FIVE-YEAR REVIEW REPORT

Fourth Five-Year Review Report

For

Chemical Sales Company Superfund Site

Denver and Adams County

September 2012

Prepared By:

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Approved by: Date:

9/26/12

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List of Acronyms

ARARS	Applicable or Relevant and Appropriate Requirements
BTEX	Benzene, Toluene, Ethyl Benzene, Xylene
BZ	Benzene
CDPHE	Colorado Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CFR	Code of Federal Regulations
CSC	Chemical Sales Company
DCA	1,1-dichloroethane
DCE	1,1-dichloroethylene
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
GAC	Granular Activated Carbon
HASP	Health and Safety Plan
ISCO	In-Situ Chemical Oxidation
KWTF	Klein Water Treatment Facility
LNAPL	Light Non-aqueous Phase Liquid
MCLs	Maximum Contaminant Levels
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OUs	Operable Units
PCE	Tetrachloroethylene
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
RALs	Risk Action Levels
RI/FS	Remedial Investigation/Feasibility Study
RMA	Rocky Mountain Arsenal
ROD	Record of Decision
SACWSD	South Adams County Water and Sanitation District
SSC	Superfund State Contract
SVE	Soil Vapor Extraction
TCA	1,1,1-trichloroethane
TCE	Trichloroethylene
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

Executive Summary

The Colorado Department of Public Health and Environment (CDPHE) has conducted the fourth five-year review of the remedial actions implemented at the Chemical Sales Company Superfund Site (Site) located in Denver and Adams Counties, Colorado. The review was conducted from January through June 2012.

The results of the five-year review indicate that the Site is currently protective of human health and the environment. In-situ Chemical Oxidation (ISCO) has been successful in significantly reducing contaminant levels in the source area of Operable Unit 1 (OU1). Monitoring data suggests that groundwater contamination, underlying OU1/OU2, has remained within predicted plume boundaries. ICs are in place at the Site and the area is served by a municipal water supply. Two issues were identified that do not immediately impact the protectiveness of the Site.

While ISCO has been successful in reducing contaminant levels, there is still a significant and unknown amount of contaminant mass underlying the source area of OU1 as suggested by current concentrations. However, the location of the center of mass has been determined to be in the vicinity of TMW-7 and TMW-12.

Since contaminant levels remain substantially above remediation levels in the subsurface of the source area, additional ISCO injections should be conducted in the vicinity of TMW-7/TMW-12 until contaminant levels in surrounding wells decrease to remediation levels set out in the OU1 Record of Decision or reach a steady state. In conjunction, sampling in surrounding wells should continue to be conducted to measure the effectiveness of ISCO in reducing the remaining contaminant mass and to determine when a steady state has been achieved. The possible impacts of the OU1 ISCO treatments on OU2 groundwater should also continue to be monitored and evaluated.

1,4-Dioxane is now considered an “emerging contaminant” and may be present in groundwater at the Site. An emerging contaminant is a chemical or material that is characterized by a perceived, potential or real threat to human health or the environment or a lack of published health standards. 1,4-Dioxane is commonly associated with 1,1,1-trichloroethane (TCA), a contaminant of concern at the Site. It is a probable carcinogen, highly mobile and has not been shown to readily biodegrade in the environment. The contaminant is currently not in the analytical suite for monitoring at the Site. CDPHE, as the lead agency, will need to evaluate the presence of 1, 4-Dioxane in groundwater and, if present, determine whether it should be added to the analytical suite for monitoring.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Chemical Sales Company Superfund Site		
EPA ID: COD007431620		
Region: 8	**State:** CO	**City/County:** Denver/Denver County and Commerce City/Adams County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: State
Author name (Federal or State Project Manager): Jim Lewis of CDPHE
Author affiliation: CDPHE
Review period: January 2012 – June 2012
Date of site inspection: March 19, 2012
Type of review: Statutory
Review number: 4
Triggering action date: August 22, 2007
Due date *(five years after triggering action date)*: August 22, 2012

Five-Year Review Summary Form (continued)

Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
OU3 and OU4				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): OU1 and OU2	**Issue Category: Remedy Performance**			
	Issue: VOC levels remain substantially above remediation levels in source area groundwater.			
	Recommendation: Additional ISCO injections should be conducted in the vicinity of TMW-7/TMW-12 until VOC levels decrease to remediation levels or reach a steady state. Current sampling programs for OU1/OU2 should continue to monitor the performance and impacts of the ISCO injections.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	12/31/13
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): OU1 and OU2	**Issue Category: Monitoring**			
	Issue: 1,4-Dioxane is now considered an "emerging contaminant" and may be present in groundwater at the Site. The contaminant is currently not in the analytical suite for monitoring at the Site.			
	Recommendation: Evaluate the presence of 1, 4-Dioxane in groundwater and, if present, determine whether it should be added to the analytical suite for monitoring.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	12/31/13

Protectiveness Statement(s)	
Operable Unit: OU1	*Protectiveness Determination:* Protective
Protectiveness Statement: OU1 is currently protective of human health and the environment.	
Operable Unit: OU2	*Protectiveness Determination:* Protective
Protectiveness Statement: OU2 is currently protective of human health and the environment.	
Operable Unit: OU3	*Protectiveness Determination:* Protective
Protectiveness Statement: OU3 is protective of human health and the environment.	
Operable Unit: OU4	*Protectiveness Determination:* Protective
Protectiveness Statement: OU4 is protective of human health and the environment.	

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter date.
Protectiveness Statement: Because the remedies at all OUs are protective or protective in the short term, the Site is currently protective of human health and the environment.	

Chemical Sales Superfund Site
Fourth Five-Year Review Report

1.0 Introduction

CDPHE has conducted the fourth five-year review of remedial actions implemented at the Site located in Denver and Adams Counties, Colorado. This review was conducted from January through June 2012. This report documents the results of the review. The purpose of the five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify deficiencies found during the review, if any, and identify recommendations to address them.

This review is required by statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121(c), as amended, states:

> *"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment is being protected by the remedial action being implemented."*

The NCP [Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR)] states:

> *"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."*

This is the fourth five-year review for the Site. The triggering action for this review was the completion of the third five-year in August 22, 2007. Due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unrestricted use and unlimited exposure, another five-year review is required.

2.0 Site Chronology

Table 1: Chronology of Site Events

Date	Event
1981	EPA conducts random survey of drinking water systems and finds elevated contaminants in SACWSD wells.
1985	EPA conducts RI/FS in area known as off-post RMA OU1.
1986-88	400 residents using private wells were connected to the SACWSD water supply.
1987-89	KWTF was constructed and began operating in 1989.
1987	VOC contamination in groundwater was confirmed near the CSC property.
1988	Site proposed for NPL. All off-post RMA activities transferred to Site.
August 1990	Site listed on NPL.
June 1991	OU1 ROD signed.
Dec 1995	First ESD for OU1 ROD.
March 2000	Second ESD for OU1 ROD.
June 2007	Third ESD for OU1 ROD.
August 1997	CDPHE becomes lead via CA.
Sept 1997	First Five-Year Review Report
June 1998	OU1 RD completed.
1998 - 2000	OU1 RA started and completed.
June 1991	OU2 ROD signed.
Nov 1994	First and Last ESD for OU2 ROD.
1995	OU2 RD and RA started and completed.
June 1991	OU3 ROD signed.
1992	OU3 RD and RA started and completed.
1995	Under OU3, an additional resident connected to SACWSD system.
Dec 1992	OU4 ROD signed.
Sept 1999	No-Action ROD Amendment for OU4 ROD.
March 2002	Construction Completion for Site
Sept 2002	Second Five-Year Review Report
August 2007	Third Five-Year Review Report

3.0 Background

In 1981, EPA conducted a random national survey of drinking water systems. Several organic chemicals were found by EPA in the South Adams County Water and Sanitation District (SACWSD) groundwater supply wells. Additional sampling in 1982 and 1985 confirmed this result. EPA then initiated a Remedial Investigation (RI) and Feasibility Study (FS) in an area referred to as the "Off-Post Rocky Mountain Arsenal (RMA) OU1". This area is bounded by East 80th Avenue to the north; East 56th Avenue to the south; South Platte River to the west; and the RMA to the east. The results of the RI indicated extensive contamination of groundwater along the eastern portion of the area.

A permanent water treatment plant for SACWSD water was the selected remedy for the Off-Post RMA OU1 ROD dated June 4, 1987. The permanent treatment plant was built and named the Klein Water Treatment Facility (KWTF). It is near the SACWSD municipal water supply center at East 77th Avenue and Quebec Street. The KWTF began operating in October 1989 treating alluvial groundwater prior to distribution. Also, approximately 400 residents using private wells were connected to the SACWSD municipal water supply under EPA removal actions between 1986 and 1988.

The RMA was suspected as one of the potential sources of groundwater contamination in the Off-Post RMA Study Area due to its history of waste disposal practices. Investigations by the EPA's Field Investigation Team indicated the potential for other source areas to also be contributing to groundwater contamination. In 1986, soil gas surveys and groundwater investigations revealed the presence of VOCs in the vicinity of the Chemical Sales Company (CSC) facility. The presence of TCE and other chlorinated hydrocarbons near the CSC was confirmed by another soil gas survey in August 1987. Groundwater monitoring wells installed on the CSC property confirmed that the CSC as the source of groundwater contamination. The chemicals of concern (COCs) for the Site are as follows:

- 1,1-dichloroethane (DCA)
- 1,1-dichloroethylene (DCE)
- Total 1,2-dichloroethylene (total 1,2-DCE)
- 1,1,1-trichloroethane (TCA)
- Trichloroethylene (TCE)
- Tetrachloroethylene (PCE)
- Benzene (BZ)
- Vinyl Chloride (VC)

The Site was proposed for listing on the National Priorities List (NPL) in June 1988. Investigations for all RMA Off-Post work were then transferred from the Off-Post RMA Study Area to the CSC Site. The NPL listing was made final in August 1990.

Subsurface soils and groundwater are contaminated at the Site. The contaminated groundwater is located in an unconfined alluvial aquifer, which extends to a maximum depth of 100 feet below the ground surface. Groundwater flow on the Site generally moves north to north-northwest within paleochannels that focus groundwater flow. The Site is divided into four operable units.

Operable Unit 1. OU1 consists of contaminated subsurface soils on the CSC property and groundwater contamination south of Sand Creek. The land use in OU1 is mainly industrial.

The CSC property was the location of a former chemical sales business. Subsurface soil contamination on and adjacent to the property is considered to be the source of the groundwater contamination. The contaminated groundwater flows northward to form OU2. See Figure 1.

OU1 is located in Denver and Commerce City. The plume area of OU1 consists of the area south of Sand Creek and north of East 48th Avenue, between Monaco and Forest Streets. The source area includes the CSC property at 4661 Monaco Street and the area south of East 48th Avenue, north of Interstate 70, between Monaco and Forest Streets.

Operable Unit 2. OU2 addresses the VOC contaminated groundwater north of Sand Creek down gradient of OU1. The RMA borders OU2 to the east. OU2 is approximately four square-miles in area. The land use consists of single and multi-family residences, small businesses, and municipal facilities. Boundaries of OU1 and OU2 are defined by the approximate extent of the groundwater contamination. No soil contamination has been found in OU2. See Figure 1.

Operable Unit 3. OU 3 addresses residential exposure to contaminated groundwater in OU2 and has the same boundaries as OU2.

Operable Unit 4. OU 4 addresses SACWSD Wells 18, 21, and 47. The wells draw water from the alluvial aquifer north of OU2 and provide water to residents connected to SACWSD.

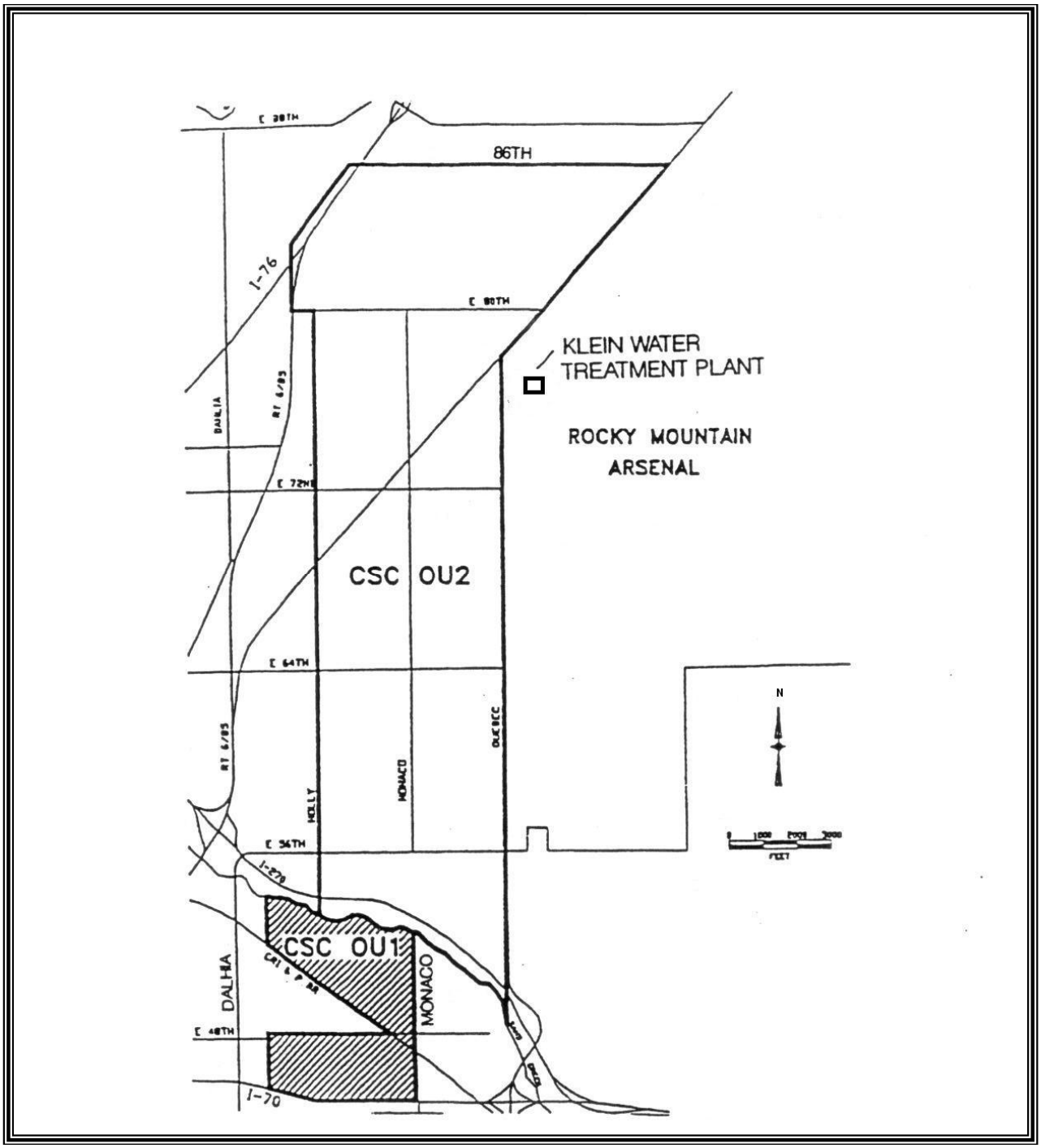
4.0 Remedial Actions

4.1 Remedy Selection & Implementation

Operable Unit 1

OU1 consists of the contaminated soils located on and around the Site property and groundwater contamination south of Sand Creek. The OU1 ROD was signed on June 27, 1991 and included the following components:

Figure 1: Site Location Map



- Treatment of contaminated groundwater with two air stripping towers for the source area;
- Re-injection of treated groundwater;
- Soil Vapor Extraction (SVE) and air stripping for treatment of contaminated soils exceeding soil remediation levels; and,
- Catalytic oxidation for treatment of air emissions from the SVE system and air stripping unit plus recirculation of exhaust from the catalytic oxidation system into the contaminated soil.

The remedial action objectives (RAOs) for the OU1 remedy include the following: 1) Prevent ingestion and inhalation of groundwater with contaminants in excess of remediation levels; 2) Protect uncontaminated groundwater for current and future use by preventing migration of contaminants in excess of remediation levels; 3) Restore contaminated groundwater to remediation levels or a steady state; and, 4) Prevent inhalation, ingestion and direct contact with soils above remediation levels.

New information from hydrogeologic investigations indicated that the selected remedy would be less efficient and effective at accomplishing remedial objectives than originally thought. This resulted in the December 11, 1995 ESD which included the following three modifications: 1) Use of air sparging (AS) rather than air stripping; 2) Use of resin adsorption rather than catalytic oxidation; and, 3) Recirculation of treated exhaust from the catalytic oxidation system into soils would not be conducted.

A minor modification to the remedy was issued via public fact sheet in August of 1999. Based on a cost-effectiveness study conducted by CDPHE, it was determined that it would be more efficient and effective to use a pollution control system that thermally destroys contaminated exhaust (or off-gas) rather condensing it into liquid form for off-site destruction. Consequently, thermal oxidation rather than resin adsorption was selected and used to remove contaminants from the air stream.

On August 12, 1997, EPA signed a Cooperative Agreement for CDPHE to conduct the Remedial Design (RD), thus making CDPHE the lead agency for OU1. CDPHE completed the RD on June 25, 1998.

During RD activities, more hydrogeologic information was acquired and another ESD was signed on March 27, 2000. The ESD calls for the use of monitored natural attenuation rather than active remediation in the plume area of OU1.

CDPHE formally awarded the RA Contract on August 19, 1998. CDPHE conducted remedial activities as planned. EPA and CDPHE conducted pre-final inspections on September 30, 1999

and February 16, 2000. Punch list items from the pre-final inspections were completed by March 2000 and the AS/SVE System was then considered operational and functional.

As a result of persistent elevated VOC levels in the source area, CDPHE performed additional assessment work in 2005 and performed some enhancements to the system in efforts to help reduce the source plume. While its efforts helped reduce part of the plume, it was not successful at minimizing the plume south of the Trammell Crowe building. After further investigations, it was determined that a third ESD would need to be executed to address the source plume.

Since the AS/SVE plant was operating less effectively and considering the costs of keeping the system operating for the next 20 years, EPA and CDPHE investigated other alternatives for solving the persistant VOC problem at the Site. Based on background information and a careful review of all available soil boring and monitoring well data, it was found that there were only a few remediation approaches that were feasible, either technologically or economically. The approaches were evaluated on their capability to eliminate the onsite PCE source material, and, ultimately, to reduce offsite migration of dissolved PCE contaminant. Additional considerations included, but were not limited to, relative effectiveness, timeliness, treatment byproducts, logistics of contaminant disposal, and overall value.

In-Situ Chemical Oxidation (ISCO) was selected. A number of in-situ oxidative technologies were considered for use at the Site. These included the use of Fenton's reagent, potassium permanganate, ozone, and combinations or modifications of all three. They are all highly effective for treating dissolved-phase VOCs.

It was decided in the third ESD that injections of modified Fenton's reagent was the best approach at minimizing the plume. Modified Fenton's reagent is pH-neutral and desorbs chlorinated VOCs from the saturated soil for treatment. It can address the source material in the saturated zone and shallow bedrock and, provided that the reagents can be delivered directly to the source contaminants, can reduce the overall contaminant mass. In addition, it can indirectly affect material in the untreated lower interval of the vadoze zone in the source area. The proprietary modified Fenton's methodology has also proven highly successful for the permanent reduction of chlorinated contaminants at other high concentration chlorinated VOC sites. The third ESD was signed in June 2007 and the SVE/AS system was decommissioned later in the year**.**

CDPHE contracted Talus Environmental Consulting, LLC to conduct the in-situ oxidation remediation. Talus sub-contracted In-Situ Oxidative Technologies, Inc. (ISOTEC) to do the injections of the Fenton's modified reagent to initiate the oxidation and biodegradation processes. Between April 24, 2006 and May 2, 2006, in-situ chemical oxidation injections into the contaminated aquifer were made to destroy the chlorinated solvent contamination. Two additional treatments were conducted between May 30, 2006 and June 6, 2006 and June 26, 2006 and June 30, 2006.

The fourth and fifth in-situ chemical oxidation injection events were completed during the fall of 2007. The fourth injection round took place between September 24, 2007 and September 28, 2007. The fifth injection round took place between October 29, 2007 and November 2, 2007.

In August 2011, CDPHE contracted ISOTEC to conduct additional treatments focusing on the area of VOC mass at the northeast corner of the Trammell Crowe Building. A baseline groundwater sampling event was conducted within the source area on September 9, 2011. The first injection took place the week of September 12, 2011 and the second injection was conducted the week of October 10, 2011.

Operable Unit 2

OU2 addresses VOC contaminated groundwater north of Sand Creek. Two distinct groundwater plumes for TCE and PCE have been identified. The ROD for OU2 was signed on June 27, 1991. The major components of the remedy for OU2 included: 1) extraction of contaminated groundwater within the plumes; 2) treatment of the groundwater by air stripping technology; 3) re-injection of the treated groundwater by injection wells; 4) monitoring of groundwater; 5) continued capture and treatment of contaminated groundwater by the existing KWTF; and, 6) voluntary abandonment of bedrock wells.

The RAOs for the OU2 remedy are to restore contaminated groundwater to remediation levels and prevent migration of contaminated groundwater. Since OU2 is located directly downgradient of OU1, successful attainment of OU1 RAOs will reduce contaminant concentrations in groundwater within OU2.

The ESD for OU2 was signed November 29, 1994. In the original remedy the PCE plume was going to require active treatment by air stripping and reinjection of the treated water into the aquifer. New information indicated that the high concentrations of PCE had dispersed and no longer required active treatment. Thus, the first three components of the original remedy were eliminated by this ESD.

Field activities were performed from September 5, 1995 through November 30, 1995 to fulfill the monitoring component of OU2. The initial groundwater sampling event for the groundwater well network was conducted in November 1995. Under a Cooperative Agreement, CDPHE has conducted the OU2 monitoring since 1999, with the last sampling event conducted in February 2011.

No well owners granted permission to abandon bedrock wells. The residual plume continues to be captured and treated by the existing KWTF.

Operable Unit 3

OU 3 addresses residential exposure to contaminated groundwater in the geographic area known as OU2. There are 11 private alluvial wells located along the OU2/RMA boundary area. The major components of the selected remedy as stated in the OU 3 ROD, dated June 27, 1991, included: 1) Connection of private alluvial well users to the SACWSD water system; 2) Provision for individual home activated treatment units for residences located in rural areas without reasonable access to SACWSD water lines; and, 3) Notification by the State Engineer to applicants for alluvial well drilling permits of the potential groundwater contamination within the RMA Off-Post Notification Area. The RAO for the OU3 remedy was to prevent residents using alluvial wells from ingesting and inhaling contaminants during showering by providing suitable water for domestic purposes.

The final inspection for all residences occurred on September 30, 1992. Of a total of 15 possible eligible connections, ten connections or partial connections were made. During the initial implementation of the remedy for OU3, residents at five locations elected not to be connected to the municipal water supply. Subsequently, connections were made to four of the residences that had declined the original installation. The remaining resident was sent a letter in September 2008 notifying him of the contaminated plume.

Operable Unit 4

OU 4 addresses SACWSD Wells 18, 21, and 47. These wells draw water from the alluvial aquifer north of OU2 and provide water to residents connected to SACWSD.

The original remedy selected in the ROD, signed December 29, 1992, included the following components: connection of the three wells to the KWTF; treatment of well water at the KWTF by granulated active carbon to below MCLs in compliance with the Off-Post RMA OU1 Record of Decision; regeneration of spent carbon off-site; transmission of treated water to a reservoir for storage; and quarterly monitoring of the three wells. The RAO for the OU4 remedy was to prevent residents using alluvial wells from ingesting contaminants during normal residential use and inhaling contaminants during showering by ensuring a suitable drinking water supply to residents of South Adams County.

Because contaminant levels in groundwater in the northern part of OU2 decreased to well below MCLs, the originally selected remedy for OU4 was no longer needed and a No-Action ROD Amendment was signed on September 23, 1999. The three wells will be monitored by SACWSD for as long as the KWTF is in operation.

4.2 Groundwater Monitoring

Operable Unit 1

Currently, sixteen wells in OU1 are sampled on an annual basis to:

- Monitor the VOC contamination in the groundwater underlying the source area; and,
- Measure the performance of ISCO in reducing the contaminant mass underlying the source area.

Operable Unit 2

Currently, eight wells in OU2 are sampled on a biannual basis to:

- Determine the extent of movement of the contaminant plume; and,
- Observe any increase/decrease in contaminant concentrations.

As the implementation of ISCO proceeds in OU1, the impact on OU2 groundwater will be monitored and evaluated.

4.3 Institutional Controls

The CSC property is subject to an environmental covenant pursuant to §25-15-321 of the Colorado Hazardous Waste Act, §25-15-101, et seq., Colorado Revised Statutes. The environmental covenant is recorded with the Adams County Clerk and Recorder's Office. The purpose of the environmental covenant is to ensure protection of human health and the environment by implementing institutional controls (ICs) related to restrictions on land and groundwater use. It also permanently ensures that the ICs will "run with the land" and be inserted in any future instrument of conveyance into perpetuity.

The South Adams County Water & Sanitation District (SACWSD) provides an additional institutional control through its authority to establish/enforce use of groundwater within its district that includes the Sand Creek and Chemical Sales Sites. SACWSD has established restrictions on the installation and use of groundwater wells for the shallow aquifer. The State Engineer's Office of the Department of Natural Resource has established informational ICs that notify well applicants of the contaminated plumes associated with the Sand Creek and Chemical Sales Sites.

4.4 Progress since the last Five Year Review

The last five-year review report was signed on August 22, 2007 with the following protectiveness statement: The remedy at the Site is expected to be protective of human health

and the environment. All of the issues and recommendations in the report were addressed as shown in the following table:

Table 2: Five-Year Review Status Table (Review Date: 8/22/07)			
Issues	**Recommendations/ Follow-Up Actions**	**Action Taken or Outcome**	**Party Responsible**
1) Contamination under the Trammel Crow Building is not decreasing as quickly as the other areas of contamination. VOC concentrations in monitoring wells around the building are high.	Multiple injections of modified Fenton's reagent into the subsurface to facilitate biodegradation of VOCs are scheduled to begin by late summer of this year centering on the Trammel Crow Building.	COMPLETED: Multiple injections were successfully conducted in 2006 and 2007.	CDPHE
2) Outside of the CSC property, ICs are not in-place to restrict use of contaminated groundwater and construction of water wells within site boundaries.	EPA/CDPHE will begin working with local governments in the Fall of 2007 to evaluate the ICs that are within Site boundaries that restrict groundwater use and the construction of water wells.	COMPLETED: It was found that SACWSD has established and enforces the necessary ICs within its district that includes the Sand Creek and Chemical Sales Sites. In June 2009, the State Engineer's Office established informational ICs that notify well applicants of the contaminated plumes associated with the Sites.	CDPHE & EPA
3) During the implementation of the OU3 remedy, owners of four residences within OU2 boundaries elected not to be connected to the municipal water supply.	CDPHE will need to double check the status of the four residents to determine if there is any potential exposure to contaminated groundwater.	COMPLETED: In May 2008, it was found that all of the residents were connected to the water supply except one. The sole resident was sent a letter in September 2008 notifying him of the contaminated plume.	CDPHE

5.0 Five-Year Review Process

The five year review was led by Jim Lewis, CDPHE Project Manager, and Armando Saenz, EPA Project Manager. The following team members assisted in the review:

- Fonda Apostolopoulos, CDPHE Project Manager
- Richard Sisk, EPA Attorney
- Marilyn Null, CDPHE Community Involvement Coordinator

The five-year review consisted of the following activities: a review of relevant documents; interviews; review of ARARS and O&M data; and, site visits. A notice, stating that the five year review was in progress, was placed in The Denver Post on April 21, 2012. Notices of completion of the five year report will also be placed in The Denver Post.

6.0 Five-Year Review Findings

6.1 Interview

Michael Weiss, ACME Metals Plant Manager. Mr. Weiss was interviewed by phone on April 12, 2012. He owns the property formerly known as the CSC property and owns/manages the business on the property known as ACME Metals. The property is part of the source area. He was satisfied with the remedy to date and had no issues.

6.2 Site Inspection

The Site was inspected on March 19, 2012 by Fonda Apostolopoulos and Marilyn Null both with CDPHE. No changes to Site conditions were noted.

6.3 ARARs Review

As part of the five-year review, Applicable and Relevant and Appropriate Requirements (ARARs) were reviewed. The primary purpose of this review was to determine if any newly promulgated or modified requirements of federal and state environmental laws have significantly changed the protectiveness of the remedies implemented at the Site. The ARARs reviewed were those included in the Site's decision documents.

Overall, the review does not indicate any substantive changes to regulations that would affect the remedy or its protectiveness. EPA and CDPHE will continue to monitor this Site and any future changes or modifications in ARARs will be reported in the next five-year review.

6.4 Data Review for OU1 Groundwater Monitoring

Currently, sixteen wells are sampled in the source area on an annual basis to monitor contamination in the groundwater (which flows in a northerly direction) and to measure the performance of ISCO. These wells include CDM-MW-5, LSS-MW-11, 12, 13,14 and Talus wells TMW-1, 2, 3, 4, 5, 6, 7, 8, 9, 11 and 12 as shown in Figures 2, 3 and 4. These wells effectively define the center of mass and the periphery of the source of contamination.

Table 3 summarizes the results of the 2011 sampling event for the three contaminants that are the most prevalent and greatest concern at the Site (PCE, TCE and 1,1-DCE). It also compares the results from different sampling events since the implementation of ISCO in 2006 (or before for wells not sampled in 2006). The majority of wells had decreases in contaminant concentrations due to oxidation and anaerobic bio-degradation. Of particular note is the PCE concentration for TMW-7 that went from 30,100 μg/L in 2006 to 11,000 μg/L in 2009 and 10,000 μg/L in 2011. The increases in concentrations in certain wells are more than likely the result of the residual desorption of the VOCs from the alluvial matrix. This "rebound" effect is a common occurrence during the implementation of ISCO. All concentrations are expected to stabilize with time. Overall, Table 3 (and Figures 3 and 4) illustrate the success, thus far, of the ISCO injections in the source area of OU1.

While ISCO has been successful in reducing contaminant levels, there is still a significant and unknown amount of contaminant mass underlying the source area of OU1 as suggested by current concentrations. However, the location of the center of mass has been determined to be in the vicinity of TMW-7 and TMW-12.

Since contaminant levels remain substantially above remediation levels in the subsurface of the source area, additional ISCO injections should be conducted in the vicinity of TMW-7/TMW-12 until contaminant levels in surrounding wells decrease to remediation levels set out in the OU1 ROD or reach a steady state. In conjunction, sampling in surrounding wells should continue to be conducted to measure the effectiveness of ISCO in reducing the remaining contaminant mass and to determine when a steady state has been achieved.

6.5 Data Review for OU2 Groundwater Monitoring

Currently, eight wells in OU2 are sampled on a biannual basis to determine the extent of any movement of the contaminant plume (which flows in a northerly direction) and to observe any increase/decrease in contaminant concentrations. Sampling is conducted in accordance with the *Field Logistics for Groundwater Sampling at Chemical Sales Company Superfund Site, Operable Unit II* (CDPHE, February 1999) which was approved by EPA. Figure 5 shows the locations of the eight wells.

Table 4 summarizes the results of the sampling events since the implementation of ISCO in 2006 for the three contaminants that are the most prevalent and greatest concern at the Site (PCE, TCE and 1,1-DCE). As expected, CMW-05, CDM-198-605 and FIT-IM-WP-02 exceeded the PCE MCL of 5µg/L. FIT-IM-WP-02 also exceeded the TCE MCL of 5µg/L. Also as expected, the highest concentrations of the contaminants were in FIT-IM-WP-02. The well is located along the southern boundary of OU2 just north of Sand Creek and immediately downgradient of OU1. Concentrations of VOCs were non-detectable or significantly below MCLs in CMW-06, CMW-17 and CDM-198-614. PCE and TCE levels have slightly increased in the three wells (FIT-IM-WP-01, -02 and -03) along the southern boundary of OU2.

In summary, concentrations of VOCs remain generally similar to the concentrations of previous sampling events. The highest concentrations are found immediately downgradient of OU1 in FIT-IM-WP-02. The contamination in the groundwater underlying OU2 has remained within predicted plume boundaries. There is no indication that VOC contamination from the Site has extended beyond the boundaries of OU2. Contaminant concentrations have remained relatively stable, but the OU1 ISCO treatments may be slightly affecting the wells along the southern boundary of OU2 as suggested by Table 4. The possible impacts of the OU1 ISCO treatments on OU2 groundwater should also continue to be monitored and evaluated.

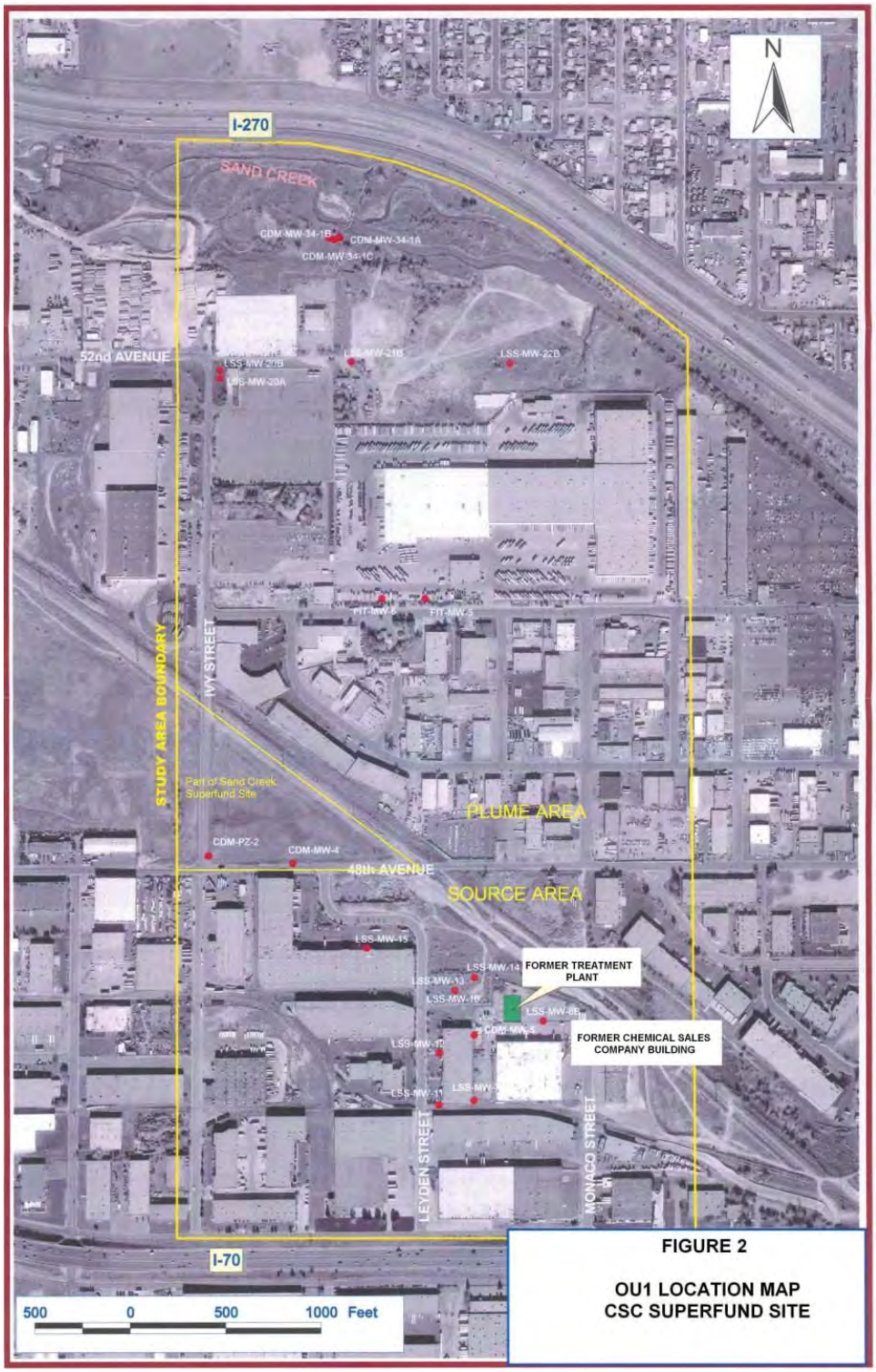


Figure 2: OU1 Location Map

Figure 3: 2009 PCE Isoconcentration Map

Figure 4: 2011 PCE Isoconcentration Map

Figure 5: OU2 Location Map

Table 3: Sampling Results for OU1 since Implementation of ISCO in 2006 (µg/L)

Well Designation	VOC	2004 or 2005 or 2006 Concentration	2009 Concentration	2011 Concentration
CDM-MW-5	PCE	619	630	380
	TCE	107	160	120
	1,1-DCE	31	39	46
LSS-MW-11	PCE	660	550	360
	TCE	1200	1000	460
	1,1-DCE	66	48	49
LSS-MW-12	PCE	300	210	180
	TCE	170	180	110
	1,1-DCE	16	14	10
LSS-MW-13	PCE	3500	2800	1900
	TCE	1040	860	540
	1,1-DCE	551	380	270
LSS-MW-14	PCE	160	150	310
	TCE	31	29	23
	1,1-DCE	25	29	26
TMW-1	PCE	9030	5100	1900
	TCE	1910	930	420
	1,1-DCE	526	310	140
TMW-2	PCE	751	620	330
	TCE	170	140	74
	1,1-DCE	107	91	48
TMW-3	PCE	360	310	440
	TCE	66	59	53
	1,1-DCE	46	46	51
TMW-4	PCE	425	1400	650
	TCE	102	260	160
	1,1-DCE	68	260	160
TMW-5	PCE	238	1100	1100
	TCE	118	230	260
	1,1-DCE	14	83	74
TMW-6	PCE	851	1100	660
	TCE	247	250	160
	1,1-DCE	46	80	49
TMW-7	PCE	30,100	11,000	10,000
	TCE	588	390	420
	1,1-DCE	182	120	180
TMW-8	PCE	3.3	30	30
	TCE	0.5	2	1.2
	1,1-DCE	ND	ND	ND
TMW-9	PCE	209	220	180
	TCE	13	16	14
	1,1-DCE	8	10	14
TMW-11	PCE	1720	3700	2100
	TCE	842	1300	870
	1,1-DCE	815	1100	850
TMW-12 (Drilled 2009)	PCE	-	15,000	11,000
	TCE	-	1400	2200
	1,1-DCE	-	370	690

Table 4: Sampling Results for OU2 since Implementation of ISCO in 2006 (μg/L)

Well Designation	VOC	2006 Concentration	2008 Concentration	2011 Concentration
CMW-05	PCE	12	8.4	8.92
	TCE	6.2	4.9	4.4
	1,1-DCE	1.3	<0.5	<0.5
CMW-06	PCE	.83	<0.5	<0.5
	TCE	<.5	<0.5	<0.5
	1,1-DCE	1.7	<0.5	<0.5
CMW-17	PCE	1.3	<0.5	<0.5
	TCE	1.0	<0.5	<0.5
	1,1-DCE	.95	<0.5	<0.5
CDM-198-605	PCE	3.8	5.2	5.24
	TCE	2.4	2.2	1.73
	1,1-DCE	.61	<0.5	<0.5
CDM-198-614	PCE	.74	<0.5	<0.5
	TCE	.52	<0.5	<0.5
	1,1-DCE	<0.5	<0.5	<0.5
FIT-IM-WP-01	PCE	<0.5	<0.5	2.08
	TCE	<0.5	<0.5	3.17
	1,1-DCE	<0.5	<0.5	<0.5
FIT-IM-WP-02	PCE	23	11	23.24
	TCE	13	6	10.04
	1,1-DCE	3.4	<0.5	<0.5
FIT-IM-WP-03	PCE	<0.5	<0.5	0.81
	TCE	<0.5	<0.5	1.12
	1,1-DCE	1.6	<0.5	<0.5

7.0 Assessment

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

HASP/Contingency Plan: Both the Health & Safety Plan and the Contingency Plan are in place, properly implemented and sufficient to control risks.

Implementation of Institutional Controls and Other Measures: Access controls are in place at the CSC property including a fence and a warning sign. The fence is in good condition. There are no planned changes in land use for the Site. ICs, called for in the RODs, have been implemented and are effective. The ICs remain in place and no uses and/or activities at the Site are inconsistent with the ICs.

Remedial Action Performance: The former OU1 SVE/AS system was decommissioned in 2007 in favor of ISCO using modified Fenton's reagents. Several ISCO injections in 2006 and 2007 were found to be successful in subsequent sampling events. The majority of wells had decreases in contaminant concentrations due to oxidation and anaerobic bio-degradation.

While ISCO has been successful in reducing contaminant levels, there is still a significant and unknown amount of contaminant mass underlying the source area of OU1 as suggested by current concentrations. However, the location of the center of mass has been determined to be in the vicinity of TMW-7 and TMW-12.

Since contaminant levels remain substantially above remediation levels in the subsurface of the source area, additional ISCO injections should be conducted in the vicinity of TMW-7/TMW-12 until contaminant levels in surrounding wells decrease to remediation levels set out in the OU1 ROD or reach a steady state. In conjunction, sampling in surrounding wells should continue to be conducted to measure the effectiveness of ISCO in reducing the remaining contaminant mass and to determine when a steady state has been achieved. The possible impacts of the OU1 ISCO treatments on OU2 groundwater should also continue to be monitored and evaluated.

System Operations/O&M/Monitoring: The groundwater monitoring programs for OU1 and OU2 are currently effective.

Opportunities for Optimization: Adjustments are made after each round of ISCO.

Early Indicators of Potential Remedy Failure: No early indicators of potential remedy failure were noted during the review.

Question B: Are the assumptions made at the time of the remedy selection still valid? Yes.

Changes in Standards: No newly promulgated or modified ARARs that would change the protectiveness of the remedies implemented at the Site were found.

Changes in Exposure Pathways: No changes in site conditions that affect exposure pathways were identified as part of the five-year review. First, there are no current or planned changes in land use. Second, no new contaminants, sources, or routes of exposure were identified as part of this five-year review. Finally, there is no indication that hydrologic/hydrogeologic conditions are not adequately characterized.

Changes in Toxicity and Other Contaminant Characteristics: Changes in toxicity and other factors for contaminants of concern, since the time of the Site decision documents, do not call into question the protectiveness of the remedy.

In March 2012, the CDPHE Hazardous Materials and Waste Management Division updated its "Air Screening Concentrations Table" which identifies indoor air remediation goals and action levels for VOCs. This revision was in response to EPA's reassessment of the health effects of TCE and PCE in 2011. Existing air concentrations were also updated to incorporate the 2009 EPA risk assessment guidance for the inhalation pathway presented in the Risk Assessment Guidance for Superfund, Part F.

In 2002, CDPHE sampled indoor air in three homes over the plume area. Since that time, one of the residences has been demolished and replaced with a commercial garage. During the five-year review, CDPHE compared indoor air levels measured in homes to the revised Air Screening Concentrations Table. There were no concentrations in excess of health protective levels.

1,4-Dioxane is now considered an "emerging contaminant" and may be present in groundwater at the Site. An emerging contaminant is a chemical or material that is characterized by a perceived, potential or real threat to human health or the environment or a lack of published health standards. 1,4-Dioxane is commonly associated with 1,1,1-trichloroethane (TCA), a contaminant of concern at the Site. It is a probable carcinogen, highly mobile and has not been shown to readily biodegrade in the environment. The Colorado groundwater standard is 3.2 ug/L. The contaminant is currently not in the analytical suite for monitoring at the Site.

Changes in Risk Assessment Methodologies: Changes in risk assessment methodologies, since the time of the decision documents, do not call into question the protectiveness of the remedy.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? No.

No additional information has been identified that would call into question the protectiveness of the remedy.

8.0 Issues

Table 5: Issues

Issue No.	*Issue*	*Currently Affects Protectiveness*	*Affects Future Protectiveness*
1	VOC levels remain substantially above remediation levels in source area groundwater.	No	Yes
2	1,4-Dioxane is now considered an "emerging contaminant" and may be present in groundwater at the Site. The contaminant is currently not in the analytical suite for monitoring at the Site.	No	Yes

9.0 Recommendations and Follow-Up Actions

Table 6: Recommendations and Follow-Up Actions

Issue	*Recommendations/ Follow-Up Actions*	*Party Responsible*	*Oversight Agency*	*Milestone Date*	*Affects Current Protectiveness?*	*Affects Future Protectiveness?*
1 VOC Levels Remain Above Remediation Levels in Source Area Groundwater	Additional ISCO injections should be conducted in the vicinity of TMW-7/TMW-12 until VOC levels decrease to remediation levels or reach a steady state. Current sampling programs for OU1/OU2 should continue to monitor the performance and impacts of the ISCO injections.	CDPHE	EPA	12/31/13	No	Yes
2 1,4-Dioxane May Be Present In Groundwater	Evaluate the presence of 1, 4-Dioxane in groundwater and, if present, determine whether it should be added to the analytical suite for monitoring.	CDPHE	EPA	12/31/13	No	Yes

10.0 Protectiveness Statement

OU 4 addresses SACWSD Wells 18, 21, and 47. Because contaminant levels in groundwater in the northern part of OU2 decreased to well below MCLs, the originally selected remedy was no longer needed and a No-Action ROD Amendment was signed on September 23, 1999. The three wells will be monitored by SACWSD for as long as the KWTF is in operation. Therefore, OU4 has been addressed and is protective of human health and the environment.

OU 3 addresses residential exposure to contaminated groundwater in the same geographic area as OU2. Connections of private alluvial well users to the SACWSD water system were completed with the final inspection for all residences occurring on September 30, 1992. Of a total of 15 possible eligible connections, ten connections or partial connections were made. Residents at five locations elected not to be connected to the municipal water supply. Subsequently, connections were made to four of the residences that had declined the installation. The remaining resident was notified of the contaminated plume in September 2008. Therefore, OU3 has been completed and is protective of human health and the environment.

OU2 and OU1 are currently protective of human health and the environment. ISCO has been successful in significantly reducing contaminant levels in the source area of OU1. Monitoring data suggests that groundwater contamination, underlying OU1/OU2, has remained within predicted plume boundaries. ICs are in place at the Site and the area is served by a municipal water supply. However, for the remedy to be protective in the long term, the following actions need to be taken: additional ISCO injections should be conducted in the source area and the presence of 1, 4-Dioxane should be evaluated.

Because the remedies at all OUs are protective or protective in the short term, the Site is currently protective of human health and the environment.

11.0 Next Review

The five-year reviews for this Site are statutory. The next review will be conducted within five years of the completion of this Five-Year Review Report. The completion date is the date shown on the signature page of this report.