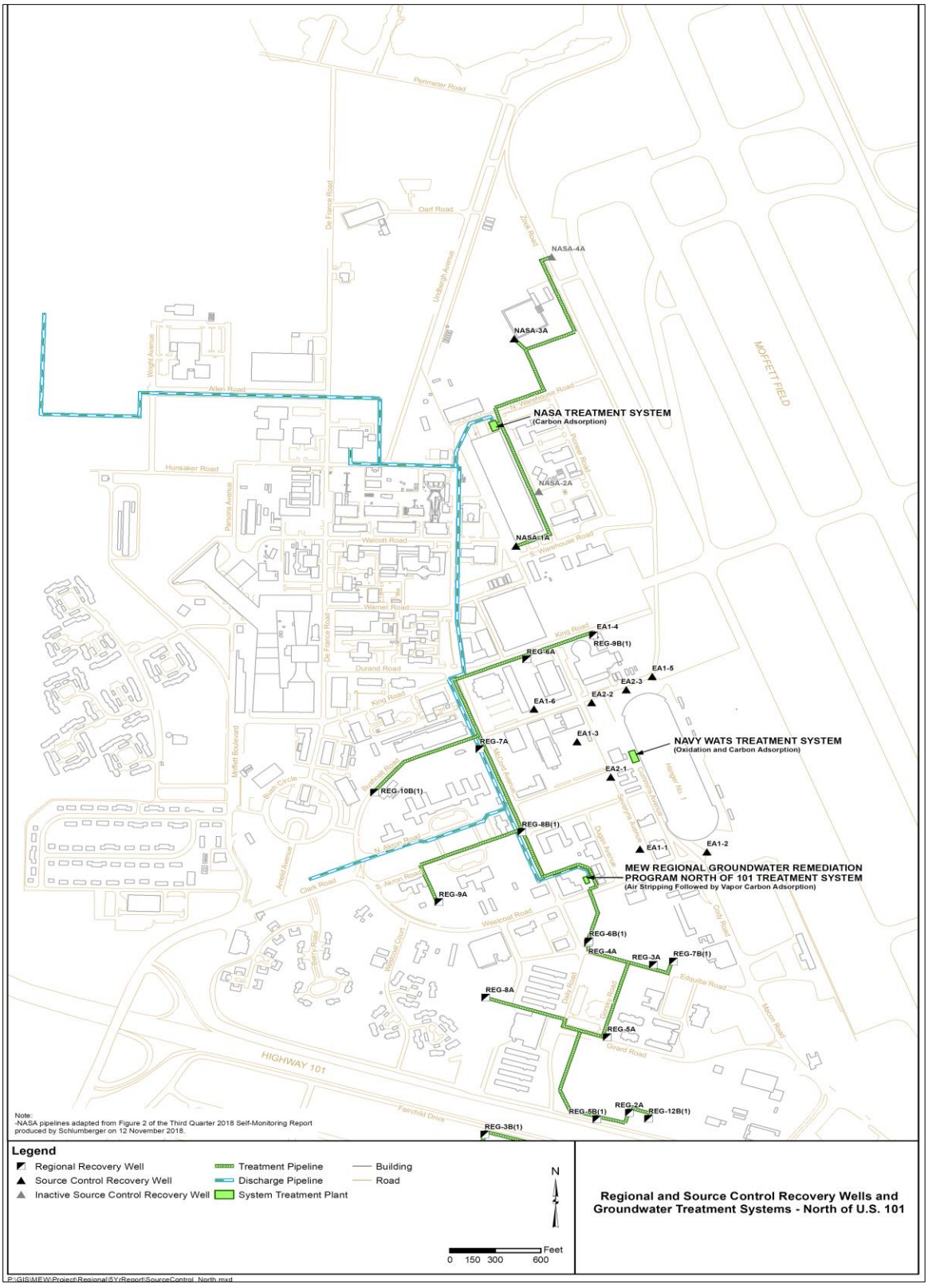


**Figure 4. Regional and Source Control Extraction Wells and Treatment Systems – North of U.S. Highway 101**

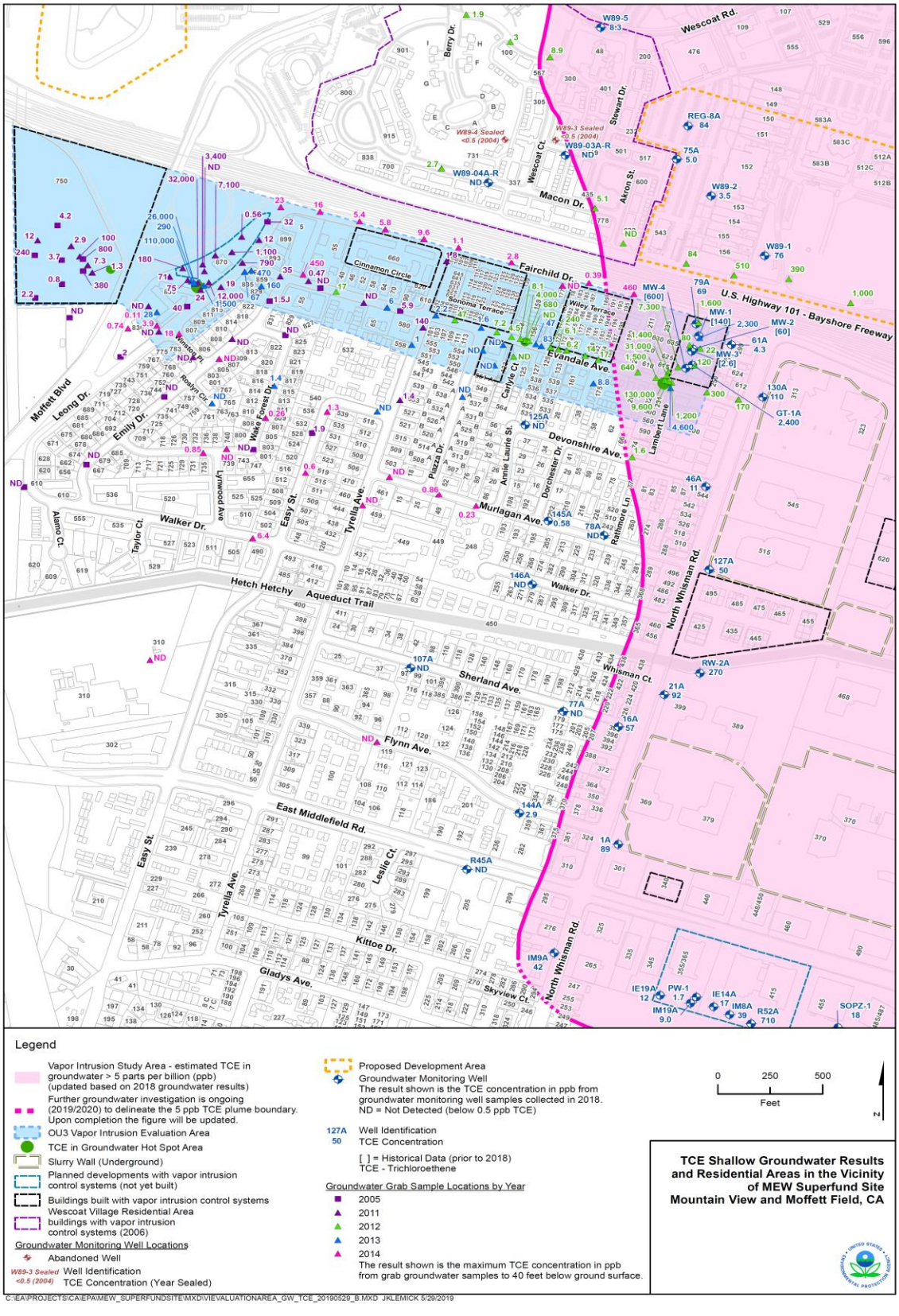


**Figure 5. TCE Shallow Groundwater Results in Residential Areas and Vicinity**

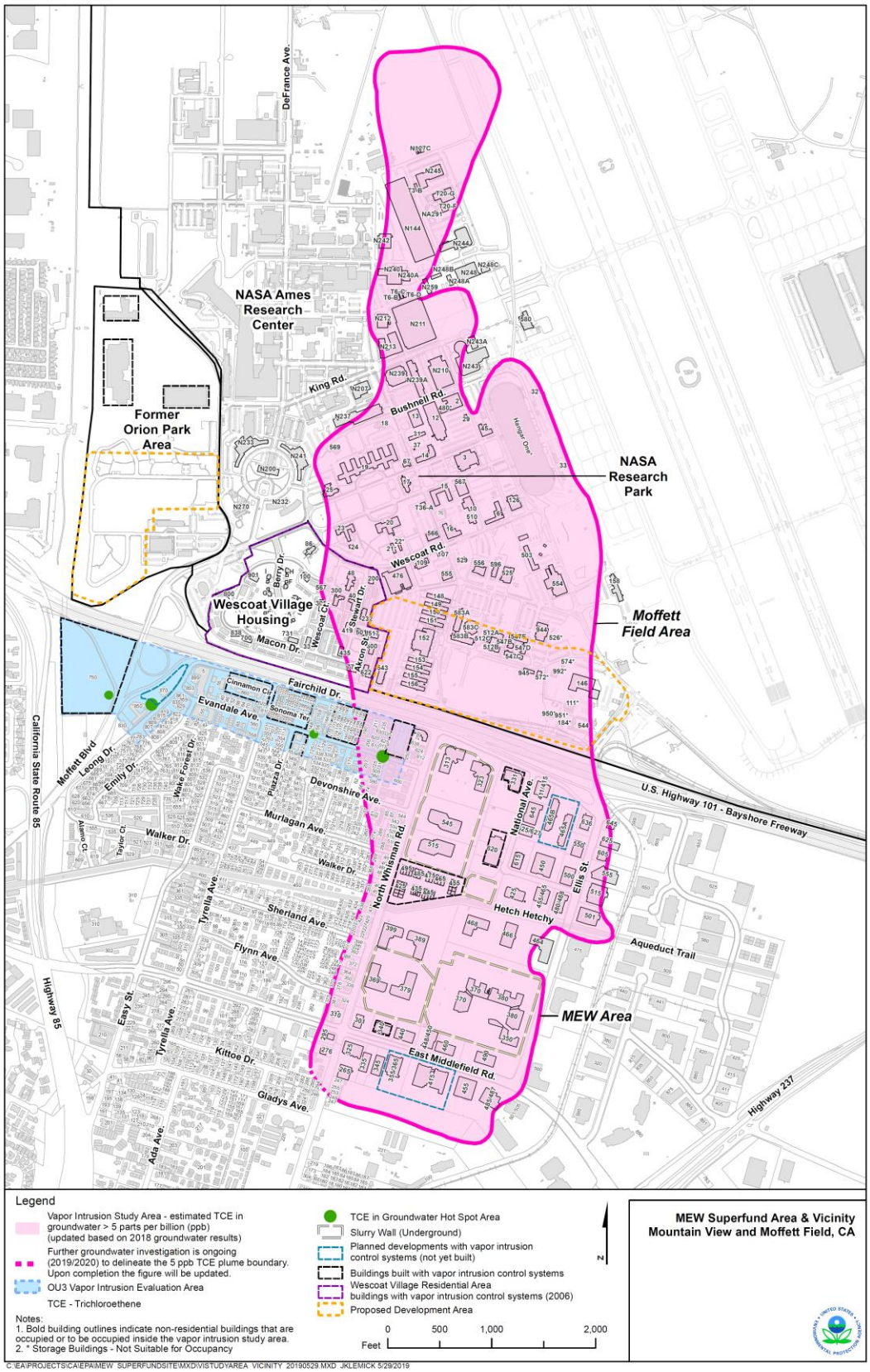


**Figure 6. MEW Vapor Intrusion Study Area and OU3 Vapor Intrusion Evaluation Area**

# Appendix A: List of Documents Reviewed


Environmental Protection Agency (EPA), 1989. *Record of Decision, Fairchild, Intel, Raytheon Sites, Middlefield-Ellis-Whisman (MEW) Site, Mountain View, California.* June 9.

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Geosyntec Consultants, Inc. (Geosyntec), Northgate Environmental Management, Inc., Schlumberger Water Services, and Weiss Associates (Geosyntec, et al.), 2008. Optimization Evaluation, Fairchild Sites, Middlefield-Ellis-Whisman Area, Mountain View, California. 3 September.

Geosyntec, 2013. *Building-Specific Long-Term Vapor Intrusion Operations, Maintenance, and Monitoring Plan*, 369 and 379 North Whisman Road, Mountain View, California. 21 October.

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Geosyntec, 2015a. Addendum to the *Final Work Plan for In Situ Chemical Oxidation Pilot Study*, 401 National Avenue, Former Fairchild Building 9, Middlefield-Ellis-Whisman Area, Mountain View, California. 16 January.

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Geosyntec, 2015c. *Pilot Study Work Plan – Enhanced Groundwater Extraction*, Former Fairchild Building 19, Middlefield-Ellis-Whisman (MEW) Area, Mountain View, California. 30 June.

Geosyntec, 2016a. Planned Decommissioning of Aboveground Components, Fairchild Treatment Systems 1 and 3, Middlefield-Ellis-Whisman Area, Mountain View, California. 30 March.

Geosyntec, 2016b. 2015 Annual Progress Report for Former Fairchild Buildings 1-4, 9, and 18, Middlefield-Ellis-Whisman Study Area Mountain View, California. 15 April.

Geosyntec, 2017a. *2016 Annual Progress Report for Former Fairchild Buildings 13, 19, and 23*, Middlefield-Ellis-Whisman Study Area, Mountain View, California. 14 April.

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Geosyntec, 2017d. *Work Plan for Fourth Injection Event, ISCO Pilot Study*, 401 National Avenue, Former Fairchild Building 9, Middlefield-Ellis-Whisman Study Area, Mountain View, California, 31 July.

Geosyntec, 2017e. *Proposed Well Deconstructions*, Middlefield-Ellis-Whisman Study Area, Mountain View, California, 31 October.

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Geosyntec, 2019. *2018 Annual Progress Report Middlefield-Ellis-Whisman, Fairchild and Regional Groundwater Remediation Programs, Mountain View, California.* April 15.

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Geosyntec, 2018b. *2017 Annual Progress Report*. Middlefield-Ellis-Whisman (MEW) Fairchild and Regional Groundwater Remediation Programs, Mountain View, California. 13 April.

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### SMI Holding LLC - 455, 485/487 and 501/505 East Middlefield Road

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### Vishay-SUMCO - 405/425 National Avenue

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ERT, 2015. *Draft 2015 Air Sampling and Vapor Intrusion Tier Response Evaluation Report*. July.

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ERT, 2017. *Final NASA Ames Land Use Controls Implementation and Monitoring Plan*. September.

ERT, 2018. *NASA Ames Draft Final 2017 Land Use Controls Report*. October.

### Navy Site 28/WATS Area Documents

EPA, 2017. EPA Notice of Violations Letter to Navy – *Failure to Maintain and Operate Site 28 West-side Aquifers Groundwater Remedy, NAS Moffett Field, Moffett Field, California. May 4.*

EPA, 2018. EPA Letter to Navy – *Stipulated Penalties for Failure to Operate, Maintain, Monitor, and Report Site 28 West-side Aquifers Area Groundwater Remedy, NAS Moffett Field, Moffett Field, California. May 4.*

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Aptim Federal Services LLC, 2019. Draft Remedial Design/Remedial Action for Installation Restoration Program Site 28, Former Naval Air Station Moffett Field, Moffett Field, California. July.

# Appendix B: Data Review

Mann-Kendall trend analysis (Table B-2) and regression analysis (Table B-1) was performed on TCE concentration data from the past 5 years from 18 randomly selected A zone wells. Wells were randomly selected from around the MEW regional plume to characterize the conditions that exist within the plume using trend analysis. Wells were selected outside of slurry wall containment to best capture the conditions of the plume, as it is known that wells inside the slurry walls tend to be elevated compared to the surrounding groundwater. Sampling has been reduced from every year to every other year, so at times 2017/2018 data was not available for inclusion if the MEW Company did not elect to sample during an unrequired time period. The dates are approximate as sampling events rarely occurred on the same date but did take place around the same time.

The results of the Mann-Kendall analysis indicate that only 2 of the 18 A zone wells selected show a trend of decreasing TCE concentrations. Most wells show either a stable trend, or no trend, and 3 wells show an increasing trend. One of the wells randomly selected for analysis demonstrated an increasing trend in TCE concentration on the Fairchild site, which could be due to poor hydraulic gradient control.

A regression analysis was performed on the same data to examine if the slope of TCE concentrations over time was positive or negative. The regression examines TCE concentration changes as a dependent variable with respect to time, which is an independent variable. The $R^2$ value indicates how likely TCE concentration changes are affected by the passage of time. Based on the analysis, 11 of the 18 wells sampled have positive regression slopes indicating that TCE concentrations are not decreasing toward cleanup levels targeted in the ROD. Only 7 of the 18 wells have negative slopes, indicating that TCE concentrations are decreasing, but based on the regression equations, the wells with negative slopes will not reach cleanup goals within 100 years under current conditions. Most wells have an $R^2$ of less than 0.5, which means that factors other than time are having an influence on the change in TCE concentrations (such as pump extraction rates, injection treatments, or groundwater levels).

Results from the Mann-Kendall and regression analyses indicate that TCE concentrations in the plume are stabilizing. Most locations within the plume are stabilizing to TCE concentrations that are above the cleanup levels. In order to reach RAOs within a timeframe that can meet the objectives of the 2010 ROD amendment, alternate cleanup methods may need to be considered. Further optimization of treatment methods and continued efforts to maintain slurry wall gradients may help contain hot spots and lower concentrations in the plume. Success at individual properties has been seen with in-situ treatment, and additional in-situ treatment may help in moving toward monitored natural attenuation for the plume as a whole.

### Table B-1. Regression Analysis Results

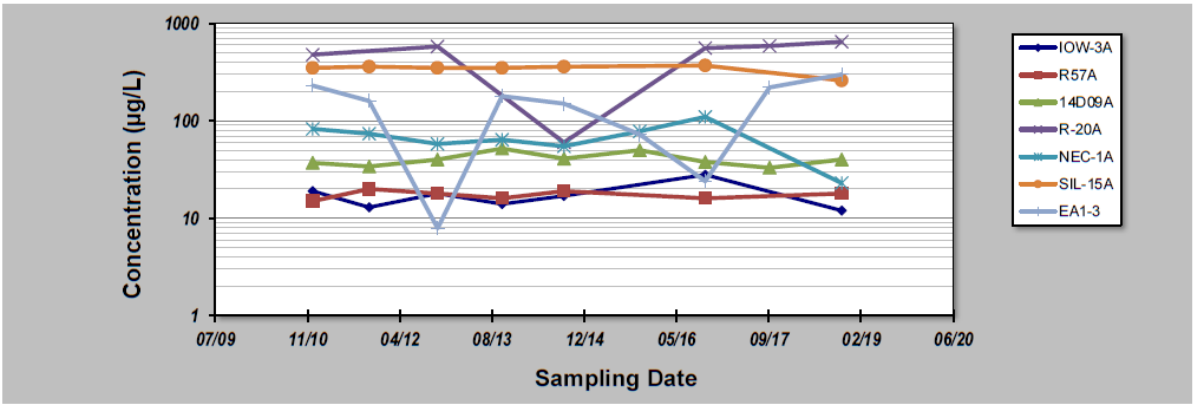
| Well ID | Location | Mann-Kendall Trend | Regression Slope | Regression $R^2$ |
|---|---|---|---|---|
| IOW-3A | Intel | Stable | 0.0005 | 0.0086 |
| R57A | Raytheon | No Trend | 0.00007 | 0.0016 |
| 14D09A | NASA Ames | No Trend | 0.0592 | 0.0919 |
| R-20A | SMI | Prob. Increasing | 0.0001 | 0.0003 |
| **NEC-1A** | **NEC/Renesas** | Stable | **-0.0077** | **0.0864** |
| SIL-15A | Vishay/SUMCO | No Trend | 0.0184 | 0.0344 |
| **EA1-3** | **U.S. Navy** | **No Trend** | **-0.0224** | **0.3733** |
| **AK-1-A** | **Regional Groundwater Program** | **Prob. Decreasing** | **-0.0012** | **0.4359** |
| 79A | Regional Groundwater Program | Increasing | 0.067 | 0.5468 |
| 23A | Regional Groundwater Program | Prob. Increasing | 0.0266 | 0.0416 |
| RW-9A | Regional Groundwater Program | No Trend | 0.2986 | 0.3501 |
| **65A** | **Regional Groundwater Program** | **Stable** | **-0.0269** | **0.0072** |
| REG-3A | Regional Groundwater Program | Stable | 0.0019 | 0.0047 |
| 74A | Regional Groundwater Program | No Trend | 0.1898 | 0.3087 |
| 37A | Fairchild Building 9 | Stable | 0.1006 | 0.2246 |
| **71A** | **Fairchild Building 19** | **No Trend** | **-1.1825** | **0.0195** |
| **RW-11A** | **Fairchild Building 19** | **Stable** | **-4.3124** | **0.0265** |
| **RW-12A** | **Fairchild Building 19** | **No Trend** | **-1.7113** | **0.0711** |

## Table B-2. Mann-Kendall Trend Analysis of Selected Wells

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

| | | | |
|---|---|---|---|
| Evaluation Date: | 20-Apr-19 | Job ID: | |
| Facility Name: | MEW Regional Groundwater Systems | Constituent: | TCE |
| Conducted By: | Justin McNabb | Concentration Units: | µg/L |

| Sampling Point ID: | IOW-3A | R57A | 14D09A | R-20A | NEC-1A | SIL-15A | EA1-3 |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (µg/L) | | | | | | |
| 1 | 17-Dec-10 | 19 | 15 | 37 | 480 | 83 | 350 | 230 |
| 2 | 19-Oct-11 | 13 | 20 | 34 | | 74 | 360 | 160 |
| 3 | 23-Oct-12 | 18 | 18 | 40 | 580 | 58 | 350 | 7.9 |
| 4 | 7-Oct-13 | 14 | 16 | 52 | | 64 | 350 | 180 |
| 5 | 8-Sep-14 | 17 | 19 | 41 | 60 | 55 | 360 | 150 |
| 6 | 24-Oct-15 | | | 50 | | 78 | | 73 |
| 7 | 13-Oct-16 | 28 | 16 | 38 | 560 | 110 | 370 | 24 |
| 8 | 26-Sep-17 | | | 33 | 590 | | | 220 |
| 9 | 22-Oct-18 | 12 | 18 | 40 | 650 | 23 | 260 | 300 |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.31 | 0.10 | 0.16 | 0.44 | 0.37 | 0.11 | 0.66 |
| Mann-Kendall Statistic (S): | | -3 | 1 | 1 | 9 | -6 | 1 | 2 |
| Confidence Factor: | | 61.4% | 50.0% | 50.0% | 93.2% | 72.6% | 50.0% | 54.0% |
| Concentration Trend: | | Stable | No Trend | No Trend | Prob. Increasing | Stable | No Trend | No Trend |



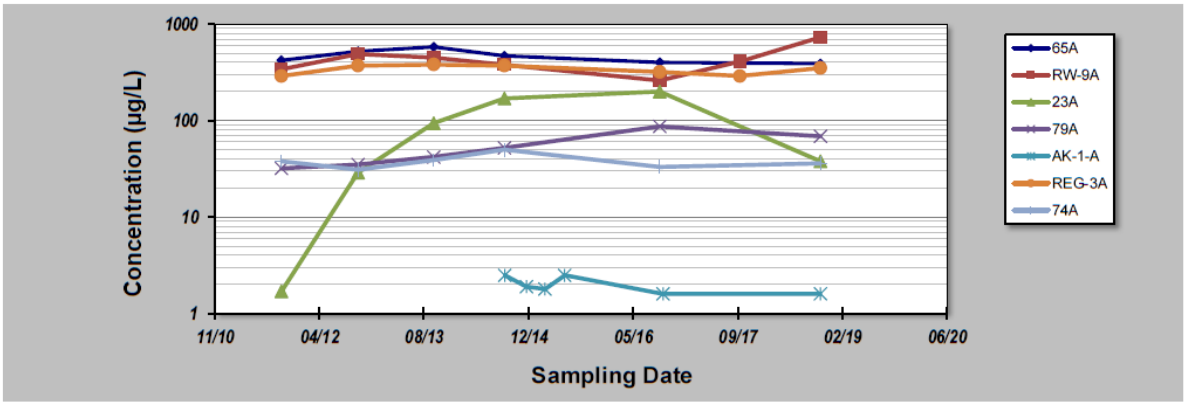

Notes:

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.

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

Evaluation Date: 20-Apr-19
Facility Name: Regional Groundwater Treatment System
Conducted By: Justin McNabb
Job ID:
Constituent: TCE
Concentration Units: µg/L

| Sampling Point ID: | 65A | RW-9A | 23A | 79A | AK-1-A | REG-3A | 74A |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (µg/L) | | | | | | |
| 1 | 3-Oct-11 | 420 | 340 | 1.7 | 32 | | 290 | 38 |
| 2 | 3-Oct-12 | 520 | 490 | 29 | 35 | | 370 | 31 |
| 3 | 30-Sep-13 | 580 | 450 | 94 | 42 | | 380 | 39 |
| 4 | 2-Sep-14 | 470 | 380 | 170 | 52 | | 370 | 50 |
| 5 | 13-May-15 | | | | | | | |
| 6 | 14-Sep-16 | 400 | 260 | 200 | 87 | | 320 | 33 |
| 7 | 2-Oct-17 | | 410 | | | | 290 | |
| 8 | 22-Oct-18 | 390 | 730 | 38 | 69 | | 350 | 36 |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | 4-Sep-14 | | | | | 2.5 | | |
| 15 | 17-Dec-14 | | | | | 1.9 | | |
| 16 | 16-Mar-15 | | | | | 1.8 | | |
| 17 | 18-Jun-15 | | | | | 2.5 | | |
| 18 | 30-Sep-16 | | | | | 1.6 | | |
| 19 | 22-Oct-18 | | | | | 1.6 | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.16 | 0.34 | 0.91 | 0.41 | 0.21 | 0.11 | 0.18 |
| Mann-Kendall Statistic (S): | | -7 | 3 | 9 | 13 | -9 | -3 | 1 |
| Confidence Factor: | | 86.4% | 61.4% | 93.2% | 99.2% | 93.2% | 61.4% | 50.0% |
| Concentration Trend: | | Stable | No Trend | Prob. Increasing | Increasing | Prob. Decreasing | Stable | No Trend |



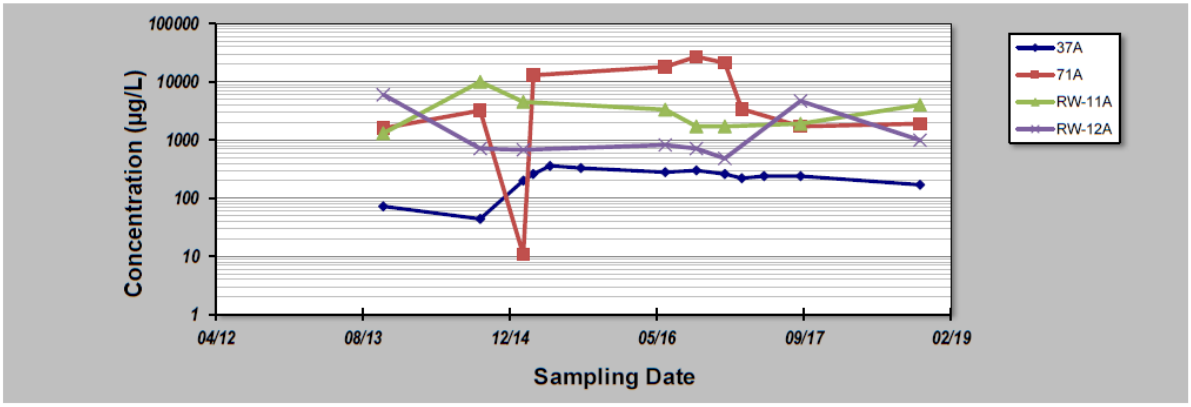

Notes:

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.

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

| | | | |
|---|---|---|---|
| Evaluation Date: | 20-Apr-19 | Job ID: | |
| Facility Name: | MEW Regional Groundwater Systems | Constituent: | TCE |
| Conducted By: | Justin McNabb | Concentration Units: | µg/L |

| Sampling Point ID: | 37A | 71A | RW-11A | RW-12A | | | |
|---|---|---|---|---|---|---|---|
| Sampling Event | Sampling Date | TCE CONCENTRATION (µg/L) | | | | | | |
| 1 | 23-Oct-13 | 72 | 1600 | 1300 | 6000 | | | |
| 2 | 17-Sep-14 | 44 | 3200 | 10000 | 710 | | | |
| 3 | 11-Feb-15 | 200 | 10.7 | 4500 | 680 | | | |
| 4 | 17-Mar-15 | 260 | 13000 | | | | | |
| 5 | 13-May-15 | 360 | | | | | | |
| 6 | 25-Aug-15 | 330 | | | | | | |
| 7 | 8-Jun-16 | 280 | 18000 | 3300 | 820 | | | |
| 8 | 21-Sep-16 | 300 | 27000 | 1700 | 710 | | | |
| 9 | 27-Dec-16 | 260 | 21000 | 1700 | 480 | | | |
| 10 | 23-Feb-17 | 220 | 3400 | | | | | |
| 11 | 10-May-17 | 240 | | | | | | |
| 12 | 11-Sep-17 | 240 | 1700 | 1900 | 4700 | | | |
| 13 | 22-Oct-18 | 170 | 1900 | 4000 | 990 | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| Coefficient of Variation: | | 0.40 | 1.08 | 0.81 | 1.15 | | | |
| Mann-Kendall Statistic (S): | | 0 | 7 | -1 | -1 | | | |
| Confidence Factor: | | 47.6% | 70.0% | 50.0% | 50.0% | | | |
| Concentration Trend: | | Stable | No 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.

# Appendix C: Summary Tables

The summary tables address the status of gradients within slurry walls (Table C-1), groundwater treatment systems (Table C-2), facility-specific optimization studies (Table C-3). Tables C-1 through C-3 were provided by the MEW Companies, Navy, and NASA and reviewed by EPA.

**Table C-1. Status of Inward and Upward Gradients within Slurry Walls**

| MEW Facility-Specific Slurry Wall Location Area | Inward and upward gradient maintained? | Efforts to achieve inward and upward gradient? If not, what other work is being performed? |
|---|---|---|
| Raytheon 350 Ellis St | Groundwater measurements in 2018 demonstrated an inward gradient except in two well pairs along the northern slurry wall and one well pair along the eastern slurry wall. Five of the ten A/B1 well pairs show an upward gradient; while the remaining five show a slight downward gradient. The five B1/B2 well pairs consistently show an upward vertical gradient. | Raytheon operates extraction wells installed in the A and B1 zones immediately downgradient of the slurry wall. These wells provide appropriate capture for the area downgradient of the slurry wall. No changes to extraction system to maintain inward or upward gradient currently are needed. |
| Fairchild/Schlumberger 369 and 441 N Whisman Rd (Former Fairchild Buildings 13, 19, and 23) | Not completely. Horizontal gradients are generally inward along the southern, eastern and western slurry wall and outward on the northern slurry wall (downgradient side of the slurry wall). Five well pairs are used to evaluate vertical gradient. Three of the five well pairs showed upward gradients and two of the five well pairs showed downward gradients. | Extraction wells within the slurry wall are operated at capacity to increase groundwater capture and promote inward and upward gradients. Operation of wells is closely monitored, and a preventative maintenance program is in place to redevelop wells and/or replace pumps when well capacity decreases. |
| Fairchild/Schlumberger 515/545 N Whisman Road (Former Fairchild Buildings 1 through 4) | Not completely. Horizontal gradients are generally inward along the southern, eastern and western slurry wall and outward on the northern slurry wall. Vertical gradient in two of the four well pair showed a downgradient migration. | Extraction wells within the slurry wall are operated at capacity to increase groundwater capture and promote inward and upward gradients. Operation of wells is closely monitored, and a preventative maintenance program is in place to redevelop wells and/or replace pumps when well capacity decreases. |
| Fairchild/Schlumberger 401 National Avenue (Former Fairchild Building 9) | Inward and upward gradients have been historically maintained when source control extraction wells are operating at former Fairchild Building 9. Since 2015, the extraction wells have been offline as part of an EPA-approved ISCO pilot treatability study test. Gradients have been outward and downward during the pilot study. | Additional information on the ongoing ISCO pilot study at the former Fairchild Building 9 is included in Table D-2. |

**Table C-2. Status of Facility-Specific and Regional Groundwater Treatment Systems**

| Facility-Specific Groundwater Treatment System | Volume Treated (Million Gallons) | Mass Removed between 2014 and 2018 (lbs VOCs) | Cumulative Mass Removed (lbs VOCs) | Comments/Notes from MEW Companies, Navy, NASA |
|---|---|---|---|---|
| **Fairchild/Schlumberger:** | | | | |
| Former Fairchild Treatment System 1 (former Buildings 1-4) | 24[1] | 370[1] | 17,700[2] | Groundwater elevations, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the extraction wells at the former Fairchild Buildings 1-4, 9, and 18 remediation areas are achieving adequate horizontal and vertical capture. TCE concentrations are decreasing, stable, or have no statistically significant trend in most monitoring and extraction wells. In addition, VOC mass loading to the groundwater treatment system has been decreasing since startup. |
| 401 National Avenue (former Building 9) | 44[1] | 600[1] | 24,200[2] | |
| Former Fairchild Treatment System 19 369 & 441 N Whisman Road (former Buildings 19, 13, & 23) | 254 | 1,870 | 14,200 | Groundwater elevations, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the extraction wells at the former Fairchild Buildings 19, 13, and 23 remediation area are achieving adequate horizontal and vertical capture. TCE concentrations have been decreasing, stable, or have no significant statistical trend in most monitoring and extraction wells. In addition, VOC mass loading to the groundwater treatment system has been decreasing since startup. |
| **Raytheon:** | | | | |
| 350 Ellis Street | 82 | 2,411 | 18,840 | Overall plume capture is adequate within the facility-specific source area. Trend analyses of monitoring wells indicate decreasing or no statistically significant TCE concentration trends in all monitoring wells. Volume of groundwater treated and VOC mass removed for the period between 2014 and 2017 are included in the 2017 Annual Progress Report (Haley & Aldrich, 2018). The data for 2018 is included in the 2018 Annual NPDES Self-Monitoring Report, submitted to the California Regional Water Quality Control Board, San Francisco Bay Region, by 15 February 2019. |
| **Intel:** | | | | |
| 365 East Middlefield Road | Not applicable | Not applicable | 364 | As part of the enhanced in-situ bioremediation pilot treatability study test, the groundwater extraction and treatment system has been suspended since 2005. |
| **SMI Holding LLC:** | | | | |
| 455 and 485/487 East Middlefield Road | 160 | 32.3 | 105 | None. |

| | | | | |
|---|---|---|---|---|
| **NEC/Renesas:** | | | | |
| 501 Ellis Street | 10 | 9 | 56 | Plume capture is occurring. Site monitoring and extraction wells indicate decreasing (65%) or no statistically significant (25%) TCE concentration trends at 90% of Site wells. |
| **Vishay/SUMCO:** | | | | |
| 405/425 National Avenue | 41.802 | 789.3 | 8,966 | Multiple lines of evidence indicate that the extent of hydraulic containment provided by facility-specific groundwater extraction satisfies the target capture zones.<br>Conversion of well 116A to an extraction well increased mass removed in 2017 compared to previous years. |
| **MEW Regional:** | | | | |
| South of U.S. Highway 101 | 275[3] | 3,330[3] | 14,000[3] | Groundwater elevations, graphical flow net analysis, capture zone width calculations, vertical gradients, and VOC concentration trends provide converging lines of evidence that the MEW regional extraction wells are achieving adequate horizontal and vertical capture of the regional plume. TCE concentrations have been decreasing, stable, or have no significant statistical trend in most monitoring and extraction wells. In addition, VOC mass loading to the groundwater treatment system has been decreasing since startup. |
| North of U.S. Highway 101 | 282 | 1,960 | 12,800 | |
| **NASA:** | | | | |
| NASA Ames Groundwater Treatment System | 43 | 19 | 80 | Additional information can be obtained in the quarterly and annual NPES Self-Monitoring Reports (Geotracker ID TI0000006705). |
| Site 28 West-Side Aquifers Treatment System (WATS) | 122 | 822 | 6,507 | Groundwater extraction volumes and mass removal calculations prior to Q3 2016 are based on Navy documentation. Additional information can be obtained in the quarterly and annual NPES Self-Monitoring Reports (Geotracker ID SL0608557397). |
| | | | | |
| **Total** | 1,338 | 12,212 | 117,767 | |

Notes:

[1] Includes totals from January 2014 through November 2015. On 12 November 2015, flow from Fairchild Systems 1 and 3 were consolidated to the South of 101 Treatment System. Total groundwater extracted and mass removed from November 2015 through December 2018 are included in the amount reported for the Consolidated South of 101 Treatment System.

[2] Value includes VOC mass removed from January 1988 through November 2015. Cumulative mass removal from November 2015 through December 2018 is included in the amount reported for the Consolidated South of 101 Treatment System.

[3] Value includes totals for the RGRP South of 101 Treatment System from January 2014 through November 2015 and the Consolidated South of 101 Treatment System from November 2015 through December 2018.

**Table C-3. Status of Facility-Specific Optimization/Pilot Tests/Treatability Studies**

| Facility/Responsible Party | Proposed Optimization | Status of Work | Comments/Notes from Parties |
|---|---|---|---|
| **Fairchild/Schlumberger:** | | | |
| 515/545 N Whisman Road and 313 Fairchild Drive (Former Buildings 1 through 4) | Optimize Pump and Treat | Groundwater model will be used to evaluate alternative extraction scenarios. Pumping modifications may be proposed based on modeling results and findings of enhanced groundwater extraction pilot study at former Fairchild Building 19 area. | As part of planned remedy optimization, a groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized and a remedy optimization work plan will be developed for submittal to EPA. |
| 369 and 441 N Whisman Road (Former Buildings 19, 13, and 23) | Optimize Pump and Treat | The Pilot Study Work Plan for Enhanced Groundwater Extraction was submitted to EPA in June 2015. The scope of the pilot study includes modifying groundwater extraction rates and evaluating resulting changes in VOC mass recovery. Schlumberger has been implementing the pilot study since late 2015. | Pilot study results are documented in the Annual Progress Reports for the Fairchild Sites. A transient increase in VOC mass removal was noted at the beginning of the pilot study and was attributed to redevelopment of one source control extraction well (71A). Conditions have returned to baseline, and the effect of increased extraction rates on VOC mass removal is currently being evaluated. |
| 401 National Avenue (Former Building 9) | In Situ Chemical Oxidation (ISCO) | Schlumberger has been implementing an ISCO pilot treatability study test since 2015. To date, seven ISCO injection events have been completed with estimated VOC mass removal (2,000-3,000 pounds) equivalent to 13 to 19 years of groundwater extraction. | Pilot study results are documented in the Annual Progress Reports for the Fairchild Sites. One additional ISCO injection is planned for 2019, followed by a post-injection monitoring period to assess long-term VOC concentration rebound. |
| 464 Ellis Street (Former Building 20) | Optimize Pump and Treat | Groundwater model will be used to evaluate alternative extraction scenarios. Pumping modifications may be proposed based on modeling results and findings of enhanced groundwater extraction pilot study at former Fairchild Building 19 area. | As part of planned remedy optimization, a groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized, and a remedy optimization work plan will be developed for submittal to EPA. |

| Facility/Responsible Party | Proposed Optimization | Status of Work | Comments/Notes from Parties |
|---|---|---|---|
| 644 National Avenue (Former Building 18) | Optimize Pump and Treat | Groundwater model will be used to evaluate alternative extraction scenarios. Pumping modifications may be proposed based on modeling results and findings of enhanced groundwater extraction pilot study at former Fairchild Building 19. | As part of planned remedy optimization, a groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized, and a remedy optimization work plan will be developed for submittal to EPA. |
| **Raytheon:** | | | |
| 350 Ellis Street | None provided | -- | -- |
| **Intel/Raytheon:** | | | |
| 355/365 and 401 East Middlefield Road | In Situ Bioremediation Injections | Completed additional injections of emulsified soybean oil in 2014 and conducted groundwater performance monitoring between 2014 and 2018. Installed four soil gas probes and monitored these probes between 2014 and 2018 to show that methane and VOCs are not a vapor intrusion concern for buildings on properties. | Monitoring and evaluating the enhanced in-situ bioremediation pilot treatability study test. |
| **SMI Holding LLC:** | | | |
| 455, 485/487, and 501/505 East Middlefield Road | In Situ Chemical Reduction (Zero Valent Iron) | Completed injections using sulfidated zero valent iron to promote abiotic TCE degradation | Selected ZVI over ISCO technology as there is less likelihood for the need for multiple injection rounds. Monitoring and evaluating the sulfidated zero valent iron in-situ pilot treatability study test for two years. |
| | Bench-Scale Evaluation of Biogeochemical Transformation and Chemical Oxidation for Destruction of TCE | Aquifer test and bench-scale test results were used to develop a conceptual remedial enhancement plan for discussion with property owner. | |
| **NEC/Renesas:** | | | |
| 501 Ellis Street | Optimize Pump and Treat | The Source Control Groundwater Remediation System was optimized on 2009 in accordance with the 2008 Optimization Evaluation (Geosyntec, 2008; Geosyntec, 2017). The system has been operating in the optimized configuration since 2009. | A Draft Work Plan for Trial Shut Down of Groundwater Extraction System was submitted in 2011 (Geosyntec, 2011) but not implemented due to concerns related to the long-term potential for vapor intrusion. |

| Facility/Responsible Party | Proposed Optimization | Status of Work | Comments/Notes from Parties |
|---|---|---|---|
| **Vishay/SUMCO:** | | | |
| 405/425 National Avenue | Off-Property shared area between 405/425 National and 401 National: Conversion of monitoring well into extraction well. | Off-Property: Well 116A was converted from a monitoring well to an extraction well in 2016-2017. | On-Property: The parties are evaluating the data collection results and results at pilot studies conducted at MEW and developing options for optimization. |
| | On-site: High resolution sampling and optimization plan based on results. | On-Property: A high-resolution sampling data collection program was conducted in 2016, and a report on the results was submitted to EPA in 2017. | |
| **MEW Regional Groundwater Remediation Program:** | | | |
| South of U.S. Highway 101 – MEW Area | Optimize Pump and Treat | Groundwater model will be used to evaluate alternative extraction scenarios. Pumping modifications may be proposed based on modeling results and findings of enhanced groundwater extraction pilot study at former Fairchild Building 19. | As part of planned remedy optimization, a groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized, and a remedy optimization work plan will be developed for submittal to EPA. |
| North of U.S. Highway 101 – Moffett Field Area | Optimize Pump and Treat | Groundwater model will be used to evaluate alternative extraction scenarios. Pumping modifications may be proposed based on modeling results and findings of enhanced groundwater extraction pilot study at former Fairchild Building 19. | As part of planned remedy optimization, a groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized, and a remedy optimization work plan will be developed for submittal to EPA. |
| **NASA:** | | | |
| Northern portion of regional plume area | Identify leading edge | Completed Hydropunch investigation and groundwater sampling of existing monitoring wells to identify leading edge of A2/B1 VOC plume (2015). | Findings and recommendations contained in Revised Technical Memorandum for Summary Findings for the Northernmost A2/B1 Aquifer Plume Definition Assessment (ERT, 2016) |
| NASA Area of Responsibility (NASA Groundwater Treatment System) | Optimize Pump and Treat | On-going field work to support groundwater extraction optimization. | Extraction rates were periodically adjusted following well rehabilitation to expand capture zones and increase mass removal. |

| Facility/Responsible Party | Proposed Optimization | Status of Work | Comments/Notes from Parties |
|---|---|---|---|
| Site 28 West-Side Aquifers Treatment System (WATS) | Optimize Pump and Treat | On-going field work to support groundwater extraction and treatment optimization. | Extraction rates were periodically adjusted following system and well rehabilitation to expand capture zones and increase mass removal. New and replacement source control extraction wells planned in A zone (EA1-4 and EA1-1R) and A2/B1 zone (EA2-4 and EA2-5). |

# Appendix D: ARARs Assessment

Section 121 (d)(2)(A) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) specifies that Superfund remedial actions must meet any Federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). 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 at a CERCLA site. In a five-year review, ARARs are evaluated to determine whether any changes with the ARARs affect the protectiveness of the remedy. Each ARAR for the MEW Site and any change to the applicable standard or criterion are discussed in this section.

The 1989 Record of Decision (ROD) identified chemical-specific ARARs for groundwater contamination and set Site cleanup goals. With the 1990 Explanation of Significant Differences (ESD), EPA changed the cleanup goals to cleanup levels and clarified that the other chemical-specific ARARs also constitute cleanup levels; the April 1996 ESD did not impact chemical-specific ARARs. The 2010 ROD Amendment adopted risk-based cleanup levels for indoor air.

Chemical-specific ARARs identified in 1989 ROD, 1990 ESD, and 2010 ROD Amendment are listed in Table E-1. EPA sets cleanup levels either through ARARs or through risk-based evaluation. EPA selected risk-based cleanup levels in the ROD for groundwater in the deep aquifer, and in the 2010 ROD Amendment for residential and commercial indoor air cleanup levels. The risk-based cleanup levels are evaluated in the Toxicity Assessment (Appendix E).

There have been no changes to the chemical-specific ARARs since the previous Five-Year Review, and because groundwater at the MEW Study is not currently used for domestic purposes, any prior changes to chemical-specific ARARs would not affect the groundwater remedy's short-term protectiveness. The current MCLs for chloroform, 1,2-dichlorobenzene, 1,1-DCA, 1,2-DCE, PCE, antimony, cadmium, and arsenic are more stringent than the cleanup levels set in the Site decision documents. However, because concentrations of chloroform, 1,2-dichlorobenzene, PCE, antimony, cadmium, and arsenic are generally below current MCLs at the Site, these changes do not affect protectiveness. For 1,2-DCE, although the promulgated standards have changed from what was selected in ARARs and current concentrations of 1,2-DCA at the site exceed the current MCL, it is anticipated that 1,2-DCA concentrations will decrease to below the MCL before the remedy has achieved its cleanup level for TCE. Until the cleanup levels are reached, institutional controls prevent direct exposure to groundwater contamination.

Table E-2 describes the action- and location-specific ARARs that have been promulgated or changed since the previous Five-Year Review. No ARARs changes affect the protectiveness of the remedy.

The following state guidances have not changed since being referenced in the 1989 ROD and 2010 ROD Amendment and do not affect protectiveness:

- California Site Mitigation Decision Tree Manual
- California Resolution 68-16 "Antidegradation Policy"

### Table D-1. Summary of Groundwater Chemical-Specific ARARs

| Chemical | 1989 Regulations (µg/L) | | Current Regulations (µg/L) | | Notes |
|---|---|---|---|---|---|
| | Calif. MCL | EPA MCL | Calif. MCL | EPA MCL | |
| Chloroform | -- | 100 | 80[1] | 80[1] | The State and Federal MCLs are now more stringent than the regulations selected at the time of the 1989 ROD. |
| 1,2-Dichlorobenzene | -- | -- | 600 | 600 | State and Federal MCLs have now been established. |
| 1,1-Dichloroethane (1,1-DCA) | -- | -- | 5 | -- | A State MCL has been established. |
| 1,1-Dichloroethene[2] (1,1-DCE) | 6 | 7 | 6 | 7 | No changes. |
| 1,2-Dichloroethene (1,2-DCE) | -- | -- | 6 | 70 | State and Federal MCLs have now been established. |
| Freon-113 | -- | -- | -- | -- | No changes from the time of the 1989. (No MCL selected). |
| Phenol | -- | -- | -- | -- | No changes. |
| Tetrachloroethene (PCE) | -- | -- | 5 | 5 | State and Federal MCLs have now been established. |
| 1,1,1-Trichloroethane | 200 | 200 | 200 | 200 | No changes. |
| Trichloroethene (TCE)[3] | 5 | 5 | 5 | 5 | No changes. |
| Vinyl chloride | 0.5 | 2 | 0.5 | 2 | No changes. |
| Antimony | -- | -- | 6 | 6 | State and Federal MCLs have now been established. |
| Cadmium | 10 | 10 | 5 | 5 | The State and Federal MCLs are now more stringent than the regulations selected at the time of the 1989 ROD. |
| Arsenic | 50 | 50 | 10 | 10 | The State and Federal MCLs are now more stringent than the regulations selected at the time of the 1989 ROD. |
| Lead | 50 | 50 | -- | -- | The State and Federal MCLs have been removed. |

Notes

1. Chloroform is now regulated as part of total trihalomethanes (TTHMs). The Federal and state MCLs for TTHMs are 80 µg/L.

2. DCE exists as *cis*- and *trans*- isomers. The more stringent MCL (*cis*- in this case) is used here.

3. The MCL is the cleanup level for the shallow aquifer. The cleanup level for the deep aquifer is 0.8 µg/L is based on toxicity (excess lifetime cancer risk no greater than $1 \times 10^{-6}$) and is discussed in Appendix E.

**Table D-2. Summary of ARAR Changes for Site Since 1989 ROD and 2010 ROD Amendment**

| Requirement and Citation | Document | Description | Effect on Protectiveness | Comments | Amendment Date |
|---|---|---|---|---|---|
| San Francisco Bay Basin Water Quality Control Plan (Basin Plan) | 1989 ROD | The Basin Plan classifies shallow aquifers in the area as "potentially suitable for municipal or domestic water supply." Standards in the Basin Plan are used by the Regional Water Quality Control Board to set NPDES effluent discharge limitations. | Changes do not affect protectiveness. | No revisions have altered the groundwater classification. | Last updated May 13, 2016 |
| Federal Drinking Water Standards<br><br>Section 1412 of the Safe Drinking Water Act<br>42 U.S.C. Section 300g-l | 1989 ROD | MCLs are ARARs for the Site and were used to establish ground-water cleanup levels. | [No revisions] | | Aug. 6, 1996 |
| State Drinking Water Standards<br><br>22 CCR § 64444 | 1989 ROD | California Drinking Water Standards establish enforceable limits for substances that may affect health or aesthetic qualities of water. | Changes do not affect protectiveness. | Revisions primarily editorial. Recent change added two new chemicals; there were no changes to the list of MEW Site chemicals of concern. | Last updated Dec. 14, 2017 |
| City of Mountain View Industrial Waste Ordinance<br><br>Mountain View City Code, Chapter 35, Article III, Division 3 | 1989 ROD | City of Mountain View requirements for discharges to the sanitary sewer. | [No revisions] | | Last updated Mar. 26, 2013 |

| Requirement and Citation | Document | Description | Effect on Protectiveness | Comments | Amendment Date |
|---|---|---|---|---|---|
| Federal Clean Water Act Pretreatment Standards<br><br>40 CFR 403.5 | 1989 ROD | National pretreatment standards for discharges to the sanitary sewer. | [No revisions] | | Last updated Oct. 14, 2005 |
| Federal Resource Conservation and Recovery Act (RCRA) Subtitle C; 42 USC §6921 et seq, (RCRA Subtitle C)<br><br>40 CFR Part 261 | 1989 ROD | For disposal, spent granular activated carbon would need to be treated to meet Best Demonstrated Available Technology and RCRA Subtitle C disposal. | Changes do not affect protectiveness. | Establishes criteria for identifying hazardous waste subject to Subtitle C treatment, storage, and disposal requirements. | Last updated Aug. 6, 2018 |
| CA Hazardous Waste Control Laws<br><br>California Code of Regulations (CCR), Title 22, Division 4.5, §66250 - §66265.1103 | 1989 ROD | For disposal, spent granular activated carbon would need to be treated to meet Best Demonstrated Available Technology and RCRA Subtitle C disposal. | Changes do not affect protectiveness. | Revisions primarily editorial. | Last updated Aug. 20, 2018 |
| Bay Area Air Quality Management District Regulation 8, Rule 47 | 1989 ROD, 2010 ROD Amendment | State of California requirements for VOC emissions controls for air stripping, soil vapor extraction operations, and sub-slab and sub-membrane depressurization systems. | [No revisions] | | |
| BAAQMD Regulation 8 Rule 40 | 2010 ROD Amendment | Coverage requirements for removal of contaminated soil with organic content above 50 ppm. | [No revisions] | | |

# Appendix E. Toxicity Assessment

EPA's Integrated Risk Information System updates toxicity values used by EPA in risk assessments when newer scientific information becomes available. For the MEW Site, EPA selected risk-based cleanup levels for groundwater in the deep aquifer (EPA, 1989, 1990) and risk-based indoor air cleanup levels for residential and commercial buildings. (EPA, 2010).

Toxicity values set in the 1989 ROD and 2010 ROD Amendment have changed since they were selected. Although TCE's toxicity value has been updated, the cleanup level for deep groundwater set through risk-based analysis is within EPA's health protective risk range.

There have also been changes to toxicity values since the 2010 ROD Amendment for the vapor intrusion pathway. For the residential scenario, current Regional Screening Levels (RSLs) and Risk-Based Threshold Concentrations calculated using current inhalation unit risks and exposure factors from the 2010 ROD Amendment are more stringent than MEW Site indoor air cleanup levels for TCE and 1,1-DCA. For vinyl chloride in the residential scenario, the current RSL is less stringent than the cleanup level, but the RBTC calculated using the current inhalation unit risk (IUR) and exposure factors from the 2010 ROD Amendment is more stringent than the cleanup level. For the commercial scenario, the current RSL and the RBTC calculated using the current IUR and exposure factors from the 2010 ROD Amendment are more stringent than the cleanup level for TCE. However, because the values arrived at using the updated calculations fall within EPA's acceptable risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, as discussed in the National Contingency Plan (NCP, 40 CFR 300.430), the changes do not affect protectiveness.

**Groundwater**

In the 1989 ROD, EPA selected the cleanup level of 0.8 ppb (µg/L) for TCE in the C and Deeper aquifers. This cleanup level was selected to correspond to a $1 \times 10^{-6}$ cumulative lifetime excess cancer risk, for drinking water purposes. The current (May 2019) TCE RSL for tap water is 0.49 µg/L, representing $1 \times 10^{-6}$ cumulative lifetime excess cancer risk. The current lowest TCE RSL for a hazard index of 1, the noncancer child ingestion RSL, is 10 µg/L. The cleanup level of 0.8 µg/L is within the range of these values and is protective.

**Vapor Intrusion**

In the 2010 ROD Amendment, EPA selected risk-based indoor air cleanup levels for residential and commercial buildings (Table F-1). For residential indoor air cleanup levels, EPA adopted RSLs published by EPA Regions 3, 6, and 9 in 2008, and also provided the equation and exposure factors for calculating the cleanup levels (Equation 1). For commercial indoor air cleanup levels, EPA adjusted indoor worker exposure from an 8-hour work day to a 10-hour work day based on public comment, and provided MEW Site-specific indoor air cleanup levels, along with the equation and exposure factors for calculating the cleanup levels (Equation 2).

For residential exposure, the indoor air cleanup level is derived based on the following equation (TCE example is shown):

$RBTC = [TR \times AT] / [IUR \times ET_r \times EF_r \times ED_r]$ (Equation 1)

Where:

RBTC = Target TCE cleanup level concentration of 1 $\mu g/m^3$ derived by EPA for residential settings

TR = Target risk of $1 \times 10^{-6}$ through application of the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) IUR and upper end of risk range through application of draft 2001 EPA IUR.

AT = Cancer averaging time, 70 years expressed in days (25,550 days)

IUR = Inhalation unit risk (per $\mu g/m^3$)

$ET_r$ = Exposure time (residential), 24 / 24 (total hours per 24 hr-day)

$EF_r$ = Exposure frequency (residential), 350 days per year

$ED_r$ = Exposure duration (residential), 30 years

For commercial indoor workers, the cleanup level is derived based on the following equation (TCE example is shown):

$RBTC = [TR \times AT] / [IUR \times ET_w \times EF_w \times ED_w]$ (Equation 2)

Where:

RBTC = Target TCE concentration of 5 $\mu g/m^3$ derived by EPA for commercial settings

TR = Target risk of $1 \times 10^{-6}$ through application of the Cal/EPA IUR and upper end of risk range through application of draft 2001 EPA IUR

AT = Cancer averaging time, 70 years expressed in days (25,550 days)

IUR = Inhalation unit risk (per $\mu g/m^3$)

$ET_w$ = Exposure time (indoor worker), 10 (hour workday)/ 24 (total hours per 24 hr-day)

$EF_w$ = Exposure frequency (indoor worker), 250 days per year

$ED_w$ = Exposure duration (indoor worker), 25 years

For each case, residential and commercial, the 2010 ROD Amendment cleanup levels were compared to current carcinogenic and noncarcinogenic RSLs, which are now published on a national basis (EPA, 2018) and/or California modified RSLs (DTSC Note 3, April 2019). The current IUR for each chemical of concern, if available, was used to re-calculate the cleanup level based on the equation and Site-specific exposure factors provided in the 2010 ROD Amendment. Changes between the cleanup level, the current RSL, and the RBTC calculated using the current IUR and the 2010 ROD Amendment exposure factors are presented in Tables F-2 and F-3.

Changes have been made to RSLs and toxicity values used to determine residential indoor air cleanup levels (Table F-2). With these changes current RBTCs are more stringent than cleanup levels, and those changes have been summarized below. However, all changes fall within EPA's acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$ as set forth in the NCP, so the changes do not affect protectiveness.

- For TCE, the current carcinogenic RSL (0.48 µg/$m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (0.48 µg/$m^3$), are more stringent than the 2010 ROD Amendment cleanup level (1 µg/$m^3$). These changes fall within EPA's acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$, so protectiveness is not affected and is below the noncancer hazard index (2 µg/$m^3$).
- For vinyl chloride, the current carcinogenic RSL (0.009 µg/$m^3$) is more stringent, and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (0.009 µg/$m^3$) is more stringent, than the 2010 ROD Amendment cleanup level (1 µg/$m^3$). These changes fall within EPA's acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$, so protectiveness is not affected (for example, the current RSL would be 17 µg/$m^3$ when calculated with 1 x $10^{-4}$ target risk).
- For 1,1-DCA, the current carcinogenic RSL (1.8 µg/$m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (1.5 µg/$m^3$), are more stringent than the 2010 ROD Amendment cleanup level (2 µg/$m^3$). These changes fall within EPA's acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$ and are below the noncancer screening level of 3500 µg/$m^3$, so protectiveness is not affected. RSLs and toxicity values used to determine commercial indoor air cleanup levels have also changed (Table F-3). Changes that have caused current RBTCs to become more stringent than cleanup levels are summarized below:
- For TCE, the current carcinogenic RSL (3 µg/$m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (2.4 µg/$m^3$), are more stringent than the 2010 ROD Amendment cleanup level (5 µg/$m^3$). These changes fall within EPA's acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$and are below the noncancer hazard index of 8 ug/$m^3$, so protectiveness is not affected.
- For vinyl chloride, the current commercial RSL is 0.16 ug/$m^3$ and the RBTC using the current California IUR and the 2010 ROD Amendment exposure factors is 0.13 ug/$m^3$, which are more stringent than the ROD cleanup level of 2 ug/$m^3$. However, the cleanup level is still within the risk range, so protectiveness is not affected.
- 1,1-DCE, the current noncancer California screening level of 310 ug/$m^3$ is 3 times more stringent than the ROD Amendment clean up level of 700 ug/$m^3$ but still within the uncertainty of the non-cancer determination, so protectiveness is not affected.

### Table E-1. Summary of MEW Site Indoor Air Cleanup Levels

| MEW Site Chemical of Concern | Indoor Air Cleanup Levels ($\mu g/m^3$) | | Notes |
|---|---|---|---|
| | Residential | Commercial | |
| TCE | 1 | 5 | Representing 1 x $10^{-6}$ lifetime target cancer risk through application of the Cal/EPA toxicity factor and a 1 x $10^{-4}$ lifetime target cancer risk through application of draft 2001 EPA toxicity factor. |
| PCE | 0.4 | 2 | Representing 1 x $10^{-6}$ lifetime target cancer risk. |
| *cis*-1,2-DCE | 60 | 210 | Not Available. Based on *trans*-1,2-DCE Non-cancer Hazard Index of 1. |
| *trans*-1,2-DCE | 60 | 210 | Representing Non-cancer Hazard Index of 1. |
| Vinyl chloride | 0.2 | 2 | Representing 1 x $10^{-6}$ lifetime target cancer risk. EPA uses a larger conversion factor from residential to commercial for vinyl chloride because the residential value takes into account child exposure and higher sensitivity earlier in life. |
| 1,1-DCA | 2 | 6 | Representing 1 x $10^{-6}$ lifetime target cancer risk. |
| 1,1-DCE | 210 | 700 | Representing Non-cancer Hazard Index of 1. |

**Table E-2. Summary of Residential Indoor Air Toxicity Changes**

| MEW Site Chemical of Concern | Residential Cleanup Level, 2010 ROD Amendment ($\mu g/m^3$) | Current Carcinogenic Screening Level, TR=1 x $10^{-6}$ ($\mu g/m^3$) | Current Noncarcinogenic Screening Level, THQ=1 ($\mu g/m^3$) | Current IUR $(\mu g/m^3)^{-1}$ | RBTC Calculated using Current IUR and 2010 ROD Amendment Exposure Factors ($\mu g/m^3$) | Notes |
|---|---|---|---|---|---|---|
| TCE | 1 | 0.48 | 2.1 | 4.1 x $10^{-6}$ | 0.5 | The current carcinogenic RSL (0.48 $\mu g/m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (0.59 $\mu g/m^3$), are more stringent than the 2010 ROD Amendment cleanup level (1 $\mu g/m^3$). |
| PCE | 0.4 | 0.5 | 42 | 8.7x $10^{-7}$ | 0.5 | The current carcinogenic RSL (0.46 $\mu g/m^3$), and the RBTC calculated using the current California IUR and 2010 ROD Amendment exposure factors (0.46 $\mu g/m^3$), are less stringent than the 2010 ROD Amendment cleanup level (0.4 $\mu g/m^3$). |
| *cis*-1,2-DCE | 60 | none | 8.3 | none listed | IUR not listed | Based on Cal DTSC Note 3 (less stringent). |
| *trans*-1,2-DCE | 60 | none | none | none listed | IUR not listed | There is no RSL or IUR (less stringent). |
| Vinyl chloride | 0.2 | 0.009 | 100 | 7.8x $10^{-5}$ | 0.009 | The carcinogenic RBTC calculated using the current California IUR and 2010 ROD Amendment exposure factors (0.009 $\mu g/m^3$) is more stringent, than the 2010 ROD Amendment cleanup level (0.2 $\mu g/m^3$). |
| 1,1-DCA | 2 | 1.8 | 830 | 1.6 x $10^{-6}$ | 2 | The current carcinogenic RSL (1.8 $\mu g/m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (1.5 $\mu g/m^3$), are more stringent than the 2010 ROD Amendment cleanup level (2 $\mu g/m^3$). |
| 1,1-DCE | 210 | none | 73 | none listed | IUR not listed | Current noncancer screening level (73 $\mu g/m^3$) based on California reference concentration is 3 times more stringent than the ROD Amendment cleanup level (210 $\mu g/m^3$). |

IUR = inhalation unit risk, RBTC = Risk-Based Threshold Concentration, RSL = Regional Screening Level, THQ = Target Hazard Quotient, TR = Target Risk

### Table E-3. Summary of Commercial Indoor Air Toxicity Changes

| MEW Site Chemical of Concern | Commercial Cleanup Level, 2010 ROD Amendment ($\mu g/m^3$) | Current Carcinogenic Screening Level, TR=1 x $10^{-6}$ ($\mu g/m^3$) | Current Noncarcinogenic Screening Level, THQ=1 ($\mu g/m^3$) | Current IUR $(\mu g/m^3)^{-1}$ | RBTC Calculated using Current IUR and 2010 ROD Amendment Exposure Factors ($\mu g/m^3$) | Notes |
|---|---|---|---|---|---|---|
| TCE | 5 | 3 | 8.8 | 4.1 x $10^{-6}$ | 2.4 | The current carcinogenic RSL (3 $\mu g/m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (2.4 $\mu g/m^3$), are more stringent than the 2010 ROD Amendment cleanup level (5 $\mu g/m^3$). |
| PCE | 2 | 1.6 | 140 | 1 x $10^{-6}$ | 1.6 | The current carcinogenic California screening level (2 $\mu g/m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (1.6 $\mu g/m^3$), are equal to or more stringent than the 2010 ROD Amendment cleanup level (2 $\mu g/m^3$). |
| *cis*-1,2-DCE | 210 | none | 28 | none listed | IUR not listed | Based on the current California RfC and the 2010 ROD Amendment exposure factors (28 ug/m3) is more stringent than the 2010 ROD Amendment level (210 $\mu g/m^3$) . |
| *trans*-1,2-DCE | 210 | none | none | none listed | IUR not listed | There is no current RSL or IUR (less stringent). |
| Vinyl chloride | 2 | 0.13 | 350 | 1.2 x $10^{-5}$ | 0.13 | The current California carcinogenic screening level (0.13 $\mu g/m^3$), and the RBTC calculated using the current California IUR and 2010 ROD Amendment exposure factors (0.13 $\mu g/m^3$), is more stringent than the 2010 ROD Amendment cleanup level (2 $\mu g/m^3$). |
| 1,1-DCA | 6 | 6.1 | 2800 | 1.6 x $10^{-6}$ | 6.1 | The current carcinogenic screening level from California (6.1 $\mu g/m^3$), and the RBTC calculated using the current IUR and 2010 ROD Amendment exposure factors (6.1 $\mu g/m^3$), are equal to 2010 ROD Amendment cleanup level (6 $\mu g/m^3$). |

| MEW Site Chemical of Concern | Commercial Cleanup Level, 2010 ROD Amendment ($\mu g/m^3$) | Current Carcinogenic Screening Level, TR=1 x $10^{-6}$ ($\mu g/m^3$) | Current Noncarcinogenic Screening Level, THQ=1 ($\mu g/m^3$) | Current IUR $(\mu g/m^3)^{-1}$ | RBTC Calculated using Current IUR and 2010 ROD Amendment Exposure Factors ($\mu g/m^3$) | Notes |
|---|---|---|---|---|---|---|
| 1,1-DCE | 700 | none | 245 | none listed | IUR not listed | The current noncarcinogenic California screening level (245 $\mu g/m^3$) is 3 times more stringent than the 2010 ROD Amendment cleanup level (700 $\mu g/m^3$). |

IUR = inhalation unit risk, RBTC = Risk-Based Threshold Concentration, RSL = Regional Screening Level, THQ = Target Hazard Quotient, TR = Target Risk

References:

EPA, 2018. *Regional Screening Levels (RSLs) - Generic Tables.* November. Accessed March 2019: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

DTSC, 2019. *California Department of Toxic Substance Control, Note 3, DTSC-modified Screening Levels, April 2019:* https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/04/HHRA-Note-3-2019-04.pdf

# Appendix F: Press Notice

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## DECLARATION

I am a resident of Los Angeles County, over the age of eighteen years and not a party to or interested in the matter noticed.

The notice, of which the annexed is a printed copy appeared in the:

**MOUNTAIN VIEW VOICE**

On the following dates:

12/28/2018

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated at Los Angeles, California, this

**16th day of January 2019**

Signature

***3205616***
*"The only Public Notice which is justifiable from the standpoint of true economy and the public interest, is that which reaches those who are affected by it"*

* A 0 0 0 0 0 0 4 9 6 2 4 6 7 *

**EPA CONDUCTS FOURTH REVIEW OF CLEANUP ACTIONS AT MIDDLEFIELD-ELLIS-WHISMAN SUPERFUND STUDY AREA**

The U.S. Environmental Protection Agency (EPA) is conducting its Fourth Five-Year Review of the cleanup actions completed at the Middlefield-Ellis-Whisman Study Superfund Area in Mountain View and Moffett Field, CA.

This review covers the groundwater, soil, and vapor intrusion remedies at the MEW Superfund Area. The MEW Superfund Area is comprised of three Superfund sites: the Fairchild Semiconductor Corp. – Mountain View site; the Raytheon Company site; and the Intel Corp. – Mountain View site; several other facilities; and portions of the former Naval Air Station (NAS) Moffett Field Superfund site. The "MEW Superfund Study Area" itself is not listed on the National Priorities List (NPL).

For sites like the MEW Superfund Area that will take more than five years to clean up, the Superfund law requires that the cleanup progress will be reviewed every five years. The protectiveness statement in the last Five-Year Review in 2014 for the MEW Superfund Area determined that the remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risk. Cleanup remedies in place are currently protective of human health and the environment. Several recommendations and follow-up actions were made to ensure long-term protectiveness that will be assessed as part of this Five-Year Review.

Information about the MEW Superfund Area is available at EPA's webpage at www.epa.gov/superfund/mew-study-area. The EPA Superfund Records Center, 75 Hawthorne Street, 3rd Floor in San Francisco, CA, contains the MEW Site's Administrative Records and other reference material. The repository's office hours are: 8:00 a.m. - 5:00 p.m, Monday-Friday and can be reached at (415) 947-8717 or R9records@epa.gov.

If you would like to provide input as part of the Five-Year Review process, contact Jackie Lane, Community Involvement Coordinator by March 30, 2019. EPA plans to complete the Fourth Five-Year Review in September 2019, and the final report will be available on EPA's web site and at the information repository noted above.

CNS-3205616#

# Appendix G: Five-Year Review Interview Records

| EPA Five-Year Review Interview Record | | | |
|---|---|---|---|
| **Site** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area<br>Mountain View, California | | |
| **Facility** | Raytheon Company Superfund Site | **EPA ID No:** | CAD09598778 |

Interview Type: Written Response to Questionnaire

Date: 25 March 2019

**Interviewers**

| Name | Title | Organization |
|---|---|---|
| Alana Lee | Project Manager | EPA |
| | | |

**Interviewees**

| Name | Organization | Title | Telephone | Email |
|---|---|---|---|---|
| Bob Luhrs | Raytheon Company | Senior Manager, Corporate EHS | (978) 858-9423 | Robert_C_Luhrs@raytheon.com |
| Elie Haddad | Haley & Aldrich, Inc. | Principal | (408) 961-4806 | EHaddad@haleyaldrich.com |
| Jennifer Boyer | Haley & Aldrich, Inc. | Senior Project Manager | (408) 961-4808 | JBoyer@haleyaldrich.com |
| | | | | |

**Five-Year Review Questions (2014-2019)**

1) What is your overall impression of the project?

The groundwater remedy maintains proper capture of the plume and inward and upward gradients, and the vapor intrusion mitigation measures maintain indoor air contaminant of concern concentrations below their respective commercial indoor air cleanup levels in EPA's 16 August 2010 "Record of Decision Amendment for the Vapor Intrusion Pathway, Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, California."

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

Horizontal gradients across most sides of the slurry wall were generally inward during the review period with the exception of the northern slurry wall. However, these gradients do not have a significant impact on remediation because: 1) Raytheon installed two recovery wells in the "A" and "B1" Zones immediately downgradient of the slurry wall, and the two wells provide a proper capture of this area, and 2) the slurry wall is a low-permeability wall that allows only minimal chemical migration across its walls even if the gradient is outward. That, combined with the fact that chemicals tend to take the easier pathway and migrate toward recovery wells within the wall enclosure, rather than across the low-permeability wall, would minimize outward chemical migration. Therefore, the slurry wall and the pumping activities within its enclosure physically contain chemicals. If a small flux of chemicals migrates through the slurry wall, it is captured immediately downgradient of the wall.

The sub-slab depressurization system maintains appropriate pressure differential at every pressure monitoring point with minimal downtime. Indoor air contaminant of concern concentrations is below their respective ROD commercial indoor air cleanup levels.

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

Capture zone analysis during the review period indicates containment of the target capture areas. The plume is not expanding, and the capture is appropriate. Concentrations have decreased significantly since remedial measures began. Confirmation indoor air samples collected with the HVAC system on and off after the startup of the sub-slab depressurization system showed contaminant of concern concentrations below the commercial indoor air cleanup level in

EPA's 16 August 2010 "Record of Decision Amendment for the Vapor Intrusion Pathway, Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, California."

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

There is no need for a continuous OMMM presence on site. Trained system operators visit the site as needed for OMMM of the groundwater extraction and treatment system (weekly), sub-slab depressurization system equipment (quarterly), sub-slab depressurization system moisture traps (every two weeks to monthly), and air purification units (quarterly). Telemetry units continuously monitor the groundwater extraction and treatment system and the sub-slab depressurization system operations and issue alarms to system operators under certain conditions, including if the systems shut down.

5) Have there been any significant changes in the OMMM 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.

Groundwater well sampling frequency was modified from annual to biennial with EPA's approval. Groundwater level monitoring continues to be performed annually, with a subset of Raytheon site-specific wells monitored on a quarterly basis. The change in monitoring requirement does not affect the protectiveness of the remedy.
Routine OMMM of the sub-slab depressurization system began in 2015 after the passive sub-slab ventilation system was activated (i.e., converted to a sub-slab depressurization system).

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.

There have been no significant unexpected OMMM difficulties or costs within the last five years.

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

Groundwater well sampling frequency was modified from annual to biennial with EPA approval. This modification provided a 50 percent reduction in groundwater sampling labor and analytical costs without affecting the protection of the remedy.

8) Have there been any modifications to the remedy in the last five years? If so, please give details.

One 1,000-pound granular activated carbon vessel was added to the groundwater treatment process in October 2016. There were no other changes to the groundwater remedy in the last five years.
The passive sub-slab ventilation system was activated (i.e., converted to a sub-slab depressurization system) in 2015. This included installation of four vapor treatment systems enclosed in sound-proof cabinets.

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.

| EPA Five-Year Review Interview Record | | | |
|---|---|---|---|
| **Site**<br><br>**Facility** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View, CA<br><br>Former Intel Facility – 355/365 E. Middlefield Road and 401 E. Middlefield Road (Intel-Raytheon shared Lot 4) | **EPA ID No:** | N/A |

Interview Type: Written Response to Questionnaire

Date: 3/19/2019

**Interviewers**

| Name | Title | Organization |
|---|---|---|
| Alana Lee | Project Manager | EPA |
| | | |

**Interviewees**

| Name | Organization | Title | Telephone | Email |
|---|---|---|---|---|
| | | | | |
| | | | | |

**Five-Year Review Questions (2014-2019)**

1) What is your overall impression of the project?
*The enhanced reductive dechlorination pilot test has generally proceeded as predicted and has been very reliable. Monitoring results suggest that reductive dechlorination is a more effective method for remediating TCE and its daughter compounds and for containing the VOCs onsite than the pump-and-treat remedy had been during its last years of operation.*

2) Is the remedy functioning as expected? How well is the remedy performing?
*The remedy specified in the Record of Decision (ROD) is groundwater extraction and above-ground treatment, with discharge of the treated groundwater to surface water. However, this system has become less effective at VOC mass removal and plume concentration reduction over the years, so other remedial technologies have been evaluated and the most promising, in-situ bioremediation, is being tested. In order to enhance already active dehalorespiring microorganisms in isolated groundwater hot spots at the site, an enhanced in-situ bioremediation pilot test was implemented in August 2005 and July 2006. Emulsified oil was injected into the subsurface as an electron donor to promote reductive dechlorination. Additional electron donor was injected at the site in July 2009, May 2010, and May 2014. The three site groundwater extraction wells (PW-2A, PW-3A, and PW-4B1) were shut off and have remained off since August 28, 2005.*
*Yes, the remedy is functioning as expected. VOC plume sizes and VOC concentrations are decreasing as a result of the enhanced in-situ bioremediation pilot test. See isoconcentration contour maps, VOC data and VOC concentration trends (2017 Annual Report).*
*Based on monitoring results and calculations, VOC mass removal and mass flux reduction has been at least as robust under in-situ bioremediation as it was under the groundwater extraction and treatment system operation. TCE concentrations have been significantly reduced in most monitored wells within the enhanced bioremediation zones, at rates significantly exceeding reductions under pump-and-treat. In addition to being at least as effective as groundwater extraction and treatment system for both plume reduction and containment, in-situ bioremediation is significantly more cost and resource efficient than the groundwater extraction and treatment system.*

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?
*Refer to the 2017 Annual Report of Weiss submittals, which indicate contaminant level decreases.*

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.
*Charles Crocker is the Field Operations Supervisor for Weiss Associates, working out of Weiss' local office at 453 Ravendale Drive, Suite E, Mountain View. Although the treatment system has been shut off since August 2005, the system is inspected on a quarterly basis.*

5) Have there been any significant changes in the OMMM 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 OMMM requirements and maintenance schedules in the last five years. With EPA approval, on a trial basis, groundwater sampling was reduced from annual to biennial starting in 2015 and*

*water level measurement was reduced from semi-annual to annual starting in 2016. Comparison of annual and biennial VOC concentration trends (2015 Annual Report) showed that biennial groundwater sampling is sufficient to identify long-term VOC concentration trends. Therefore, no groundwater sampling was conducted in 2015 and 2017, and water levels were measured only once per year in 2016 and 2018 (water levels were measured semi-annually in 2017 at EPA's request due to higher-than-normal rainfall). These monitoring frequency changes do not affect protectiveness of the remedy.*

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.
*No.*

7) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
*The remedy was optimized by implementing the in-situ bioremediation project.*
*An efficiency evaluation, comparing the annual O&M costs of the groundwater extraction and treatment system against the annual O&M costs of the in-situ bioremediation project was included in the 2008 Optimization Report. The cost efficiency evaluation showed that the VOC removal cost is over 70% less than that for the groundwater extraction and treatment system at the end (2001 through 2004) of its operation. Also, the in-situ bioremediation project is more resource efficient than operating the groundwater extraction and treatment system. Operation of the groundwater extraction and treatment system required an estimated 30,000 to 73,000 kW hrs/year, while in-situ bioremediation requires only an estimated 200 kW hrs/year. Additionally, the groundwater extraction and treatment system generated an average of 2.9 Mgal of ground water annually during its last three years of operation, while only approximately 50-100 gallons are generated annually under in-situ bioremediation (monitoring well purge water).*
*A more detailed evaluation is included in the 2008 Optimization Report.*
*As described under #5, the monitoring schedule was optimized to reduce costs without impacting protectiveness, with an estimated annual cost savings of approximately $15,000.*

8) Have there been any modifications to the remedy in the last five years? If so, please give details.
*No modifications have been made to the remedy in the last five years, other than the monitoring reductions described under #5. No changes to the vapor intrusion remedy have been made in the past five years.*

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?
*Monitoring results of the in-situ bioremediation project have shown that reductive dechlorination is an effective method for remediating TCE and its daughter compounds at the site and for containing the VOCs onsite.*

## EPA Five-Year Review Interview Record

| | | | |
|---|---|---|---|
| **Site** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View, CA | | |
| **Facility** | 405 National Avenue (Vishay/SUMCO) | **EPA ID No:** | |

Interview Type: Written Response to Questionnaire

Date: 3/19/2019

**Interviewers**

| Name | Title | Organization |
|---|---|---|
| Alana Lee | Project Manager | EPA |
| | | |

**Interviewees**

| Name | Organization | Title | Telephone | Email |
|---|---|---|---|---|
| Luis Muñoz | Vishay Intertechnology | Director – IEHS The Americas | 610-407-4897 | luis.munoz@vishay.com |
| | | | | |

**Five-Year Review Questions (2014-2019)**

1) What is your overall impression of the project?

*The groundwater extraction and treatment system is achieving contaminant mass removal. Multiple lines of evidence indicate that the extents of hydraulic containment provided by on-site and off-site groundwater extraction meet the target capture zones. Results of the 2016 data collection program are being used to evaluate remedial options to accelerate contaminant mass removal. It is expected that the groundwater extraction and treatment system will continue to operate in conformance with the design parameters outlined in the final remedy and as required by its operating permits.*

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

*The remedy is functioning as expected and, as noted, is accomplishing contaminant mass removal. Multiple lines of evidence indicate that the extents of hydraulic containment provided by on-property and off-property groundwater extraction meet the target capture zones.*

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

*Project monitoring includes the following: (1) monthly system sampling associated with the NPDES permit; (2) semiannual water level monitoring under the Regional Groundwater Remediation Program (RGRP); and (3) biennial groundwater monitoring under the RGRP. Contaminant concentrations in site extraction wells and monitoring wells show stable or decreasing trends over the last 10 years of monitoring (2008-2018).*

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

*There is 24/7 remote monitoring of the groundwater extraction and treatment system with an in-person weekly inspection and immediate troubleshooting and maintenance, as necessary.*

5) Have there been any significant changes in the OMMM 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.

*From December 2015 to February 2016, the groundwater extraction and treatment system used to treat groundwater associated with the former 405 National Avenue facility was relocated to accommodate redevelopment in the area. Through the end of 2015, the groundwater extraction and treatment system consisted of pretreatment by an ultraviolet light-hydrogen peroxide oxidation (UVOx) unit followed by final treatment through a shallow tray air stripper. Concurrent with the groundwater extraction and treatment system relocation, the UVOx unit was replaced with a HiPOx system, and the air stripper was retained for final treatment. In addition, well 116A was converted to an extraction well in 2016. These changes to the groundwater extraction and treatment system and extraction well network enhanced mass removal and system operations.*

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.

*There have not been any significant OMMM issues related to the groundwater extraction and treatment system in the last five years (other than the noted relocation and treatment system improvements noted above).*

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

*The early 2016 improvements noted above enhanced mass removal and system operations.*

8) Have there been any modifications to the remedy in the last five years? If so, please give details.

*As noted, the groundwater extraction and treatment system was re-located and improved in 2016 (see #5 above).*

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

*We expect the remedy to continue to be protective.*

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

*Not at this time*.

| EPA Five-Year Review Interview Record | | | |
|---|---|---|---|
| **Site**<br><br>**Facility** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, CA<br><br>NASA Ames Groundwater Area | **EPA ID No:** | |

Interview Type: Written Response to Questionnaire

Date: 3/25/2019

**Interviewers**

| **Name:** Alana Lee | **Title:** Project Manager | **Organization:** EPA |
|---|---|---|
| | | |

**Interviewees**

| **Name** | **Organization** | **Title** | **Telephone** | **Email** |
|---|---|---|---|---|
| Garrett Michael Turner | NASA | Restoration Program Manager | 650-604-1406 | garrett.michael.turner@nasa.gov |
| Ingrid Warburg | ERT | Scientist III | 650-604-1129 | ingrid.j.dittmar@nasa.gov |
| Dan Ducasse | Locus | Project Manager | 408-640-8174 | ducassed@locustec.com |
| Joseph Lukas | ERT | Project Manager | 650-604-2057 | joseph.r.lukas@nasa.gov |

**Five-Year Review Questions (2014-2019)**

1) What is your overall impression of the project?
Reasonably effective at containing site contamination, however, excessive costs to remove minor amount of product.

2) Is the remedy functioning as expected? How well is the remedy performing?
Yes. Performing as designed and installed.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?
Data indicates capture of contamination. Trends tend to show decreasing levels except in the former Navy Bldg. 88 and Traffic Island groundwater contamination areas.

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.
Yes, the NASA groundwater extraction and treatment system has a continuous OMMM presence. Daily and weekly system checks are completed via desktop PC access. Monthly and annual OMMM inspections are also completed and documented and retained onsite.

5) Have there been any significant changes in the OMMM 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.
Recent Water Board NPDES discharge permit changes to sampling frequency and chemical analysis have increased the protectiveness of the current remedy.

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.
There were two unexpected events in the last five years. 1st was the replacement of the NASA 1-A extraction well pump and motor. 2nd was the replacement of the system SCADA computer. As reported in the quarterly NPDES permit reports, the system was off for only a few hours during each event,

7) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
Optimization of the flow rate of extraction well NASA 1-A to ensure best groundwater capture was the only such event.

8) Have there been any modifications to the remedy in the last five years? If so, please give details.
No. There have been no modifications in the last five years.

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

| |
|---|
| As indicated in the response to Question #5, changes to the NPDES discharge permit has only improved the protectiveness of the remedy.<br><br>10) Do you have any comments, suggestions, or recommendations regarding the project?<br>Considering the project timeframe for site cleanup, recommend revising the site action levels. |
| |

## EPA Five-Year Review Interview Record

| | | | |
|---|---|---|---|
| **Site** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, CA | | |
| **Facility** | Navy Site 28 – West- Side Aquifers Treatment System Area | **EPA ID No:** | |

Interview Type: Written Response to Questionnaire

Date: 3/25/2019

**Interviewers**

| | | |
|---|---|---|
| **Name:** Alana Lee | **Title:** Project Manager | **Organization:** EPA |
| | | |

**Interviewees**

| Name | Organization | Title | Telephone | Email |
|---|---|---|---|---|
| Garrett Michael Turner | NASA | Restoration Program Manager | 650-604-1406 | garrett.michael.turner@nasa.gov |
| Jeffery Linder | ERT | Scientist IV | 650 604-4294 | jeffery.l.linder@nasa.gov |
| Dan Ducasse | Locus | Project Manager | 408 640-8174 | ducassed@locustec.com |
| Joseph Lukas | ERT | Project Manager | 650-604-2057 | joseph.r.lukas@nasa.gov |

**Five-Year Review Questions (2014-2019)**

1) What is your overall impression of the project?
Reasonably effective at containing site contamination, however, excessive costs to remove minor amount of product.

2) Is the remedy functioning as expected? How well is the remedy performing?
Yes. Performing as designed and installed.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?
Data indicates capture of contamination. Trends tend to show decreasing levels except in the Bldg. 88 and Traffic Island areas.

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.
Since November 2016, there is a continuous OMMM presence. Daily, weekly, monthly and annual OMMM inspections are completed, and documented and retained onsite.

5) Have there been any significant changes in the OMMM 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.
Recent Water Board NPDES discharge permit changes to sampling frequency and chemical analysis have increased the protectiveness of the current remedy.

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.
WATS was offline for several months in late 2016 (non-functional equipment replacements) and late 2018 to early 2019 (AOP tank repairs pending).Groundwater depth-to-water (DTW) and chemical analysis completed during these shutdowns did not indicate a change in groundwater gradients nor an increase in contaminant concentrations during either of these system shutdown periods.

7) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
Optimization of the number of wells utilized for the DTW measurements was proposed, however, EPA requested more information than was feasible to provide. This optimization was based on an evaluation of all existing wells currently utilized for DTW such that closely spaced wells were selectively omitted as redundant for DTW measurements. The reduced DTW data sets as compared to full DTW data sets did not reduce the accuracy of the potentiometric surface maps or capture zones. This DTW well reduction would continue to provide an accurate representation of the site potentiometric surfaces while at the same time reduce the cost of the DTW measurements.

8) Have there been any modifications to the remedy in the last five years? If so, please give details.

Minor modifications, such as removal of non-utilized equipment and changing piping runs, have occurred in the last five years. Other activities that have occurred include equipment repairs/replacements in kind plus system SCADA control and monitoring component upgrades.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?
As indicated in the response to Question #5, changes to the NPDES discharge permit has only improved the protectiveness of the remedy.

10) Do you have any comments, suggestions, or recommendations regarding the project?
Considering the project timeframe for Site cleanup, recommend revising the Site action levels.

## EPA Five-Year Review Interview Record

| | | |
|---|---|---|
| **Site** | Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, CA | **EPA ID No:** CAR000164228 (Treatment System 19) CAR000104695 (Consolidated South 101 Treatment System) CAR000164293 (North 101 Treatment System |
| **Facility** | MEW Regional Program and Fairchild/Schlumberger Facility-specific Work | |

Interview Type: Written Response to Questionnaire
Date: 3/29/2019

**Interviewers**

| | | |
|---|---|---|
| **Name:** Alana Lee | **Title:** Project Manager | **Organization:** EPA |
| | | |

**Interviewees**

| Name | Organization | Title | Telephone | Email |
|---|---|---|---|---|
| Lea Kane | Geosyntec | Senior Geologist | 510-285-2786 | Lkane@geosyntec.com |
| Eric Suchomel | Geosyntec | Principal | 510-285-2786 | esuchomel@geosyntec.com |
| | | | | |
| | | | | |

**Five-Year Review Questions (2014-2018)**

1) What is your overall impression of the project?

*The project is going well. Progress toward the Remedial Action Objectives (RAOs) continued between 2014 and 2018.*

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

*Yes, the MEW Regional Groundwater Remediation Program (RGRP) and Fairchild facility-specific groundwater remedies are performing as intended. The objectives of the remedy are to control and reduce concentrations of volatile organic compounds (VOCs) in groundwater. Groundwater elevations and gradients, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the Fairchild source control recovery wells (SCRWs) and RGRP regional recovery wells (RRWs) are achieving adequate horizontal and vertical capture. In addition, VOC concentrations are decreasing over time, indicating the remedy is effectively removing VOC mass.*

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

*With a few exceptions, VOC concentrations in groundwater are well below historical maximums and generally show long-term decreasing trends. On average, concentrations within the regional trichloroethene (TCE) plume have decreased by an order of magnitude or more since remedy implementation and the perimeter extent of TCE concentrations has largely stabilized.*

4) Is there a continuous Operations, Maintenance, Monitoring, Management (OMMM) presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

*The contractor responsible for OMMM is located within one mile of the site. Contractor staff routinely inspect and/or remotely monitor the remedy to verify operation. When needed, scheduled and unscheduled maintenance is performed promptly, and system downtime is minimal.*

5) Have there been any significant changes in the OMMM 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.

*The following modifications have been made to the monitoring programs:*
- *A permanent reduction in gauging frequency from semi-annual to annual;*
- *A permanent reduction in slurry wall well pair gauging frequency from quarterly to annually;*
- *A permanent reduction in sampling frequency from annual to biennial (occurring in even numbered years); and*
- *Discontinuation of the MEW Study Area settlement survey (previously conducted biennially).*

*The impacts of monitoring changes were evaluated as part of the 2016 Annual Progress Reports for the Regional and Fairchild Groundwater Remediation Programs (submitted to EPA in April 2017) and the 2017 Gauging Reduction Request (submitted to*

*EPA in February 2017). The evaluation concluded that the above frequency was sufficient to monitor performance of the remedy with respect to achieving RAOs.*

*During subsequent communications between EPA and Geosyntec in 2017, EPA indicated that a letter would be forthcoming approving a permanent reduction in groundwater gauging and monitoring frequency, with the caveat that wells associated with pilot study monitoring, optimization monitoring, or other non-routine activities would not be affected by the change. Geosyntec transmitted the details of these discussions in an email to the MEW PRPs on 12 September 2017.*

6) Have there been unexpected OMMM difficulties or costs at the site/facility in the last five years? If so, please give details.

*None.*

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

*See response to question 5.*

*EPA has requested that the MEW parties work to optimize performance of the groundwater remedy with respect to mass removal. Optimization performance with respect to mass removal is being evaluated at the following sites:*
*• Former Fairchild Building 9 site – Optimization began in 2013 and includes an ongoing in-situ chemical oxidation (ISCO) pilot treatability study which began in 2015. Activities performed as part of the ISCO pilot study are summarized each year in the Annual Progress Report for the MEW Study Area.*

*• Former Fairchild Building 19 area – A pilot study work plan for enhanced groundwater extraction was submitted to EPA on 30 June 2015. Schlumberger has elected to proactively move forward with the proposed optimization scope of work. Activities performed as part of the enhanced groundwater extraction pilot study are summarized each year in the Annual Progress Report for the MEW Study Area.*
*• RGRP – As part of planned remedy optimization, a regional groundwater flow model was developed in 2014 and transmitted to EPA for review. Once EPA comments are received, the groundwater model will be finalized and remedy optimization work plan for the RGRP will be developed for submittal to EPA.*

*On 31 October 2017, a letter titled Proposed Well Deconstructions was submitted to the EPA. The letter requested EPA approval to destroy 10 redundant monitoring wells no longer needed to evaluate site conditions. In January 2018, EPA verbally requested additional information prior to approving the request. A table was transmitted to EPA via email on 29 January 2018 providing the requested information. EPA has not approved the well destruction request to date.*

8) Have there been any modifications to the remedy in the last five years? If so, please give details.

*In 2015, upgrades were made to the RGRP South of 101 treatment system and the piping networks for former Systems 1 and System 3 were realigned such that groundwater from those networks now discharges to the RGRP South of 101 system for aboveground treatment and discharge. The work was completed for the following reasons:*
*• Consolidation of treatment represented an opportunity for significant streamlining of project OMMM;*
*• The RGRP South of 101 system is significantly newer than former Systems 1 and 3; and*
*• There are fewer access and space limitations at the RGRP South of 101 system, allowing for capital improvements and other maintenance upgrades at that system that could not be implemented at Systems 1 and 3.*

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?

*None at this time.*

# Appendix H: Site Inspection and Photographs

Trip Report
Middlefield-Ellis-Whisman (MEW) Superfund Study Area Site
Mountain View and Moffett Field, California

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1. INTRODUCTION

a. Date of Visit: March 12, 2019

b. Location: Mountain View and Moffett Field, California

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

2. SUMMARY

A site inspection for the Five-Year Review for the MEW Superfund Study Area (Site) was conducted on March 12, 2019. Participants from the EPA Five-Year Review Site Inspection team (EPA, USACE, and EA), proceeded to visit each of the groundwater extraction and treatment facilities and facility groundwater extraction and treatment system. y-specific properties, and met with representatives of the MEW Companies, Navy, and NASA. The weather was sunny and clear with a light breeze, and cool (temperature approximately 61º F).

The MEW Site is located in Mountain View and Moffett Field, California, and is comprised of multiple sites including: Fairchild Semiconductor Corp. – Mountain View Superfund site; Raytheon Company Superfund site; and Intel Corp. – Mountain View Superfund site; several other facilities, and portions of the Naval Air Station Moffett Field Superfund site. The MEW Site is a heavily populated, light-industrial, commercial, and residential area. Remediation is currently being conducted on site, consisting of groundwater extraction and treatment systems, slurry walls, monitoring, vapor intrusion control systems, and institutional controls. The EPA Five-Year Review site inspection team conducted a site visit and inspected the groundwater treatment system facilities with the representatives of each of the individual parties responsible for the operations, maintenance, and monitoring of the groundwater and vapor intrusion remedies at the MEW Site.

3. DISCUSSION

EPA's Five-Year Review site inspection team: Alana Lee, EPA Superfund Project Manager, Ben McKenna, USACE, and Laura Levine, EA Engineering, Science and Technology, Inc.

08:30 am: The EPA Five-Year Review team met at 501 Ellis Street with Geosyntec Consultants staff to inspect the NEC Electronics/Renesas groundwater extraction and treatment system and discuss the associated extraction wells, conveyance piping, and monitoring wells.

09:05 am: The EPA Five-Year Review team met with PES Environmental Inc staff and representatives of Symantec (property owner) at 455, 485/487 East Middlefield Road to inspect the SMI groundwater extraction and treatment system, discuss the associated extraction wells, conveyance piping, and monitoring wells, and planned upcoming groundwater activities.

After conducting the system inspection, the EPA Five-Year Review team walked to the adjacent former Intel facility at 365 East Middlefield Road. Intel representatives were not available for the site visit. EPA provided an overview

of the remediation activities. The groundwater extraction and treatment system has been shut down since 2005 while the in-situ enhanced bioremediation pilot treatability test is ongoing and being monitored. The property is planned for residential redevelopment.

10:00 am: The EPA Five-Year Review team met with WSP USA and Geosyntec Consultants to inspect the Vishay/SUMCO/Schlumberger shared groundwater treatment system (HiPox oxidation and granular activated carbon) and 405/425 National and 401/600 National facility-specific work The groundwater treatment system compound also houses carbon treatment system that for the active sub-slab depressurization for the office building at 620 National Avenue, which was unoccupied at the time of the site visit. A newly constructed above-ground parking structure is located at the former 401 National Avenue (now 600 National Avenue) property. The ongoing in-situ chemical oxidation (ISCO) pilot treatability study area was inspected. The groundwater pumping has ceased during the pilot study.

11:00 am: The EPA Five-Year Review team next traveled to inspect the Schlumberger and Regional Groundwater Remediation Program – South of 101 treatment system located in the parking area of 331 Fairchild Drive (formerly 644 National Avenue). The EPA Five-Year Review team met with Geosyntec Consultants and Weiss Associates and proceeded to inspect the South of 101 Regional Treatment system Fairchild/Schlumberger treatment system (Treatment System 19) located at 399 North Whisman Road
and the associated extraction wells, conveyance piping, and monitoring wells.

The EPA Five-Year Review team next traveled to the 277 Fairchild Drive, 228/236 Evandale Avenue redevelopment property. The EPA Five-Year Review team observed the wells that have been preserved during the redevelopment, as well as the installation of the vapor barrier for the vapor intrusion control system being utilized beneath the slab foundation of the new residential buildings.

12 noon: The EPA Five-Year Review team traveled to inspect the MEW Regional Groundwater Remediation Program treatment system – North of 101 located on the corner of Wescoat Road and McCord Ave on Moffett Field. EPA Five-Year Review team were met on site by Geosyntec Consultants and Weiss Associates and proceeded to inspect the North 101 Treatment system on site and the associated extraction wells, conveyance piping, and monitoring wells. This concluded the site visits for the Fairchild/Regional Groundwater Remediation Program sites.

1:15 pm: The EPA Five-Year Review team next traveled to the NASA Ames Research Center to inspect the West-Side Aquifers Treatment System (WATS) located within the Navy Site 28 Area, west of Hangar 1 on Cummins Avenue. EPA Five-Year Review team were met by NASA and Navy representatives and Earth Resources Technology, Inc. (ERT), and proceeded to inspect the treatment system (WATS) and the associated extraction wells, conveyance piping, and monitoring wells. The system was not in operation at the time of inspection due to damage sustained to one of the oxidation tanks and the connecting off-gassing header pipe.

The EPA Five-Year Review team next walked to the Navy Former Building 88/Traffic Island Area located at the intersection of Cummins Avenue and Wescoat Road. This location is located downgradient from a former Building 88 dry cleaning facility.

The EPA Five-Year Review team next observed was the phytoremediation treatability test area located near the baseball fields on the southern border of Moffett Field has is being studied since 2015. Endophyte-assisted hybrid poplar trees have been to evaluate the effectiveness of this phytoremediation technology to remediate the regional TCE concentrations in shallow A zone groundwater. TCE groundwater concentrations from the upgradient groundwater monitoring well is reported at 300 micrograms per liter (µg/L), and TCE has not been detected (below laboratory reporting limit of 0.5 µg/L) in the monitoring well immediately downgradient of the poplar trees are reporting non-detectable levels of TCE.

The EPA Five-Year Review team next traveled to the NASA Ames groundwater treatments system located at the corner of North Warehouse Road and H Lane. EPA Five-Year Review team was escorted by NASA representatives and ERT and inspected the NASA Ames groundwater extraction and treatment system and the associated extraction wells, conveyance piping, and monitoring wells.

3:30 pm: The EPA Five-Year Review team next inspected the Raytheon groundwater extraction and treatment system at 350 Ellis Street. The EPA Five-Year Review team were met by Haley & Aldrich consultants to Raytheon and proceeded to inspect the HiPOx Oxidation and carbon system located on the southwest corner of the property and the associated extraction wells, conveyance piping, and monitoring wells. The EPA Five-Year Review team inspected one of the carbon treatment units of the building vapor intrusion control systems.

Lastly, the EPA Five-Year Review team inspected the treatment system of the vapor intrusion control system for the office building at 440 East Middlefield Road.

## 4. ACTIONS

Information obtained during the site inspection visit will be incorporated into the Five-Year Review report.

| | |
|---|---|
|  |  |
| NEC/Renesas Groundwater Extraction and Treatment System Granular Activated Carbon Vessel & Manifold | SMI Groundwater Extraction and Treatment System, Granular Activated Carbon Units, Manifold & Filtration |


Vishay/SUMCO/Schlumberger – Groundwater Treatment System - Granular Activated Carbon Advanced Oxidation Process Oxygen Generator Unit

MEW Regional Program - Vapor Intrusion Control System Control Panel

MEW Regional Groundwater Remediation Program - South of 101 Treatment System

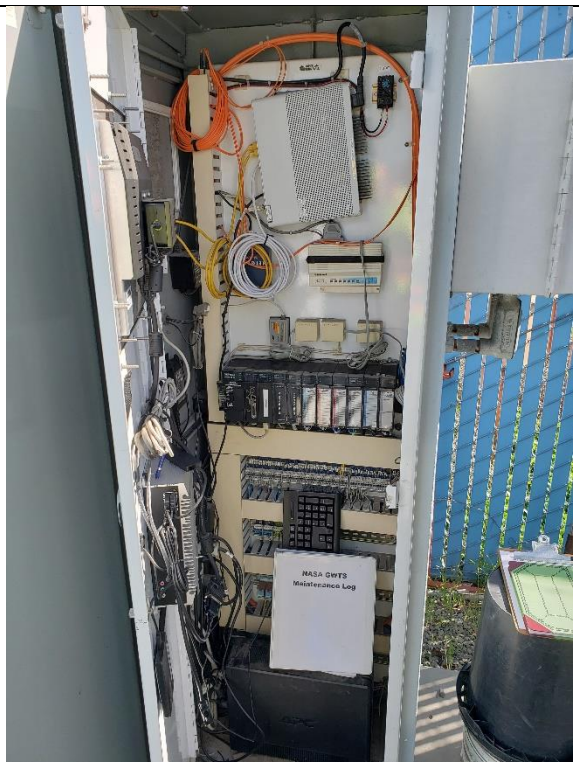

Fairchild/Schlumberger System 19 Treatment System

Residential Redevelopment - Installation of Vapor Barrier and Sub-slab Vapor Intrusion Control System

MEW Regional Groundwater Remediation Program - North of 101 Treatment System


Navy Site 28 WATS Ozone Generator & Oxidation Tanks

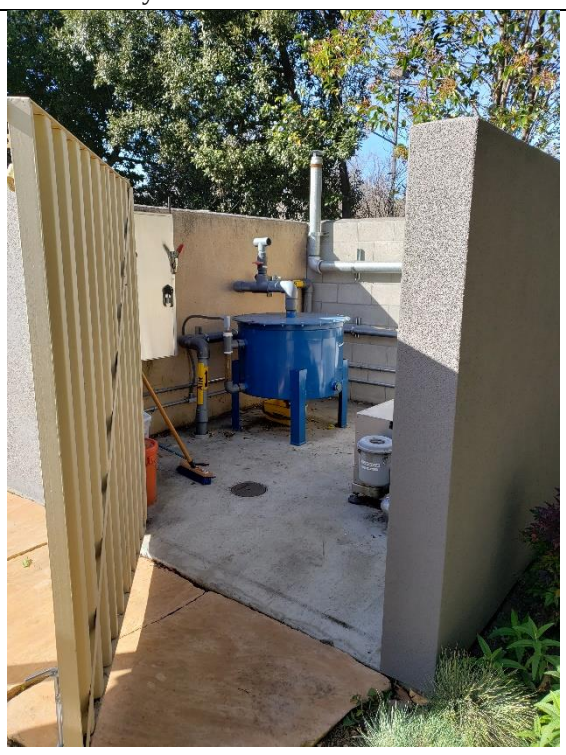
Navy Site 28 - Traffic Island Area (Hangar One in background)

| | |
|---|---|
|  |  |
| NASA Phytoremediation Treatability Study Test Area | NASA Ames Groundwater Extraction and Treatment System Control Panel |


Groundwater Treatment System-HiPOX System Oxygen Tanks - Raytheon 350 Ellis Street


Vapor Intrusion Control System Carbon Treatment Unit – Raytheon – 350-380 Ellis Street


Building Vapor Intrusion Control System Influent Sample Port Raytheon 350 -380 Ellis Street



Vapor Intrusion Control System Carbon Treatment Unit – MEW Regional Program - 440 East Middlefield Rd