FOURTH FIVE-YEAR REVIEW

STRINGFELLOW SUPERFUND SITE
GLEN AVON, RIVERSIDE COUNTY, CALIFORNIA

Prepared for
U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, California 94105

Prepared by
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9/28/11
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Acronyms & Abbreviations

µg/kg	microgram/kilogram
µg/L	microgram/liter
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substance and Disease Registry
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CWA	Clean Water Act
CWTS	Community Wellhead Treatment System
DDT	Dichloro-diphenyl-trichloroethane
DTSC	Department of Toxic Substances Control
ESD	Explanation of Significant Differences
FS	Feasibility Study
ft/d	feet/day
GAC	Granular Activated Carbon
gpd	gallons per day
gpm	gallons per minute
HMI	Human Machine Interface
HRA	Health Risk Assessment
IC	Institutional Control
IPRS	Interim Pesticide Removal System
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
LCR	Lifetime Cancer Risk
LCTF	Lower Canyon Treatment Facility
LGAC	Liquid Granular Activated Carbon
LUC	Land Use Controls
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant Level
MG	Million Gallons
MTS	Metals Treatment System
NCP	National Contingency Plan
NDMA	n-nitrosodimethylamine
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OEHHA	California Office of Environmental Health Hazard Assessment
O&M	Operation and Maintenance
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PCTF	Pyrite Canyon Treatment Facility
pCBSA	para-chlorobenzene-sulfonic acid
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
PRS	Pesticide Removal System

Acronyms & Abbreviations, Continued

PTP	PreTreatment Plant
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RDEH	Riverside Department of Environmental Health
RfCi	Inhalation Reference Concentration
RfDo	Oral Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SARI	Santa Ana Regional Interceptor
SAWPA	Santa Ana Watershed Project Authority
SCADA	Supervisory Control and Data Aquisition
SCAQMD	South Coast Air Quality Management District
SDWA	Safe Drinking Water Act
SFi	Inhalation Slope Factor
SFS	Supplemental Feasibility Study
SFo	Oral Slope Factor
SLERA	Screening Level Ecological Risk Assessment
SVE	Soil Vapor Extraction
SVOC	Semi Volatile Organic Carbon
TCDB	Toxic Criteria Database
TCE	Trichloroethylene
TI	Technical Impracticability
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Executive Summary

This is the fourth Five-Year Review for the Stringfellow Hazardous Waste Site (Site). This fourth Five-Year Review was conducted to determine whether the remedy at the Site is protective of human health and the environment.

The Site is located in the City of Jurupa Valley, (formerly known as the community of Glen Avon), in Riverside County, California, approximately 50 miles east of Los Angeles. The original 17-acre Site is located in Pyrite Canyon in the Jurupa Mountains at the head of Pyrite Creek. As a result of previous activities at Zone 1 (disposal of liquid industrial water in unlined evaporation ponds) and subsequent migration of contaminants in groundwater, groundwater contamination from the Site extends approximately 4 miles south towards the Santa Ana River. The three areas located down-gradient from Zone 1 are evaluated as three separate geographic zones – Zones 2, 3, and 4. Zones are identified as: Zone 1, On-site/Upper Mid-Canyon Area; Zone 2, Mid-Canyon Area; Zone 3, Lower Canyon Area, and Zone 4, within the Glen Avon Community.

Remedial actions for the Site were selected in four interim ROD documents. The first ROD directed the completion of several activities, including fencing, erosion control, interim source control, and off-site hauling and disposal of contaminated liquids. The second ROD included construction of an on-site PreTreatment Plant (PTP) to treat contaminated groundwater, and included installation of an expanded extraction system in Zone 2. The third ROD selected installation of a groundwater barrier system in Zone 3, and installation of peripheral surface channels to direct up-gradient surface water runoff. The fourth ROD included dewatering in the original disposal area (Zone 1), installation of a groundwater extraction system in Zone 4, field testing of soil vapor extraction (SVE), and field testing of reinjection of treated groundwater in the upper canyon area.

The exposure pathway of greatest concern to public health at the time of each Record of Decision (ROD) was consumption of contaminated groundwater (SAIC, 1987). Groundwater at the Site is contaminated with high concentrations of soluble organic and inorganic contaminants, including, but not limited to, acids, minerals, and heavy metals. Groundwater contamination from the Site extends from Zone 1 to the Santa Ana River in Zone 4. The vertical extent of contaminated groundwater in Zones 1, 2, 3 is found in the alluvium, weathered bedrock, and the fractures in the unweathered bedrock down to 150 feet below ground surface. Groundwater contamination in Zone 4 has been observed in the alluvium and weathered bedrock and could potentially migrate to the unweathered bedrock (Tetra Tech, 2007).

A Supplemental Feasibility Study (SFS) for Zones 1, 2, and 3 was completed in 2009 and the Feasibility Study (FS) for the perchlorate in Zone 4 is expected to be completed in 2012. These studies will support the selection of the final remedy in the fifth and final ROD scheduled for completion in December 2012.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name: Stringfellow Superfund Site		
EPA ID: CAT080012826		
Region: 9	**State:** CA	**City/County:** Glen Avon/Riverside County

SITE STATUS

NPL status: ☒ Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete	
Multiple OUs?* ☒ YES ☐ NO	**Construction completion date:** Construction not complete
Has site been put into reuse? ☐ YES ☒ NO	

REVIEW STATUS

Lead agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency _____	
Author names: Charnjit Bhullar and Julie Santiago-Ocasio	
Author title: Remedial Project Manager	**Author affiliation: USEPA Region 9**
Review period: September 2010 through April 2011	
Date(s) of site inspection: November 5, 2010	

Type of review:

☒ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

Review number: ☐ 1 (first) ☐ 2 (second) ☐ 3 (third) ☒ Other (specify) : 4 (fourth)

Triggering action:

☐ Actual RA On-site Construction at OU ☐ Actual RA Start at OU#____
☐ Construction Completion ☒ Previous Five-Year Review Report
☐ Other (specify)

Triggering action date: September 19, 2006

Due date *(five years after triggering action date)*: September 19, 2011

Five Year Review Summary Form, continued

Issues:

1. Zones 1, 2, and 3. The current monitoring network may be inadequate to monitor contaminants and assess extraction well capture zones in the weathered and unweathered bedrock.
2. Zone 1. Alluvium is not completely dewatered to bedrock, and weathered and unweathered bedrock along the western portion of the clay barrier dam may not be completely sealed by the grout curtain.
3. Zones 2, 3, and 4. There are potential off-site sources of perchlorate in groundwater and surface water.

Recommendations:

1. Zones 1, 2, and 3. Optimize the monitoring program so that there are sufficient wells to assess containment at extraction systems and migration in weathered/unweathered bedrock. Modify the extraction systems as necessary.
2. Zone 1. Evaluate the need for additional monitoring and /or extraction wells or dewatering in Zones 1 and 1b.
3. Complete additional investigations as necessary to verify the off-site perchlorate sources.

Protectiveness Statements:

The interim remedies at the Stringfellow Superfund Site are currently protective because exposure pathways that could result in unacceptable risks are being controlled. However, to be protective in the longterm the following action should be completed:

- Optimize the existing monitoring and extraction well systems in Zones 1, 2 and 3 in order to determine if there are sufficient wells to assess containment and contaminant migration. Modify or augment the monitoring and extraction systems as necessary.
- Evaluate the need for additional monitoring and/or extraction wells in Zone 1.
- Complete additional investigations as necessary to verify the off-site perchlorate sources.

The selected remedy for the Site is protective of human health and the environment in the short-term because exposure pathways that could result in unacceptable risks are being controlled.

Other Comments: The following are follow-up recommendations that do not necessarily affect protectiveness but should be addressed:

- Evaluate additional background soil data and prepare a Screening-Level Ecological Risk Assessment (SLERA) Addendum for inclusion in the final ROD.
- Finalize the groundwater monitoring program optimization and complete the revised Sampling and Analysis plan.
- Analyze pCBSA at Zone 1 wells using EPA Method 331/332 or an equivalent method that will accurately quantify the chemical.
- Complete the Biennial Evaluation Report within one year of completion of groundwater sampling or O&M activities to allow evaluation of the data in timely manner and complete recommended activities. The capture zone evaluation should be included in all future reports to

compare temporal stresses and assess system effectiveness.

1.0 Introduction

The purpose of the Five-Year Review process is to evaluate whether the remedial measures implemented at the Site are 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 provide recommendations for addressing them.

The United States Environmental Protection Agency (USEPA) is preparing this Five-Year Review report pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA Section 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 are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with Section [104] or [106], the President shall take or require such action. The President shall report to Congress a list of facilities for which such review is required, the results of all such reviews, and any action taken as a result of such reviews.

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations 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.

Consequently, this statutory Five-Year Review was undertaken because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

The USEPA has conducted a review of the Stringfellow Hazardous Waste Site located in Riverside County, California, approximately 50 miles east of Los Angeles (Figure 1). This review was conducted by the U.S. Army Corps of Engineers (USACE), on behalf of USEPA, between September 2010 and April 2011. This is the fourth Five-Year Review report for the Site. The trigger for the first review was five years after the start of on-site construction in February 1993, followed by subsequent Reviews dated September 2001, and September 2006. The third Five-Year Review was the triggering action for this Review.

This report addresses the following zones and media at the Site (see Figure 2):

- Zone 1 – On-site/Upper-Mid Canyon Area (soil and groundwater)
- Zone 2 – Mid-Canyon Area (groundwater)
- Zone 3 – Lower Canyon Area (groundwater)
- Zone 4 – Glen Avon Community (groundwater)

The name, description, applicable zone, and status of each operable unit (OU) at the Site are identified in Table 1. The scope of each OU is based on the scope of the Record of Decision (ROD) documents that have been recorded for the Site.

Table 1. Description of Stringfellow Superfund Site Operable Units (OUs) and status.

Operable Unit	*OU Name*	*OU Description*	*Zone*	*Status*
00	Site Evaluation	Pre-remedial and Emergency Response (Interim Abatement Program).	1	Complete
01	Site Source Control	First ROD.	1	First ROD issued July 22, 1983. Remedy implemented.
02	Pretreatment Plant (PTP)	Second ROD.	2	Second ROD issued July 18, 1984. Remedy implemented.
03	Lower Canyon	Third ROD.	3	Third ROD issued June 25, 1987. Remedy implemented.
04	Dewatering/Community Wells	Fourth ROD.	1, 4	Fourth ROD issued September 30, 1990. Remedy implemented.
05	Final Remedy	Final remedy for all zones.	1, 2, 3, 4	Evaluations to support selection of final remedy underway.

Source: Modified from Operable Units, 1996. USEPA Stringfellow Site overview Technical Documents (http://www.epa.gov/region9/superfund/index.html)

2.0 Site Chronology

The chronology of key events for the Site is provided in Table 2. The State of California regulatory agencies, which have been involved with response and cleanup activities at this Site, include the California Regional Water Quality Control Board (Water Board) and the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), formerly the California Department of Health Services, Toxic Substances Control Division. DTSC became the primary responsible party for the Site and is conducting the investigation, cleanup, and operations and maintenance (O&M) actions at the Site. The USEPA is the oversight agency.

In 1992, a consent decree between USEPA and the potentially responsible parties (PRPs, named the Pyrite Canyon Group [PCG]) required containment of the groundwater plume in the community. In 1995-1996 an investigation was conducted by the PRPs in Zone 4 down-gradient of the southern-most Zone 4 extraction well. In 1996, the State of California took over operations of the Pretreatment Plant (PTP), although the PRPs continued work in other zones. In 1997, to address the down-gradient extent of TCE plume, the PRPs installed and started operation of the Community Wellhead Treatment System, which included 2 extraction wells.

In early 2001, DTSC detected perchlorate at the Site and began a perchlorate investigation in Zone 4 which delayed the Supplemental Feasibility Study (SFS). From 2007 through 2010, new extraction wells were added to Zones 1 through 3 to increase groundwater capture effectiveness. In 2009, the Final SFS for Zones 1 through 3 was completed and the PTP was upgraded. In 2010, the Final Zone 4 Remedial Investigation (RI) for perchlorate was completed.

Table 2. Chronology of Site Events

Date	Event
August 1956	Hazardous waste disposal operations at Stringfellow commenced.
1969	Excessive rainfall leads to overflow of former disposal ponds.
February 1972	Site contaminants first detected in groundwater down-gradient of waste disposal area.
November 1972	Hazardous waste disposal operations at Stringfellow Site ceased.
1975	Water Board initiates response actions and studies.
November 1978	Controlled release of contaminated water to Pyrite Creek; discharge supervised by Water Board.
1978-1981	Water Board removed 6.5 million gallons (MG) of contaminated water and dichloro-diphenyl-trichloroethane (DDT)-contaminated soil.
1980	USEPA performed initial site inspection. Ten MG of contaminated water removed; containment barriers were installed and surface drainage improvements were made.
December 1980	Water Board adopted Interim Abatement Program.
October 1981	Stringfellow Site placed on the USEPA Interim Priorities List of Hazardous Waste Sites.
1981	California Department of Health Services began the investigation and cleanup at the Site.
July 22, 1983	USEPA issued first ROD.
September 8, 1983	Stringfellow Site placed on USEPA National Priorities List (NPL).
1983-1984	"Fast-track" Remedial Investigation/Feasibility Study (RI/FS) conducted by USEPA
July 18, 1984	USEPA issued second ROD (addressed Zones 1 and 2).

Date	Event
September 18, 1984	Start of Remedial Design (RD) for Zone 2 groundwater extraction system.
October 23, 1984	Completion of RD for Zone 2 groundwater extraction system.
November 29, 1984	Start of Remedial Action(RA) for Zone 2 groundwater extraction system.
November 15, 1985	Completion of RA for Zone 2 groundwater extraction system.
1985	On-site PTP startup in Zone 2.
June 1987	Draft RI Report released for public comment.
June 25, 1987	USEPA issued third ROD (addressed Zones 1 and 3).
September 30, 1987	Start of RD for Zone 3 groundwater extraction system.
May 1988	Potentially responsible parties (PRP) agreed to construct certain components of the third ROD remedial actions in an Administrative Order on Consent.
June 1988	Draft Final FS Report issued.
June 1988	USEPA and DTSC issued Proposed Plan to address Zone 4 groundwater contamination.
August 31, 1988	Completion of RD for Zone 3 groundwater extraction system.
February 1989	USEPA and DTSC issued second Proposed Plan (included long-term continuation of down-gradient plume management activities for Zones 2 through 4, and for Zone 1, dewatering coupled with soil vapor extraction [SVE] and installation of an improved cap).
March 2, 1989	Start of long-term response action for Zone 1.
March 2, 1989	Start of remedial action for Zone 3 groundwater extraction system.
April 5, 1990	Completion of RA for Zone 3 groundwater extraction system.
July 25, 1990	Start of RD for Zone 4 groundwater extraction system.
September 30, 1990	USEPA issued fourth ROD (addressed Zones 1 through 4).
1992	A consent decree between USEPA and the potentially responsible parties (PRPs) required containment of the groundwater plume in the community.
February 1993	USEPA issued First Five-year Review Report.
January 3, 1995	Completion of RA for Zone 4 groundwater extraction system.
1995	Construction completed on Zone 1 dewatering system (fourth ROD).
1996	The State of California took over PTP operations, although the PRPs continued work in other zones.
1997	PRPs installed and started up the Community Wellhead Treatment System (CWTS).
July 9, 1998	Explanation of Significant Differences (ESD) issued for the second ROD for construction of an effluent pipeline between the PTP and the Santa Ana Regional Interceptor (SARI) pipeline.
October 1998	Construction of effluent pipeline extending to SARI pipeline completed.
1998	Construction completed on additional components to Zone 4 extraction system.
1998	DTSC performed additional Zone 4 investigation.
1998-2000	DTSC performed additional field investigations in zones 1 through 3.
October 1999	Groundwater extraction system in Zone 1 expanded.
April 2000	DTSC issued Draft Supplemental Feasibility Study (SFS) Report for Zones 1 through 4.
April - May 2001	DTSC detected perchlorate at Site and began perchlorate investigation in Zone 4.
June 2001	Volatile Organic Compound (VOC) emissions recovery systems installed at the PTP in Zone 2 for A-Stream storage tanks.

Date	Event
September 2001	USEPA issued Second Five-year Review Report.
January – March 2002	Installation of 28 new monitoring wells in Zone 3.
March 2002	Phase I audit conducted for historical uses of perchlorate in Glen Avon area in Zone 4.
2002	All residents with private wells in Zone 4 were connected to the public water supply. The private wells were converted to irrigation uses only.
October 2002 – January 2003	Soil sampling in Zone 1 and along Pyrite Creek.
January 2003	New PTP Conceptual Process Evaluation Report completed.
June 2003	Perchlorate detected in water supply wells east of Site.
October 2003	Interim Pesticide Removal System (IPRS) installed at PTP in Zone 2.
December 2003	DTSC amended the CWTS with resin beds to treat perchlorate contaminated influent from Zone 4.
2004	Zone 4 RI for perchlorate initiated.
2005	Permanent Pesticide Removal System (PRS) installed at PTP in Zone 2.
August 2005	DTSC completed seismic reflection survey for Zone 4 and cone penetrometer testing.
2004 – 2007	Bench-Scale testing for New PTP conducted.
August 2005	Final Screening-Level Ecological Risk Assessment (SLERA) completed.
August 2005	One monitoring well converted to extraction well in Zone 1.
September 2006	Third Five Year Review report issued by USEPA.
January 2007	Three monitoring wells in Zone 1 converted to extraction wells.
February 2006 – November 2007	Pilot-Scale testing for proposed New PTP train conducted.
2008	One monitoring well converted to extraction well in Zone 2.
2009	Air strippers installed at PTP in Zone 2.
June 2009	Final Health Risk Assessment for Zone 4 completed.
July 2009	Final Supplemental Feasibility Study for Zones 1, 2, and 3 completed.
July 2009	New PTP Design began (referred to as Pyrite Canyon Treatment Facility [PCTF]).
June 2010	Installed secondary containment for the decontamination pad.
Nov 2010	PCTF (new PTP) 30% design completed.
February 5, 2010	Final Zone 4 RI report completed.
November 2010	Pilot Study of In-Situ Bioremediation of Zone 4 perchlorate completed.
July 7, 2010	Three monitoring wells converted to extraction wells in Zone 3.
December 2010	Proposed boundaries for Zone 4 Institutional Controls updated.
December 2010	Bedrock aquifer testing completed in Zones 1-4 wells.

3.0 Site Background

3.1 Physical Characteristics

The Site is located in the City of Jurupa Valley (formerly known as the community of Glen Avon) in Riverside County, California, approximately 50 miles east of Los Angeles (Figure 1). The original 17-acre Site is located in Pyrite Canyon in the Jurupa Mountains at the head of Pyrite Creek. As a result of previous activities at Zone 1 and subsequent migration of contaminants in groundwater, groundwater contamination from the Site extends approximately 4 miles south towards the Santa Ana River. The area down-gradient of Zone 1 is evaluated as three separate geographic zones – Zones 2, 3, and 4 (Figure 2). Zones are identified as follows:

- **Zone 1: On-site/Upper Mid-Canyon Area**, which includes the original 17-acre disposal facility in the northern part of Pyrite Canyon and an area extending southward a distance of 600 feet south of the clay barrier dam. The clay core barrier dam was constructed down-gradient of the disposal ponds to mitigate the migration of subsurface leachate.
- **Zone 2: Mid-Canyon Area**, encompassing the portion of Pyrite Canyon that extends from the southern edge of Zone 1 to, and including, the existing mid canyon extraction wells (approximately 800 feet south of Zone 1);
- **Zone 3: Lower Canyon Area**, which extends southward from the mid-canyon extraction system to the lower-canyon extraction system located just north of State Highway 60 (extending approximately 3,200 feet south of Zone 1); and
- **Zone 4: Glen Avon Community**, which includes the area south-southwest of the lower-canyon extraction system to the leading edge of the known groundwater plume at the Santa Ana River (approximately 22,000 to 24,500 feet southwest of the former disposal site in Zone 1).

The Stringfellow Site is located within a semiarid climate zone, and intermittent stream flow in Pyrite Creek occurs as a result of infrequent, intense rainfall events. The Pyrite Creek watershed covers approximately 270 acres (USEPA, 1983). Natural surface water flow in the canyon has been altered due to the construction of the former disposal ponds and surface water channels. Surface water that drains from the canyon walls upstream of the Site and from Zone 1 collects into a surface water drainage channel that borders the original site property (Figure 3). Surface water that collects in the channel either discharges into Pyrite Creek or infiltrates into exposed soil in portions of the drainage channel that are not lined with concrete.

Pyrite Canyon is bordered by undeveloped steep canyon walls that reach a height of 1000 feet above the canyon floor in Zone 1. The floor of the canyon descends approximately 100 feet from the northern-most boundary of the Stringfellow Site to the clay barrier dam at the southern end of Zone 1 and an additional 840 feet down to the mouth of the canyon around U.S. Highway 60 (ENVIRON, 2009).

Pyrite Canyon is underlain by the following geologic units. Typical cross-sections through Zone 1 and through Zones 2 and 3 are shown on Figures 4 and 5.

- **Fill/Alluvium.** In general, the fill and alluvium materials are found at the surface and extend across all zones. The fill material consists of soil and unconsolidated sediments that are adjacent to the disposal area and mixed with the natural soil to create berms, roads, and soil caps. The alluvium materials consist mainly of silts and sands with interbedded layers of clayey

sand and clean sand. The alluvium is thickest (over 100 feet in Zone 2) along the thalwag of the paleo-channel that was incised into the underlying bedrock. Hydraulic conductivity values from pumping tests and slug tests ranged from 0.72 to 39.7 feet/day (ft/d). The thickness of the saturated alluvium in Zone 1 ranges from zero to about 30 feet. The horizontal hydraulic gradient ranges from 0.054 to 0.093 ft/ft in Zones 1 through 3 and decreases across Zone 4 to about 0.0066 ft/ft near the Santa Ana River.

- **Weathered Bedrock.** The alluvium is underlain by granitic and metamorphic bedrock that has been weathered to varying degrees and depths across the Site. The rock fragments range from coarse-grained, sand-sized particles to cobbles and vary in competence from friable (easily crumbled) to hard. Borehole data indicate that the thickness of the weathered bedrock varies from 2-feet near the hills in Zone 4 to over 150-feet below ground surface near the paleo-channel. Hydraulic conductivity values from pumping tests and slug tests ranged from 0.001 to 1.68 ft/d. The horizontal hydraulic gradient ranges from 0.26 to 0.11 ft/ft in Zones 1 through 3 and decreases across Zone 4 to about 0.0076 ft/ft.

- **Unweathered, Fractured Bedrock.** A variety of bedrock types are present at the Site. The upper watershed above the Site consists of older metamorphosed sedimentary rocks that were intruded by younger granitic rocks. The top of the unweathered bedrock can exceed 150 feet below ground surface in the paleo-channel area. Hydraulic conductivity values from pumping tests and slug tests ranged from 0.00065 to 1.58 ft/d.

Ground water originates from groundwater upstream of the Site and canyon sidewalls. Depth to groundwater varies within the canyon, and groundwater is found in all three underlying geologic units (alluvium, weathered bedrock, and unweathered bedrock). The groundwater flow direction across Zones 1 through 3 mimic the topography and generally flows to the south. Across Zone 4, the flow direction shifts from nearly due south to southwest and then finally west, just north of the Santa Ana River.

3.2 Land and Resource Use

From 1956 until 1972, the Stringfellow Quarry Company, Inc. operated a Class 1 hazardous waste disposal site (USEPA, 1983). The land of the original site remains undeveloped, and is largely used to support treatment and Operation and Maintenance (O&M) activities associated with the remedy for the Site.

Land use surrounding the Site is limited to several commercial developments south of the Site (Zones 3 and 4), including an active rock quarry and an automobile recycling facility. The quarry is located immediately west of the Site and has been identified as a potential off-site source of perchlorate to surface and groundwater in Zones 2, 3, and 4. Perchlorate is a common additive in blasting products. The canyon walls east and west of the original site (Zone 1) are undeveloped. Land north of the Site (on the other side of the Jurupa Mountain Range) has been developed for residential purposes. The residential community of Glen Avon, which is approximately 4,500 feet southwest of the former disposal ponds, historically used groundwater as a source of drinking water. Residents of Glen Avon within the plume footprint are currently connected to a public water supply and no longer use the private wells as a source of drinking water. The Riverside Department of Environmental Health (RDEH) currently restricts the installation of domestic wells within the plume boundaries.

3.3 History of Contamination

During operation as a hazardous waste disposal site from 1956 to 1972, more than 34 million gallons (MG) of liquid industrial waste, primarily from metal finishing, electroplating, and pesticide production, were deposited in approximately 20 unlined evaporation ponds located in Zone 1. Spray evaporation procedures were used to decrease the volume of wastes in the ponds. Evaporation ponds covered a 3.5 acre area and an additional 5.6 acre area was contaminated from evaporation procedures (USEPA, 1983).

In 1969, excessive rainfall caused the disposal ponds to overflow and discharge contamination to Pyrite Creek. In response, the Regional Water Quality Control Board (RWQCB) directed the property owner to implement several measures (for example, construction of earthen berms, a collection sump, and a waste liquid return system) to prevent another surface water discharge. In 1972, analytical results from groundwater samples collected from a monitoring well in Zone 3 detected concentrations of Site related chemicals. Stringfellow Quarry Company, Inc., voluntarily closed the Site in November 1972 (ENVIRON, 2009).

Environmental sampling efforts from 1975 to 1984 were conducted at the Site. Analytical sampling results collected as part of this effort indicated that soils and groundwater at the Site were contaminated with several chemical including volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), pesticides, perchlorate, n-nitrosodimethylamine (NDMA), 1,4-dioxane, para-chlorobenzene-sulfonic acid (pCBSA), salts, and heavy metals such as cadmium, nickel, chromium, copper, manganese, and zinc. Wells in Zone 1 contained highly acidic groundwater, with pH ranging from 2.6 to 4.1.

3.4 Initial Response

Between 1975 and 1981, the RWQCB, Santa Ana Region, initiated the excavation of contaminated soil from areas down-gradient of the Site, constructed three down-gradient containment berms, conducted a controlled release of Stringfellow contaminants to Pyrite Creek after heavy rains, and removedapproximately 6.5 MG of liquid wastes and dichloro-diphenyl-trichloroethane (DDT)-contaminated material. Removal of all remaining surface liquids occurred followed by partial neutralization and capping of the wastes. Starting in 1981, a clay barrier dam was installed, improvements were made to the surface drainage system, and interceptor wells and monitoring wells were installed (ENVIRON, 2009).

In 1980, the RWQCB adopted an interim abatement solution to prevent leaching and washout of the contaminated waste. The interim program was designed to reduce the amount of waste, neutralize its pH, reduce surface flow contamination, and contain, reduce, and treat contaminated groundwater. The program installed a gravel collection system and a clay core barrier dam downstream of the Site, concrete gutters and gunite channels for surface runoff, a 1-foot kiln dust layer and 2-foot clay cap on top of the disposal site, 14 monitoring wells, 3 extraction wells upstream of barrier dam, 1 extraction well downstream of barrier dam and 3 interceptor wells; graded the Site for drainage control; and injected gel into bedrock below the barrier dam.

3.5 Basis for Taking Action

Based on an evaluation of all contaminated media analytical sampling data, the exposure pathway identified with the greatest risk to human health was from the consumption of contaminated groundwater (SAIC, 1987). Groundwater at the Site was found to be contaminated with high concentrations of soluble organic and inorganic contaminants, including, but not limited to, acids, minerals, and heavy metals. Groundwater contamination from the Site extends from Zone 1 to the Santa Ana River in Zone 4. The vertical extent of contaminated groundwater in Zones 1, 2, 3 was found in the alluvium, weathered bedrock, and the fractures in the unweathered bedrock to depths over 150 feet bgs. Contamination in Zone 4 has been observed in the alluvium and weathered bedrock and could potentially migrate to the unweathered bedrock (Tetra Tech, 2007).

Of the other exposure pathways, the exposure to contaminated soils (without a cap) was of potential concern only in Zone 1. On the basis of these findings, remedial action was determined to be warranted to mitigate risks to human health and the environment.

4.0 Remedial Actions

The following sections summarize the interim remedial actions selected for each zone in the four RODs, describe the implemented remedial actions and the O&M activities of the existing remedial systems. A summary of the interim RODs remedial actions is also presented in Table 3. The first interim ROD, issued on July 22, 1983, was for completion of several initial abatement activities, including fencing, erosion control, interim source control, and off-site hauling and disposal of contaminated liquids (USEPA, 1983). The second interim ROD, issued on July 18, 1984, included construction of an on-site PTP to treat contaminated groundwater and installation of an expanded extraction system in Zone 2 (USEPA, 1984). The third interim ROD remedy, issued on June 25, 1987, included the installation of a groundwater barrier system in Zone 3, and installation of peripheral surface channels to direct up-gradient surface water runoff (USEPA, 1987). The fourth interim ROD selected remedy , issued on September 30, 1990, included dewatering in the original disposal area (Zone 1), installation of a groundwater extraction system in Zone 4, field testing of soil vapor extraction (SVE), and field testing of reinjection of treated groundwater in the upper canyon area (USEPA, 1990). A Supplemental Feasibility Study (SFS) for Zones 1, 2, and 3 was completed in 2009, and the Feasibility Study (FS) for Zone 4 perchlorate is expected to be completed in 2012. These studies will support the selection of the final remedy in the fifth and final ROD scheduled for completion in 2013.

4.1 Zone 1 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented in Zone 1 and presents a summary of current Zone 1 system operations.

4.1.1 Remedy Selection

All four RODs selected interim remedial actions to address the hazards and risks posed by the original waste disposal area (Zone 1). The RODs focus primarily on remedial measures involving site fencing, erosion control, surface water management, and controlling the source of contaminants (by waste removal, capping/containment, groundwater barrier, and extraction). The primary remedial action objectives (RAO) for Zone 1 are to (1) prevent direct and/or indirect contact with site-related contaminants in soils and surface water; (2) reduce the potential for the release and migration of site contaminants to groundwater; and (3) control, recover, and treat contaminated liquids in Zone 1 using diversion, dewatering, extraction, and on-site pretreatment systems.

4.1.2 Remedy Implementation

Remedial actions completed at Zone 1 consist of the following key elements:

- A clay cap and vegetative cover to retard infiltration of rainfall and prevent erosion.
- An up-gradient groundwater and surface water interception system that consists of groundwater drainage trenches, surface drainage channels, and 15 up-gradient interception wells.
- A hydraulic control and dewatering system that currently consists of 38 extraction wells operating with timed on/off cycles to maintain prescribed pumping water levels.
- A down-gradient hydraulic control system consisting of 8 extraction wells and a French drain at the subsurface clay barrier dam.

Additional details on the components of the remedial actions performed in Zone 1 are summarized in Table 3. The remedial measures selected in the first interim ROD were completed primarily by DTSC under a cooperative agreement with USEPA. Improvements and expansion of erosion control systems were completed in accordance with the second and third interim RODs. The fourth interim ROD, issued in 1990, directed groundwater dewatering down to bedrock in Zone 1, to reduce the potential for further release of site contaminants, and initiated SVE field testing to evaluate the feasibility of removing VOCs from the vadose zone in the source area. Subsequent pilot tests for SVE and 2-Phase™ extraction were determined to have only limited effectiveness and were ruled out as viable remedial alternatives.

4.1.3 System Operations

Groundwater monitoring has been performed on a semiannual basis for monitoring wells until 2010, when the frequency was modified to annual. Extraction wells are sampled on a monthly to semi-annual frequency, depending on requirements per zone. The extraction well frequency will be modified to annual in 2012 (unless required to be more often per permit). The new wells will be sampled quarterly for 2 years. DTSC is currently evaluating the monitoring program, which will be revised in 2012.

There have been 104 monitoring and 44 extraction wells installed within Zone 1 (Tetra Tech, 2010). Due to the large number of wells, only a subset is sampled during each event, which is determined by DTSC. The following modifications to the extraction system have been completed since the last Five-Year Review: (1) three monitoring wells in the north cap area of Zone 1 were converted to extraction wells in January 2007 to help control contaminant migration (Tetra Tech, 2010); and, (2) MW-22, located within the weathered bedrock down-gradient of the clay barrier dam, was converted to an extraction well in 2005 as a replacement for the horizontal well that was decommissioned in 2003.

Water intercepted or extracted up-gradient of the original disposal area is discharged to the surface drainage channels that drain to Pyrite Creek. All groundwater recovered from extraction wells within the original disposal area is treated at the on-site mid-canyon PTP located in Zone 2 (described in the following section). Groundwater extracted from wells located in the waste disposal area is designated "A-Stream." Groundwater extracted from wells located on the perimeter of Zone 1 was formerly designated "F-Stream;" the F-Stream was connected to the A-Stream in August 2005. A-Stream water is treated for low pH, pesticides, metals, and VOCs. Average annual flow rates for the A-Stream were approximately 7,769; 18,645; 16,454 and 11,004 gallons per day (gpd) in 2004, 2005, 2006, and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010). Average annual contaminant mass removals for the A-Stream were 3,446; 4,019; 4,843 and 3,377 pounds (primarily due to metals) in 2004, 2005, 2006 and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010). The A-Stream extraction wells were shut down for the first part of February 2007 due to problems during the transition period when plant operation contractors changed (EarthTech to Veolia).

The remedial components in Zone 1 are operated and maintained according to the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c) and the *Groundwater Monitoring Program Work Plan* (Geo-Logic Associates, 2001). The remedial components in Zone 1 are inspected on a daily or weekly basis, in accordance with the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c). The cap is also inspected during and following heavy rainfall to assess potential erosion problems. Weeding is performed on an annual basis and re-grading is performed as necessary. An example of the daily and weekly inspection activities is shown in Figures 6 and 7.

A 2-foot by 3-foot sinkhole was first observed in the Zone 1 cap in March 2006. The hole later widened to about 4-foot by 4-foot with a depth of about 5 feet. Although, geotechnical studies involving ground-penetrating radar surveys and cone penetration tests were conducted, the cause of the sinkhole remained uncertain (BAS, 2007). The sinkhole was backfilled with cement slurry in November 2007 and the area was monitored for additional subsidence; no subsequent problems have been reported (BAS, 2008).

Table 3. Remedial actions implemented by zone at the Stringfellow Site.

Decision Document	**Remedial Action/ Components**			
	Zone 1	Zone 2	Zone 3	Zone 4
N/A (Interim Abatement Program) – PreRODS (see ROD1, Appendix 1B)	Source Control • Remove all surface liquids • Neutralize acid soils Installation of clay barrier dam			
First ROD, July 1983	Sitewide Fencing Erosion Control • Maintenance of existing cap and surface drainage • Vegetative seeding to prevent erosion Source Control • Off-site disposal of leachate Groundwater extraction and monitoring wells			
Second ROD, July 1984	On-site Pretreatment System • Heavy metals and organics removal • Off-site disposal of sludge • Effluent discharge to publicly owned treatment works (POTW)	On-site Pretreatment System • Mid canyon PreTreatment Plant (PTP) • Extracted groundwater (Zones 1 and 2) treatment • Effluent discharge to POTW • Pretreatment system O&M Mid canyon interceptor well system • Installation of additional extraction & monitoring wells		
Third ROD, June 1987	Erosion Control • Install peripheral drainage channel to direct up-gradient surface water runoff • Extend existing gunite channels southward to discharge surface water to Pyrite Creek		Lower Canyon Interceptor Well System • Extraction Wells • Treatment at Lower Canyon Treatment Facility (LCTF) • Effluent discharge to POTW	
Fourth ROD, Sept 1990	Source area dewatering Treat Zone 1 extracted groundwater at existing mid-canyon PTP; discharge treated effluent to POTW Feasibility evaluation of Soil Vapor Extraction (SVE) to remove VOCs (pilot tests determined SVE was not a viable option)	Feasibility evaluation of reinjection of treated groundwater from Zone 4 to enhance flushing of COCs (pilot tests determined ineffective)	Feasibility evaluation of reinjection of treated groundwater from Zone 4 (pilot tests)	Community Groundwater Pump and Treat • Extraction & monitoring wells • Groundwater treatment at LCTF and Community Wellhead Treatment System (CWTS) • Effluent discharge to POTW and/or irrigation reuse Surface Water Management • Discharge under National Pollutant Discharge Elimination System (NPDES) permit and/or reuse
Explanation of Significant Differences (ESD), 1998		Construction of effluent pipeline to convey effluent form the PTP to the Santa Ana Regional Interceptor (SARI) pipeline		

4.2 Zone 2 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 2, and presents a summary of current system operations in Zone 2.

4.2.1 Remedy Selection

The remedy selected for Zone 2 in the second ROD included construction of an on-site PTP (for all site-related contaminated groundwater) and installation of a groundwater extraction and barrier system in Zone 2. The RAO for the groundwater remedial system was to prevent further down-gradient migration of contaminated groundwater from Zone 2 to Zone 3. Because the specific performance requirements for the groundwater remedy were not identified in the second ROD, pumping tests and evaluations were later conducted to complete the design of the extraction system.

4.2.2 Remedy Implementation

The Zone 2 groundwater extraction system was initially installed in 1985 and consisted of a total of seven extraction wells located near the southern down-gradient boundary of Zone 2 (Tetra Tech, 2010). One additional monitoring well (MW-19B) was converted to an extraction well in 2008. The extraction wells, electrical panels, power systems, and collector pipelines in Zone 2 were upgraded and replaced in 2004.

The PTP was constructed in the mid-canyon area of Pyrite Canyon and has been in operation since 1985. The PTP utilizes lime precipitation for metals removal, followed by granular activated carbon (GAC) for removal of organic contaminants. The PTP treats all contaminated groundwater recovered from extraction systems operating in Zones 1 and 2. A-Stream water runs through the Pesticide Removal System (PRS) prior to metals treatment to prevent pesticide exceedances in the metals treatment system filter cake that prevent landfill disposal and require incineration. Prior to 1998, the treated effluent from the PTP was transported by truck to a pipeline collection point and then conveyed to the local Publicly Owned Treatment Works (POTW), the Santa Ana Regional Interceptor (SARI) industrial wastewater treatment plant. In October 1998, construction of a new PTP effluent pipeline, which conveys effluent from the PTP to the SARI pipeline, was completed as directed by the 1998 Explanation of Significant Differences (ESD) (USEPA, 1998).

A new PTP is currently being designed to replace the existing functions of the PTP. The existing PTP meets SARI discharge limits; however, it was determined that a new PTP is needed to replace the aging infrastructure and to provide long-term reliable treatment capabilities. The new PTP will be moved to a new location at the Site and is referred to as the Pyrite Canyon Treatment Facility (PCTF). The PCTF will be expandable in size, if future new contaminants of concern (COCs), (e.g., perchlorate, 1,4-dioxane, hexavalent chromium, and/or NDMA) that are not specified in the second ROD or current discharge limits, need to be treated. Pilot-scale tests and conceptual process evaluation reports have been completed for the PCTF if treatment for new COCs is needed (Shaw, 2008; Shaw, 2009).

4.2.3 System Operations

Groundwater monitoring has been performed semiannually until 2010, when the frequency changed to annual. New monitoring wells are sampled quarterly for 2 years. Extraction wells are sampled on a monthly to semi-annual frequency, depending on the monitoring requirements per zone. The

monitoring program is currently under evaluation and will be revised in 2012.

There are currently 16 monitoring wells in Zone 2 (Tetra Tech, 2010). Zone 2 is not owned by the State of California, except for the PTP location; wells have not been installed in an adequate number of locations to monitor all of the preferential pathways for contaminant flow or to maintain full capture effectiveness. Currently, informal property access is granted by the property owners to the State of California for operation and maintenance of its existing structures and wells.

All groundwater recovered from the Zone 2 extraction system (designated "B-Stream") is treated at the PTP for VOCs and is then discharged to the SARI pipeline. Average annual well production from the Zone 2 groundwater interceptor system was approximately 8,645; 39,165; 22,915; and 14,479 gpd in 2004, 2005, 2006, and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010). Average annual contaminant mass removals for the B-Stream were 24.4, 68.7, 44.1 and 34.1 pounds in 2004, 2005, 2006 and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010).

The remedial components in Zone 2 are operated and maintained according to the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c) and the *Groundwater Monitoring Program Work Plan* (Geo-Logic Associates, 2001). The remedial components in Zone 2 are inspected on a daily or weekly basis, in accordance with the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c). Routine maintenance of filters, pumps, valves, and meters at the PTP are performed on either a weekly or monthly basis. An example of the daily and weekly inspection activities is shown in Figures 6 and 7.

Pretreatment Plant (PTP)

The PTP consists of four primary groundwater treatment processes as shown in Figure 8:

- A Volatile Organic Compounds Removal process using air strippers followed by vapor phase GAC adsorption (installed in 2009);
- A Pesticides Removal process, which adds slight amounts of hydrated lime and anionic polymer (which raises the pH and increases flocculation), to the water to concentrate the pesticides on settleable solids, which are further concentrated by clarifiers and dewatered by filter presses;
- A Metals Treatment System (MTS) process, which mitigate the low pH water and reduce its metal content by adding hydrated lime to increase the pH and by adding anionic polymer to increase flocculation, which causes the dissolved metals to precipitate; the precipitated metals are then further concentrated by clarifiers and dewatered by filter presses; and
- A final Volatile Organic Compounds Removal System process to adsorb VOCs onto liquid phase GAC.

Water collected from Zones 1 and 2 (A-Stream and B-Stream), is currently treated at the PTP (ENVIRON, 2009). All treated wastewater from the PTP is discharged to the SARI sewer under Permit No. 4D-98-S101 from the Santa Ana Watershed Project Authority (SAWPA, 2009). The SARI conveys discharges to Orange County Sanitation District's Plant Number 2, a POTW that provides treatment and chlorination before discharge to the Pacific Ocean. Treated effluent discharges to the SARI from 2006-2007 met all permit discharge limits (Tetra Tech, 2010). Available O&M reports from January 2008, 2009, January – November 2010 showed continuing compliance with effluent discharge permit requirements (Veolia, 2008, 2009a,b,d, and 2010a-j).

During the treatment process, the plant produces metal-rich sludges (filter cake) from the filter presses and treated groundwater, which are disposed of in a Class I landfill. Filter cake from the pesticides removal process is disposed via off-site incineration (Tetra Tech, 2010). Table 4, below, provides PTP chemical usage and filter cake production from 2006 to 2010.

Table 4. PTP Chemical Usage and Filter Cake Production

Year	Hydrated Lime (tons)	PRS Filter Cake (tons)	MTS Filter Cake (tons)	Polymer (pounds)	PTP Liquid Phase GAC (pounds)	PTP Antifoam (pounds)	PTP Vapor Phase GAC (pounds)
2006	263	294	1,766	1,608	60,000	NA	NA
2007	165	73	1,275	930	20,000	NA	NA
2008	139	72	1,454	465	20,000	NA	1,000
2009	129	53	1,138	1,860	40,000	NA	0
2010	134	45	1,247	930	20,000	1,764	11,500

NA: Not applicable

A DTSC contractor (Veolia) currently operates the PTP and performs related treatment and disposal activities. The PTP generally runs eight hours a day five days a week. Design plans are currently in progress that will enable DTSC and site operators to monitor PTP operations remotely. Recent modifications and additions to the PTP include the following:

- 2006: DTSC installed aluminum shields to protect control panels from the sun; replaced plate packs in the south clarifier, which forced a temporary shutdown of the pesticides removal system from February 1 to March 26, 2007 (Tetra Tech, 2010); and installed new chutes beneath the PTP MTS filter presses.

- 2009: DTSC installed two air strippers along with four vapor phase granulated activated carbon tanks and anti-foam system; two rapid mix tanks; two MTS flock tanks; a polymer system; a lime feed tank; cable trays; MTS clarified water tank; HMI (Human-Machine Interface) and a SCADA (Supervisory Control and Data Acquisition) system; interconnecting walkways, platforms, ladders, stairs, pipe racks; and electrical system; and several electrical and control panels at the PTP.

- 2010: DTSC installed secondary containment for the decontamination pad.

4.3 Zone 3 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 3, and presents a summary of current system operations in Zone 3.

4.3.1 Remedy Selection

The third ROD, issued in June 1987, established the following RAOs for Zone 3: (1) to remove contaminated groundwater and (2) to stop additional contaminated groundwater from moving south into the community of Glen Avon. The remedy selected for Zone 3 specified the installation of a groundwater interception system in the Lower Canyon area and treatment of extracted groundwater, followed by discharge to a POTW.

4.3.2 Remedy Implementation

The PRPs designed and installed the Zone 3 extraction system between 1987 and 1990 to intercept and remove groundwater contaminated with VOCs. Five groundwater extraction wells screened in the alluvium and located near the down-gradient boundary of Zone 3 have been operational since 1989. A sixth extraction well was established in the deeper weathered bedrock unit in 2000, through conversion of an existing monitoring well. Two of the six wells are intermittently dry because water levels have occasionally fluctuated. The extraction wells, electrical panels, power systems, and collector pipelines in Zone 3 were upgraded and replaced in 2003. A phased approach was proposed to enhance the Zone 3 extraction system in 2009. In July 2010, three monitoring wells screened in the weathered bedrock unit were converted to extraction wells. In 2011, two, additional, weathered bedrock extraction wells were installed, and one, weathered bedrock monitoring well was converted into an extraction well.

4.3.3 System Operations

Groundwater monitoring has been performed semiannually until 2010, when the frequency changed to annual. New monitoring wells are sampled quarterly for 2 years. Extraction wells are sampled on a monthly to semi-annual frequency, depending on the monitoring requirements per zone. The monitoring program is currently under evaluation and will be revised in 2012.

As of 2010, there were 84 operational monitoring wells in Zone 3 (Tetra Tech 2010). Groundwater extracted from Zone 3 (designated "C-Stream") is currently sent to the Lower Canyon Treatment Facility (LCTF) prior to being sent to the PTP storage tanks. The treated groundwater is then discharged to the SARI pipeline. Annual average flow of the C-Stream was approximately 3,959; 17,348; 16,617 and 10,147 gpd in 2004, 2005, 2006 and 2007, respectively (Tetra Tech, 2008, 2010). Average annual contaminant mass removals for the C-Stream were 2.4, 6.2, 7.2 and 4.9 pounds in 2004, 2005, 2006 and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010).

The remedial components in Zone 3 are operated and maintained according to the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c) and the *Groundwater Monitoring Program Work Plan* (Geo-Logic Associates, 2001). The remedial components in Zone 3 are inspected on a daily or weekly basis, in accordance with the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c). Routine maintenance of filters, pumps, valves, and meters at the LCTF are performed on either a weekly or monthly basis. An example of the daily and weekly inspection activities is shown in Figures 6 and 7.

Lower Canyon Treatment Facility (LCTF)

Since 1989, the LCTF has treated groundwater from Zones 3 and 4 (C- and D-Streams) for volatile organic compounds. The treatment train at the LCTF consists of GAC vessels used to remove VOCs from the extracted ground water as shown in Figure 9. The extracted groundwater is pumped through two GAC vessels connected in series. The first vessel generally removes the contaminants and the second contactor serves as a backup when the carbon in the first vessel becomes spent. After treatment, the effluent is routed to the PTP effluent holding tanks and is discharged to the SARI pipeline with effluent from the PTP. Treated effluent discharged from 2006-2007 met SARI permit discharge limits (Tetra Tech, 2010). The available O&M reports (from January 2008, 2009, January – November 2010) reviewed showed continuing compliance with effluent discharge permit requirements (Veolia, 2008, 2009a, b, d, and 2010a-j). Annual usage of liquid phase GAC at the LCTF was 30,000; 15,000; 0; 15,000; and 0 pounds in 2006, 2007, 2008, 2009, and 2010, respectively.

An operator visits the LCTF on weekdays to monitor and adjust operations, but no continuous on-site operator is required. The LCTF generally operates 24/7, with occasional suspension of treatment operations when inflow from groundwater wells drops below a certain level. Design plans are currently in progress that will enable DTSC and site operators to monitor LCTF operations remotely.

4.4 Zone 4 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 4, and presents a summary of current system operations in Zone 4.

4.4.1 Remedy Selection

The remedy selected for Zone 4 in the fourth ROD (issued September 1990) was for the installation of a Community Extraction System for pumping and treatment of site-related groundwater contamination in the Glen Avon area. The RAOs for the Zone 4 groundwater remedy were (1) to prevent further migration of contaminated groundwater, and (2) to restore groundwater to applicable or relevant and appropriate requirements (ARAR) or background levels. Restoration of groundwater quality in the area is intended to allow the unrestricted use of groundwater in this Zone, consistent with the Water Board's Water Quality Control Plan for the Santa Ana River Basin, which designates groundwater in this Zone as having a present or potential beneficial use for municipal supply (Santa Ana RWQCB, 2008).

The fourth ROD identified the following contaminants that exceed MCLs or ARARs in groundwater in Zone 4: trichloroethylene (TCE), chloroform, nitrate, and sulfate. The remediation goals established in the fourth ROD were the groundwater maximum contaminant level (MCL) of 5 micrograms per liter (μg/L) for TCE and the health-based level of 6 μg/L for chloroform. The Agencies deferred setting final remediation goals for nitrate and sulfate.

4.4.2 Remedy Implementation

Two extraction wells were installed in the community area as an initial groundwater response action. These two extraction wells, designated as the north (CTN-TW1) and south (CTS-TW1) wells have continued to operate for plume control in Zone 4 since 1992. Groundwater extracted from these wells (designated the "D-Stream") is treated at the LCTF. Two additional extraction wells (CTP-TW1 and CTP-TW2), referred to as "tree farm wells," were installed in 1998 (designated the "E-Stream"). Groundwater extracted from the tree farm wells is treated at the Community Wellhead Treatment System (CWTS).

4.4.3 System Operations

Groundwater monitoring has been performed on semiannually basis until 2010, when the frequency changed to annual. New monitoring wells are sampled quarterly for 2 years. Extraction wells are sampled on a monthly to semi-annual frequency, depending on the monitoring requirements per zone. The monitoring program is currently under evaluation and will be revised in 2012.

One-hundred monitoring wells and 71 piezometers have been installed to assess contaminant transport and cleanup in Zone 4 (Tetra Tech, 2010).

Based on analytical sampling results, DTSC identified perchlorate as a new Site COC in 2001 in Zone 4. Consequently, bottled water was supplied to residents as an interim measure, and in 2002 the local

water service company was contracted to provide potable water to local residents.

The RI for perchlorate in Zone 4 has recently been completed (Kleinfelder, 2010b) and the FS is expected to be completed in 2012. Average daily flow for the D-Stream wells was approximately 71,091 and 70,545 gpd in 2006 and 2007 (Tetra Tech, 2010). Average daily flow for the E-Stream wells was approximately 28,416 and 25,819 gpd in 2006 and 2007, respectively (Tetra Tech, 2010). Average annual contaminant mass removals for D- and E-Streams were 25.5, 21.4, 20.3 and 15.5 pounds in 2004, 2005, 2006 and 2007, respectively (Tetra Tech, 2008; Tetra Tech, 2010).

The remedial components in Zone 4 are operated and maintained according to the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c) and the *Groundwater Monitoring Program Work Plan* (Geo-Logic Associates, 2001). The remedial components in Zone 4 are inspected on a daily or weekly basis, in accordance with the *Influent Systems Operations, Monitoring, and Maintenance Manual* (Veolia, 2009c). An example of the daily and weekly inspection activities is shown in Figures 6 and 7.

Community Wellhead Treatment System (CWTS)

The CWTS consists of treatment systems for VOCs and perchlorate from groundwater extracted from the two tree farm wells in Zone 4. The CWTS treatment train consists of two liquid-phase GAC vessels for VOC removal and two resin adsorber vessels for perchlorate removal (Figure 10). The effluent from the CWTS is typically about 25 gallons per minute (gpm) and is discharged to Pyrite Creek or reused for irrigation (ENVIRON, 2009; Tetra Tech, 2010). Discharges to Pyrite Creek are performed in accordance with Water Board Order R8-2007-0008, NPDES No. CAG918001 (California RWQCB, 2007). In July 2006, GAC vessels were replaced due to excessive corrosion and the CWTS was shut down between July 15 and July 20, 2006, to replace the carbon vessels. The GAC vessels were again replaced in 2008 due to the excessive corrosion on one of nozzle. CWTS Chemical usage from 2006 through 2010 is shown in Table 5.

Table 5. CWTS Chemical Usage

Year	CWTS Liquid Phase GAC (pounds)	CWTS Resin (cubic feet)
2006	6,000	50
2007	2,000	30
2008	2,000	40
2009	2,000	40
2010	2,000	50

An operator visits the CWTS on weekdays to monitor and adjust operations, but no continuous on-site operator is required. The CWTS operates 24 hrs per day, 7 days per week. Design plans are currently in progress that will enable DTSC and site operators to monitor CWTS operations remotely.

5.0 Progress since Last Review

The following section presents the protectiveness statements and recommendations included in the Third Five-year Review Report (CH2M HILL, 2006) and an evaluation of follow-up actions completed since the last Five-Year Review.

5.1 Protectiveness Statements from Last Five-Year Review

The protectiveness statements in the last Five-Year Review (CH2M Hill, 2006) stated:

> *Zone 1: The remedy in Zone 1 is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedy to be protective in the long-term, the final remedy for Zone 1 should be implemented, including recording Land Use Controls (LUC) to prevent exposure to contamination, to ensure long-term protectiveness.*
>
> *Zone 2: The remedy in Zone 2 is expected to be protective of human health and the environment upon completion and, in the interim, exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedy to be protective in the long-term, the final remedy for Zone 2 should be implemented, including recording LUCs to prevent exposure to contamination, to ensure long-term protectiveness.*
>
> *Zone 3: The remedy in Zone 3 is expected to be protective of human health and the environment upon completion and, in the interim, exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedy to be protective in the long-term, the final remedy for Zone 3 should be implemented to ensure long-term protectiveness.*
>
> *Zone 4: The remedy in Zone 4 is expected to be protective of human health and the environment upon completion and, in the interim, exposure pathways that could result in unacceptable risks are being controlled. However, in order for the remedy to be protective in the long-term, a final remedy for Zone 4, including ICs to restrict uses of private wells in Glen Avon, should be selected and implemented to ensure long-term protectiveness.*

5.2 Status of Recommendations and Follow-Up Actions from Last Review

Recommendations presented in the last Five-Year Review (2006):

1. *Zones 1, 2, 3, and 4. While groundwater monitoring and other site characterization activities are currently underway to address the new COCs, further characterization is required to identify trends in concentrations in groundwater over time and to ensure that the existing extraction systems provide for adequate capture of new COCs. Pilot studies and evaluations to support the design of the proposed new PTP to treat these contaminants should continue. RI/FS activities, including soil and groundwater characterization, risk assessments, and evaluation of remedial alternatives, should continue to support the selection of a final remedy to address perchlorate in groundwater in Zone 4. Remedies for the new COCs will be selected in future decision documents, which include a fourth ROD amendment (expected in 2008) and a fifth ROD (expected in 2009).*

Status: Ongoing. The SFS was completed in 2009 and evaluated alternatives for final remediation of Zone 1 and potential modifications to the selected remedies for Zones 2 and 3. The RI/FS activities for Zone 4 include completion of the RI report (Kleinfelder 2010b), Human Health Risk Assessment (HRA) (Kleinfelder, 2009), and a pilot study for bioremediation (Kleinfelder, 2010d). The following additional characterization activities have been completed since the last Five-Year Review:

- Groundwater monitoring completed semi-annually. The 2006-2007 Biennial Groundwater

Remedy Effectiveness Evaluation (Tetra Tech, 2010) presents summaries and recommendations based on data trends in each zone.

- The following monitoring wells have been converted to extraction wells to control contaminant migration: Zone 1: OW-15D, OW-6B and OW-5 converted in 2007, MW-22 converted in 2005; Zone 2: MW-19B converted in 2008; Zone 3: OW-87D, OW-80D, and OW-19D converted in 2010, OW-90DR converted in 2011, OW-96D and OW-97D installed in 2011.
- Bedrock aquifer testing was proposed to obtain more reliable values for remedy modification. This work was completed in 2010.
- Pilot scale testing and evaluation for the new PTP (PCTF) has been completed (Shaw, 2009). Recommended treatment includes a combination of air stripping, pesticide removal system, metals precipitation system, anoxic biological fluidized bed reactors, aerobic biological fluidized bed reactors, HiPOx® advanced oxidation technology, liquid-phase granular activated carbon, and vapor-phase granular activated carbon to remove all new and existing COCs. The anoxic and aerobic biological fluidized bed reactors, and the HiPOx® advanced oxidation technology will be designed and constructed as part of the PCTF only if treatment for perchlorate, pCBSA, 1,4-dioxane and NDMA are required for continued discharge into the SARI.

2. *Zones 1, 2, and 4. While controls are currently in place in Zone 4 to reduce the potential for exposure of residents to contamination in groundwater, Institutional Controls (IC) should be selected as part of the remedy in future decision documents to prevent disturbance of soil in the original disposal area in Zone 1, to prevent buildings from being constructed in Zones 1 and 2, and to further prevent unauthorized uses of groundwater in the Glen Avon community area in Zone 4. In addition, the 1986 plume boundary map currently used by the Riverside Department of Environmental Health (RDEH) for well permit applications in Zone 4 should be updated based on current plume boundary information to facilitate future well permitting decisions.*

Status: Ongoing. The 2009 SFS identified ICs as applicable to the Stringfellow Site and recommended the following to prevent disturbance of contaminated soils and construction of inhabitable structures over the VOC plume: 1) land use restrictions of adjacent land so it cannot be used for potentially sensitive uses, such as residential or school; 2) deed restrictions or covenants on land surrounding the Site that would restrict incompatible land uses such as houses, schools, or hospitals; 3) covenant to restrict use of land underlain by contamination where remediation systems are constructed; and, 4) restrictions on domestic well installation in Zone 4. ICs will be formally implemented following the completion of the final ROD.

In December 2010, DTSC issued an updated map to Riverside County delineating new boundaries for Zone 4 ICs (see: Appendix H). The map replaces any former Stringfellow plume boundary or well restriction maps and will be used by Riverside County to restrict potable well installations until the IC is legally in place through the final ROD.

3. *Zones 1, 2, 3, and 4. Additional data should be collected as recommended in the Final Screening-Level Ecological Risk Assessment (SLERA) (CH2M HILL, 2005) to verify the conclusions of the ERA. These data should be collected so that they may be included in the fifth ROD, which is scheduled to be issued in December 2009.*

Status: Ongoing. The SLERA was completed in 2005 to evaluate whether site contaminants have the potential to affect sensitive ecological receptors in Zone 1. Recommendations for additional data collection included: 1) evaluation of background metal concentrations to clarify whether metals in soil pose a significant risk to plants and/or insectivorous small animals; 2) collect plant samples to evaluate bioaccumulation of perchlorate in plants and perchlorate doses to herbivorous receptors; and 3) continue evaluations on the distribution of perchlorate and pCBSA in soil and evaluation of new ecotoxicity information as it becomes available. In 2010, background soil samples were collected in accordance with the approved workplan (Kleinfelder, 2010c). These sample results should be evaluated and a SLERA Addendum issued to address ecological issues for Zone 1 in the final ROD.

4. *Zones 2 and 3. The effectiveness of the existing extraction systems in Zones 2 and 3 should be evaluated to identify the need for system upgrades and/or system optimization. The extraction systems should be upgraded/optimized as determined to be necessary through this evaluation. System optimization and upgrades will be performed as part of the O&M program included in the amendment to the fourth ROD.*

Status: Ongoing. One monitoring well in Zone 2 and three monitoring wells in Zone 3 were converted to extraction wells to enhance groundwater capture in the weathered bedrock. The 2006-2007 Biennial Evaluation (Tetra Tech, 2010) completed a capture zone evaluation using several different methods, following the EPA guidance "A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems" (USEPA 2008). The SFS (ENVIRON, 2009) and 2006-2007 Biennial Evaluation (Tetra Tech, 2010) recommended additional enhancements for Zone 2 and 3.

6.0 Five-Year Review Process

6.1 Administrative Components

The Five-Year Review team was led by Charnjit Bhullar, USEPA Remedial Project Manager for the Site. The review team included personnel from the USACE, Seattle District, Sharon Gelinas and Heather Whitney. The review schedule and major components included:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection;
- Local Interviews; and
- Five-Year Review Report Development and Review.

6.2 Community Involvement

A notice was posted in the local newspaper*, The Riverside Press-Enterprise,* on March 16, 2011, to notify the public that a Five-Year Review had been started for the Site. This Five-Year Review report will be placed in the Stringfellow Site information repositories and a fact sheet will be prepared to inform the public of the findings of this Five-Year Review. The public will be able to submit to USEPA any comments or concerns about the remedy to date. A notice will be sent to the local newspapers when the

completed report and results can be viewed at the Stringfellow Site repositories.

6.3 Document Review

This Five-Year Review consisted of a review of relevant documents as summarized in Appendix A. Electronic versions of the Site documents are available from the DTSC's EnviroStor document library located at: http://www.envirostor.dtsc.ca.gov/public. Some documents may also be available from the EPA website: http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/BySite/Stringfellow. Hard copies of some are located at the Glen Avon Public Library in Riverside, California.

6.4 Data Reviewed

Soil and groundwater data collected between 2006 and 2010 were evaluated as part of this Five-Year Review. Groundwater plume maps are generated for the Biennial Groundwater Remedy Effectiveness Evaluation. At the time of writing, the 2006-2007 Biennial Evaluation report (Tetra Tech, 2010) had just been completed. The following discussion of the general contaminant distribution and plume size utilizes the maps completed using data from 2007; however, all data collected between 2006 and 2010 were evaluated to generate the summary below.

Soil

Soil samples were collected as part of the RI for Zone 4 to evaluate risks to human health. Surface soil samples were collected at ten locations in Zone 4 in 2007 in order to evaluate perchlorate concentrations in soil. Perchlorate was detected in nine out of ten of the samples analyzed, with the highest concentration detected at 42 µg/kg (Kleinfelder, 2010b). These soil sample analytical data along with soil sample analytical data collected in 2001, 2002, and 2003 were used in a Human Health Risk Assessment , which concluded that the perchlorate concentrations detected in the soil samples do not pose a health risk (Kleinfelder, 2009).

Groundwater

The objectives of the groundwater monitoring program are to (1) collect groundwater quality samples to identify Site-related COC groundwater impacts; (2) document and evaluate hydrogeologic conditions and the concentrations and extent of COC impacted groundwater; and (3) assess the effectiveness of the groundwater extraction systems and provide information to make modifications to these systems, if needed.

Groundwater data has been collected on a monthly to semi-annual basis at extraction wells and semi-annually at monitoring wells. In 2010, the monitoring well sampling frequency was modified to annual. Currently, there are over 500 monitoring and extraction wells at the Site screened within the alluvium, weathered bedrock, or unweathered bedrock. Due to the large number of wells, not all wells were sampled during each event, although in 2010 the full set of the accessible wells were sampled. DTSC previously sampled wells intermittently based on several considerations including: the size of the historical data set, changes in data concentration trends, and operational considerations. DTSC is in the process of optimizing the overall groundwater sampling program. Groundwater monitoring reports are produced following each sampling event and an evaluation of the data is presented in the Biennial Groundwater Remedy Effectiveness Evaluation.

The pump and treat systems have been effective at reducing migration of contaminated groundwater from the Site and have treated approximately 458.7 MG of contaminated ground water between 1999 and 2007 (Tetra Tech, 2010). TCE, chloroform, and perchlorate are the chemicals typically used to help assess the remedy performance. TCE and chloroform are the only constituents with ROD cleanup goals. Figures 11 through 16 indicate the most recent conceptualization of contaminant distribution at the Site from the 2006-2007 Biennial Report (Tetra Tech, 2010). Exceedances of the TCE cleanup goal are currently observed in Zones 1, 2, 3 and 4; the TCE plume is currently thought to end in the northern part of Zone 4 (see Figures 11 through 14). As of 2007, only five out of over 100 wells in Zone 4 have residual TCE concentrations above the cleanup goal. Chloroform is found above its cleanup goal in Zones 1 and 2. Residual chloroform concentrations had been detected at two wells within the weathered and unweathered bedrock in Zone 3; however, as of the 2010 sampling event, chloroform concentrations had decreased below cleanup levels at these wells. Perchlorate is detected throughout Zones 1, 2, 3 and 4 and the plume extends over four miles southwest of Zone 1 to just north of the Santa Ana River (see Figures 15 and 16).

Due to the large quantity of information and data available for the Site, only a summary of the significant findings identified during the review is presented below. A detailed evaluation of the data can be found in the documents referenced.

Zone 1:

- Concentrations of contaminants in groundwater at the north and south caps and near the clay barrier show variability over time without any consistent long-term trends. This may be associated with the variability in rainfall and quantity of groundwater extracted from the system and does not directly indicate a significant problem with the selected remedy.
- The groundwater extraction system has lowered groundwater levels in the alluvium, which was described as an interim goal of ROD 4, and most of the alluvium extraction wells do not produce significant quantities of water. The 2006-2007 Biennial Evaluation report (Tetra Tech, 2010) noted that areas of deeper alluvium on the eastern side of Zone 1 are not completely dewatered and further evaluation may be needed to determine if additional extraction is necessary (see Figure 17).
- A highly fractured bedrock area is located along the western section of the clay barrier dam (near well OC-10B). Pump tests in wells across the barrier showed hydraulic communication indicating the fractures had not been completely sealed by the grout curtain installed beneath the clay barrier dam (ENVIRON, 2010c; Tetra Tech, 2010). Groundwater concentration data in bedrock wells near this area also support this hypothesis (see Figure 18). Improvement of the hydraulic control in this area has been recommended during the 2009 SFS (ENVIRON, 2010c) and DTSC has proposed additional extraction and monitoring in this area. Further evaluation of the hydraulic connection and dewatering effectiveness in this area may also be warranted following installation of the additional wells.
- The extraction system in Zone 1B is intended to capture any contaminants that are not contained by the clay barrier dam. Extraction wells are screened within the alluvium and the weathered/unweathered bedrock. Due to the limited number of monitoring wells in the weathered and unweathered bedrock, the extent of the extraction well capture zones are uncertain. The 2006-2007 Biennial Evaluation Report (Tetra Tech, 2010) recommended a more detailed evaluation of the extraction required for containment of Zone 1 groundwater.
- The 2006-2007 Biennial Evaluation Report (Tetra Tech, 2010) noted matrix interferences from high concentrations of pCBSA in groundwater analytical samples collected in Zone 1, and

included a recommendation to analyze future groundwater samples by EPA Method 331/332 or an equivalent method to accurately quantify the concentrations.

Zone 2:

- The extraction system in Zone 2 contains three wells screened in alluvium, four wells screened in the weathered bedrock, and one well screened in the unweathered bedrock. Concentrations of chloroform and TCE in groundwater analytical samples collected in the alluvium show a decrease between wells located up-gradient of the extraction system (e.g. MW-2B and MW-8B) and down-gradient of the extraction system (e.g. MW-10B and MW-14B). However, there are limited monitoring wells down-gradient of the extraction system in the weathered and unweathered bedrock to use for evaluation of the extraction well capture zone and system effectiveness. Additional monitoring wells may be necessary to evaluate contaminant migration in Zone 2.
- 3-D Seismic Reflection studies indicated there may be deeper areas of alluvium without extraction or monitoring wells (ENVIRON, 2009). Additional exploration may be necessary in this area to determine potential migration pathways.
- A review of the groundwater data show a visually increasing trend for TCE and chloroform at extraction wells MA-1 (screened primarily in weathered bedrock), MB-1 (screened primarily in the unweathered bedrock), and MW-19B (screened primarily in the alluvium (see Figures 19 and 20). Well locations in Zone 2 are shown on Figure 21. Increasing concentrations in groundwater analytical samples collected in the extraction wells could be indicative of higher concentrations of contaminants migrating from Zone 1. If improved containment at Zone 1 is not possible, optimization of the Zone 2 extraction system may be necessary to capture groundwater contamination in the weathered and unweathered bedrock.
- The 2006-2007 Biennial Evaluation report (Tetra Tech, 2010) documented that perchlorate mass removal in Zone 2 is greater than Zone 1B, which is consistent with previous findings that quarry operations within Zone 2 are a potential additional source to groundwater.

Zone 3:

- Three new weathered bedrock extraction wells were activated in July 2010 to control groundwater contaminant migration; there are currently no unweathered bedrock extraction wells in Zone 3. Additional extraction wells were proposed in a phased approach (ENVIRON, 2010a); two additional extraction wells were installed and one more monitoring well converted to an extraction well in 2011. Additional system enhancement should be considered following an evaluation of data from the new wells.
- Perchlorate has been detected in the majority of wells at Zone 3 (see Figure 15). Groundwater analytical sampling data indicate that perchlorate transported down the western side of Zone 3 in the alluvial and bedrock zones is potentially from adjacent quarry operations (Tetra Tech, 2010). Additional investigations should be completed to verify the off-site source and potential remedial alternatives should be evaluated.

Zone 4:

- Chloroform is currently not detected above cleanup goals in Zone 4. TCE has been detected in groundwater analytical samples above the ROD cleanup goal of 5 µg/L at a few wells in the

alluvium and weathered bedrock between 2006 and 2010; however, concentration and plume size has decreased significantly since 1996 (see Figure 22). The highest, recent concentrations detected in groundwater analytical samples were from monitoring wells at approximately 30 µg/L in 2006 and 18 µg/L in 2010. South extraction well CTS-TW-1 continues to remove contaminated groundwater in the alluvium; concentrations in the extracted groundwater still slightly exceed the cleanup goal (see Figure 23).

- Perchlorate is detected in groundwater analytical samples from wells located throughout Zone 4. Several sources are suspected to contribute to the elevated concentrations detected in groundwater and surface water sample results, including former disposal activities at Zone 1, adjacent quarry operations near Zone 2, and widespread use of Chilean nitrate fertilizers, which contains caliche with naturally-occurring perchlorate (Kleinfelder, 2010b). Remedial alternatives for perchlorate in groundwater at Zone 4 will be evaluated in the future FS.

Surface Water

DTSC has collected surface water runoff samples since 2005 after moderate to heavy rainfall events. Samples were collected at locations on-site in Zone 1, downstream of the concrete lined drainage channels in Zone 2, in Pyrite Creek, and tributaries to Pyrite Creek to evaluate perchlorate concentrations in stormwater runoff. The groundwater analytical samples collected in samples collected from Zones 1 and 2 had trace detections of perchlorate, while those collected downstream in Zone 3 and from tributaries of Pyrite Creek had concentrations exceeding the 6 µg/L California MCL, up to over 300 ug/L during two separate storm events. Because of the presence of perchlorate in surface water leaving its property, the quarry to the west of the Site has been identified as a potential off-site secondary source of perchlorate (Kleinfelder, 2010b).

6.5 Site Inspection

Representatives of USACE and USEPA performed a site inspection on November 5, 2010. The purpose of the inspection was to assess the protectiveness of the remedy, including the presence of fencing to restrict access to the original site, the integrity of the cap, and the condition of the groundwater extraction and treatment systems. A summary of the inspection findings is presented below. A site inspection checklist and photos taken during the inspection are provided in Appendices C and D, respectively.

Overall, the various components of the remedy appear to be functioning as designed and appear to be well maintained. Inspected areas were secured with adequate fencing and signage. The cap appeared to be in moderately good condition with regular mowing occurring to control grass and taller weeds. Prior heavy rains had caused some erosion on the north cap and indications of re-grading were still present. The sink hole located at the southwest corner of northern disposal area was backfilled in 2007 and is no longer a hazard. Indications of erosion or burrowing were not observed on cap during the site inspection. Surface water channels appeared well maintained and in good condition.

Groundwater monitoring and extraction wells appeared to be functioning and in good condition. The groundwater treatments systems (PTP, LCTF, and CWTS) were also functioning and appeared to be in good condition. Applicable O&M plans, health and safety and contingency plans, regulatory permits, and Occupational Safety and Health Administration records were available on-site for review.

6.6 Interviews

Interview summary forms are provided in Appendix E. DTSC is responsible for maintenance of the Site, USEPA is the oversight agency, and CH2M Hill performs technical oversight for USEPA. The following DTSC and CH2M Hill employees were interviewed on November 5, 2010, as part of this Five-Year Review:

- Allen Wolfenden, DTSC, Chief San Joaquin Legacy Landfill Office
- Ziggy Kostecki, DTSC, Site Engineer
- Tom Perina, CH2M Hill, EPA Contractor

The interviewees have the overall impression that the remedy is effective and contaminant concentrations in groundwater have either stabilized or are decreasing with time as a result of the existing groundwater extraction systems. Investigations have indicated that COCs are present not only in the alluvium, but also in weathered and unweathered bedrock. DTSC plans to install additional extraction wells in Zones 1, 2, and 3 to address this issue.

The existing on-site treatment systems have been optimized to address new contaminants identified through recent investigations. A new PTP to replace the existing PTP is currently in the design phase. DTSC is also currently in the process of optimizing the groundwater monitoring program. All interviewees expressed concern regarding the active quarry in Zone 3 as a potential source of perchlorate to the groundwater. There have been no significant community concerns within the last five years.

7.0 Technical Assessment

7.1 Zone 1 Remedial Actions

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

Yes, the remedies selected for Zone 1 in RODs 1, 2, 3, and 4 are functioning as intended. RAOs for Zone 1 include prevention of direct or indirect contact with site-related contaminants; reduction of the potential for release and migration of site contaminants to groundwater; and control, recovery, and treatment of contaminated liquids using diversion, dewatering, extraction, and on-site pretreatment. Direct and/or indirect contact with site-related contaminants in soil is prevented by the clay cap, surface drainage, and by controlling access onto the Site. A fence is located around the perimeter of the Zone 1 and security personnel are present on-site 24 hours a day. During the site visit, the clay cap and surface drainage channels appeared to be well maintained. The clay barrier dam and groundwater extraction system provide hydraulic control and reduce the potential for release and migration of contaminants from the Site. Extracted groundwater is treated at the PTP prior to discharge to the SARI pipeline. The interim goal of dewatering the alluvial aquifer to bedrock has been met across the majority of the Site; however, there are areas near the center of the former paleo-channel where the need for additional monitoring and/or extraction should be evaluated.

Remedial Action Performance and Monitoring
Although contaminant concentrations at Zone 1 are highly variable due to rainfall and quantity of water extracted without any consistent long-term trends, there are no significant indications of problems with

the selected remedy. There are several areas where containment could be improved, such as in the fractured bedrock along the western clay barrier and in the alluvium along the eastern side of Zone 1. The new PTP will replace the aging PTP and it should reliably and efficiently meet the current pre-treatment standards of SAWPA. The enlarged physical footprint will allow space for future treatment process expansion should more strict pre-treatment standards be promulgated for emerging contaminants.

System Operations/Operations and Maintenance
The clay cap appeared to be well maintained during the site visit. Cap maintenance includes annual weeding and re-grading as necessary to control erosion problems. The extraction systems appeared to be well maintained and wells are inspected and rehabilitated as necessary. There is full time O&M staff on-site and EPA contractors perform bi-weekly site inspections.

Opportunities for Optimization
DTSC is in the process of optimizing the groundwater monitoring program. This optimization will include a qualitative analysis based on the monitoring objectives in each zone and a quantitative analysis using the Monitoring and Remediation Optimization System (MAROS) software. Recent data evaluations have noted that there are limited monitoring wells in the weathered and unweathered bedrock in Zone 1B. Additional wells should be installed to ensure adequate evaluation of extraction system capture zones and contaminant distribution.

One of the interim goals for Zone 1 listed in ROD 4 was to dewater to bedrock. This has been accomplished across the majority of the Site; however, there could be opportunities for extraction system expansion along the eastern portion of the Site. In addition, the extraction system near the fractured bedrock area along the western portion of the clay barrier dam could be expanded or optimized to decrease the required extraction down-gradient at Zone 1B.

Opportunities for optimization of Zone 1 source area mass reduction and hydraulic barrier treatment technologies were evaluated in the 2009 SFS (ENVIRON, 2009). The SFS recommended alternative was containment using an impermeable soil cap and enhanced hydraulic control in Zones 1b, 2 and 3.

Indicators of Potential Remedy Problems
A hydraulic connection across the western side of the clay barrier dam has been identified in the bedrock. Additional monitoring and capture evaluation should be conducted and extraction systems enhanced if necessary.

Implementation of Institutional Controls and other Measures
Institutional controls have not been selected as part of the remedy for Zone 1. Engineering restrictions are in place to control access to the Site, such as fencing and on-site security. ROD 1 stated that restrictions of future use of the property were recorded on the title in 1981 when the State of California purchased the property. Preliminary title reports found during the third Five-Year Review did not reveal any recorded environmental restrictions.

Vapor intrusion could be a concern if habitable structures are constructed over VOC contaminated groundwater. Institutional controls for Zone 1 have been evaluated in the 2009 SFS for inclusion in the final ROD. ICs identified that may apply to the final remedy include land use restrictions of adjacent land so it cannot be used for potentially sensitive uses, deed restrictions or covenants on surrounding land that would restrict incompatible land uses, or covenants to restrict use of land underlain by

contamination where remediation systems are constructed.

7.1.2 Question B: Are the assumptions used at the time of remedy selection still valid?

Yes. The assumptions used at the time of remedy selection that would affect protectiveness for Zone 1 are still valid. The remedy selected for Zone 1 is not intended to meet a risk-based cleanup level. As discussed in Section 4.2.2, new COCs have been identified since the remedy was selected for Zone 1; however, a new PTP is being designed with capacity to treat these COCs and any future effluent discharge limits.

Changes in Standards and To Be Considered
ARARs listed in RODs 1, 2, 3, and 4 were reviewed to evaluate changes, additions, or deletions. Summary tables of the ARAR analysis completed for all zones are presented in Appendix F.

There are no chemical specific goals specified for Zone 1. Action specific ARARs include the Clean Water Act, National Pollutant Discharge Elimination System (NPDES) for liquid discharge and Resource Conservation and Recovery Act (RCRA) land disposal restrictions for the PTP (see Section 7.2.2, Zone 2). There have been no changes to the action specific ARARs for Zone 1 that would negatively impact the protectiveness of the remedy.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics
A toxicity and risk assessment analysis was performed as part of this Five-Year Review to determine if the assumptions used in performing the baseline HRA remain valid for Zone 1. A summary is provided here and a more detailed assessment is presented in Appendix G.

All of the exposure pathways identified in the health risk assessments are currently incomplete in Zone 1. Furthermore, there have been no significant changes to existing or expected land use on or near Zone 1 that have created new exposure pathways. There have been no newly identified contaminants or contaminant sources in Zone 1 since the last Five-Year review.

While there have been a few changes in toxicity values since the original baseline HRA, none of the changes affect the protectiveness since all of the exposure pathways identified for Zone 1 are currently incomplete.

7.1.3 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 calls into question the protectiveness of the remedy. Additional data analyses are still required to verify the conclusions of the SLERA; however, this does not affect the current protectiveness.

7.1.4 Technical Assessment Summary
Overall, the selected remedy for Zone 1 is functioning as intended. Direct and/or indirect contact with site-related contaminants is prevented by the clay cap, surface drainage and by controlling site access. The clay barrier dam and groundwater extraction system provide general hydraulic control and reduce potential for contaminant migration; however, system optimization or additional monitoring and extraction may be necessary along the eastern portion of the Site in the deeper alluvial areas and along the western portion of clay barrier dam in the weathered and unweathered, fractured bedrock or in Zone 1B, south of the clay barrier dam. There have been no changes to the assumptions utilized that

would affect the current remedy.

7.2 Zone 2 Remedial Actions

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

Yes. The remedy selected for Zone 2 in ROD 2 is functioning as intended. The RAO for Zone 2 was to prevent further migration of contaminated groundwater from Zone 2 to Zone 3. The groundwater extraction system is removing contaminants that have migrated from Zone 1. An on-site PTP was constructed in Zone 2 to treat extracted groundwater prior to discharge and has been modified to treat for pesticides. A new PTP is currently being designed to reliably and efficiently meet the current pre-treatment standards of SAWPA, and to also allow future treatment process expansion should more strict pre-treatment standards be promulgated for emerging contaminants.

Remedial Action Performance and Monitoring
The extraction system at Zone 2 continues to remove contaminants from groundwater. Recent data evaluations have identified that there are limited monitoring wells in the weathered and unweathered bedrock at Zone 2 to monitor contaminant migration. Seismic Reflection studies have also indicated that there could be deeper areas of alluvium without extraction or monitoring wells at Zone 2. Surface water sampling following moderate to heavy rainfall showed trace levels (below the California MCL) of perchlorate in runoff from the Zone 1 drainage channel and in perchlorate concentrations above the California MCL in the surface water leaving the quarry property. Perchlorate mass removal in Zone 2, which is greater than that in Zone 1B, is consistent with the previous finding that operations within Zone 2 are potentially impacted by an additional source of perchlorate to groundwater.

System Operations/Operations and Maintenance
The extraction systems appear to be well maintained and wells are inspected and rehabilitated as necessary. There is full time O&M staff on-site and EPA contractors performed bi-weekly site inspections. Currently, informal access to the quarry property is granted to the State of California for operation and maintenance of existing structures and wells.

The existing PTP treatment process includes pH control, pesticide removal, metals removal and GAC adsorption system for removal of organics. All treated wastewater is discharged to the SARI. Available O&M reports show compliance with effluent discharge requirements. The new PTP should reliably and efficiently meet the existing pre-treatment standards of SAWPA, and it will also allow future treatment process expansion should more strict pre-treatment standards were to be promulgated for emerging contaminants.

Opportunities for Optimization
Similar to Zone 1, DTSC is in the process of optimizing the groundwater monitoring program. Recent data evaluations show there are limited monitoring wells in the weathered and unweathered bedrock at Zone 2 to adequately evaluate the potential for contaminant migration in these zones. Additional wells should be installed to ensure adequate evaluation of the extraction system capture zones and contaminant distribution. Following the evaluation of contamination in the weathered and unweathered bedrock, enhancements to the extraction system should be evaluated, if necessary.

Indicators of Potential Remedy Problems
Perchlorate has been detected throughout Zone 2. Perchlorate has been identified in groundwater at

Zone 1 and has migrated down-gradient into Zone 2. There are also potential off-site sources to the west of Zone 2. The current extraction system may not be able to contain the extent of the dissolved phase perchlorate and prevent some portion of its mass from migrating further down-gradient to Zones 3 and 4.

Implementation of Institutional Controls and other Measures
Institutional controls were not selected as part of the remedy for Zone 2. Vapor intrusion could be a concern if habitable structures are constructed over VOC contaminated groundwater. The 2009 SFS identified ICs that may apply to the final remedy such as land use restrictions of adjacent land so it cannot be used for potentially sensitive uses, deed restrictions or covenants on surrounding land that would restrict incompatible land uses, or covenants to restrict use of land underlain by contamination where remediation systems are constructed.

7.2.2 Question B: Are the assumptions used at the time of remedy selection still valid?

Yes. The assumptions used at the time of remedy selection that would affect protectiveness for Zone 2 are still valid. The remedy selected for Zone 2 is to prevent further migration and is not intended to meet a risk-based cleanup level. As discussed in Section 4.2.2, new COCs have been identified since the remedy was selected for Zone 1; however, a new PTP is being designed with capacity to treat these COCs and any future effluent discharge limits, if necessary.

Changes in Standards and To Be Considered
ARARs listed in RODs 1, 2, 3, and 4 were reviewed to evaluate changes, additions, or deletions. Summary tables of the ARARs analysis completed for all zones are presented in Appendix F.

There are no chemical specific goals for Zone 2. Several action-specific ARARs for the PTP in Zone 2 have received revisions or amendments; however, these changes do not affect the protectiveness of the remedy for Zone 2. The Santa Ana Watershed Project Authority (SAWPA) is authorized by the Clean Water Act to regulate discharge of treated effluent from the PTP in Zone 2 and the LCTF in Zone 3 prior to discharge into the SARI line. The third ROD (1987) listed the existing SAWPA permit water quality requirements at the time. While no changes have occurred to these requirements, five additional constituents have since been added and are included in the most current SAWPA permit No. 4D-98-S101 (see Appendix F, Table 5). Review of the monthly operations, monitoring, and maintenance reports confirms that treated effluent from the PTP is meeting all the permit requirements (Veolia, 2008, 2009a,b,d, and 2010a-j). Other changes at the PTP include installing air strippers on the A-Stream to control VOC emissions from the PTP.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics
A toxicity and risk assessment analysis was performed as part of this Five-Year Review to determine if the assumptions used in performing the baseline HRA remain valid for Zone 2. A summary is provided here and a more detailed assessment is presented in Appendix G.

All of the exposure pathways identified in the health risk assessments are currently incomplete in Zone 2. Furthermore, there have been no significant changes to existing or expected land use on or near Zone 2 that have created new exposure pathways. There have been no newly identified contaminants or contaminant sources in Zone 2 since the last Five-Year review.

While there have been a few changes in toxicity values since the original baseline HRA, none of the

changes affect the protectiveness since all of the exposure pathways identified for Zone 2 are currently incomplete.

7.2.3 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 calls into question the protectiveness of the remedy.

7.2.4 Technical Assessment Summary

Overall, the selected remedy for Zone 2 is functioning as intended. The extraction system is removing contaminants from groundwater to control migration from Zone 2 to Zone 3. Since there are limited monitoring wells in the weathered and unweathered bedrock, additional wells may be necessary to adequately evaluate extraction system capture zones and contaminant migration. Following this evaluation, enhancements to the monitoring and extraction system should be completed as necessary. Perchlorate is detected in the majority of Zone 2 wells; however, an off-site source may be present to the west of Zone 2 that may add to the contamination through surface runoff and groundwater migration. There have been no changes to the assumptions utilized that would affect current remedy.

7.3 Zone 3 Remedial Actions

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

Yes. The remedy selected for Zone 3 in ROD 3 is functioning as intended. The RAO for Zone 3 was to remove contaminated groundwater and to stop additional contaminated groundwater from moving south into the community of Glen Avon. The extraction system in Zone 3 has been effective at removing contaminated groundwater and treating it at the LCTF. Concentrations of chloroform are currently below the remediation goal (6 µg/L), and the majority of the TCE plume is considered to be captured by the Zone 3 extraction system. Perchlorate is present in Zone 3; however, there is also a potential off-site source at the quarry up-gradient from Zone 3.

Remedial Action Performance and Monitoring

The extraction system was expanded in 2010 and 2011 by converting four monitoring wells screened in the weathered bedrock into extraction wells and installing two additional extraction wells. Following an evaluation of the performance of these new wells, additional extraction wells in the weathered or unweathered bedrock may be necessary. Perchlorate is detected in the majority of Zone 3 wells . Perchlorate transported down the western side of Zone 3 is potentially from adjacent quarry operations (Tetra Tech, 2010).

System Operations/Operations and Maintenance

The extraction system appears to be well maintained and wells are inspected and rehabilitated as necessary. Effluent from the LCTF is routed to the PTP holding tanks and is discharged to the SARI pipeline. There is full time O&M staff on-site, and EPA contractors perform bi-weekly site inspections.

Opportunities for Optimization

Similar to Zones 1 and 2, DTSC is in the process of optimizing the groundwater monitoring program. Following an evaluation of the new extraction wells, additional monitoring or extraction wells may be needed to monitor and control migration in the weathered or unweathered bedrock.

Indicators of Potential Remedy Problems

Perchlorate located along the western side of Zone 3 has been attributed to off-site sources. The current extraction system may not be able to treat perchlorate from all sources.

Implementation of Institutional Controls and other Measures
Institutional controls were not selected as part of the remedy for Zone 3. Vapor intrusion could be a concern if inhabitable structures were constructed over VOC contaminated groundwater. The 2009 SFS identified ICs that may apply to the final remedy such as land use restrictions of adjacent land so it cannot be used for potentially sensitive uses, deed restrictions or covenants on surrounding land that would restrict incompatible land uses, or covenants to restrict use of land underlain by contamination where remediation systems are constructed.

7.3.2 Question B: Are the assumptions used at the time of remedy selection still valid?

Yes. The assumptions used at the time of remedy selection that would affect protectiveness for Zone 3 are still valid. The remedy selected for Zone 3 is not intended to meet a risk-based cleanup level. As discussed in Section 4.2.2, new COCs have been identified since the remedy was selected for Zone 3 that may require optimization of the extraction system.

Changes in Standards and To Be Considered
ARARs listed in ROD 3 were reviewed to evaluate changes, additions, or deletions. Summary tables of the ARARs analysis completed for all zones are presented in Appendix F.

There are no chemical specific goals for Zone 3. Action specific ARARs that have changed since the last five year review include revisions to the Tank Systems regulation (applicable to the LCTF) to streamline information collection, rescinded sections in the South Coast Air Quality Management District's (SCAQMD) Regulation XII in 2010, and changes to the SAWPA discharge permit as described in Section 7.2.2. These changes do not affect the protectiveness of the remedy.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics
A toxicity and risk assessment analysis was performed as part of this Five-Year Review to determine if the assumptions used in performing the baseline HRA remain valid for Zone 3. A summary is provided here and a more detailed assessment is presented in Appendix G.

All of the exposure pathways identified in the health risk assessment are currently incomplete in Zone 3. Furthermore, there have been no significant changes to existing or expected land use on or near Zone 3 that have created new exposure pathways. There have been no newly identified contaminants or contaminant sources in Zone 3 since the last Five-Year review.

While there have been a few changes in toxicity values since the original baseline HRA, none of the changes affect the protectiveness since all of the exposure pathways identified for Zone 3 are currently incomplete.

7.3.3 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 calls into question the protectiveness of the remedy.

7.3.4 Technical Assessment Summary
Overall, the selected remedy for Zone 3 is functioning as intended. The extraction system continues to

remove contaminants from groundwater and was expanded in 2010 to include extraction wells in the weathered bedrock. Following a performance evaluation of the expanded extraction system, additional monitoring and extraction wells may be needed to monitor and control contaminant migration. Perchlorate is detected in the majority of Zone 3 wells; however, an off-site source may add to the contamination in Zone 3 through surface runoff and groundwater migration from Zone 2. There have been no changes to the assumptions utilized that would affect current remedy.

7.4 Zone 4 Remedial Actions

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

Yes. The remedy selected for Zone 4 is functioning as intended. The RAOs for Zone 4 are to prevent further migration of contaminated groundwater and to restore groundwater to ARARs or background levels that would allow unrestricted use of groundwater. Chloroform detected in analytical sampling data has not been detected above cleanup goals in Zone 4, and TCE is the only COC detected in samples collected at a few wells above cleanup goals. Perchlorate has been detected in groundwater analytical samples at locations throughout Zone 4. The RI for Zone 4 was recently completed and remedial alternatives are currently being evaluated for inclusion in a future FS and final ROD. In the interim, residents have been provided with water from the public water supply and the RDEH restricts the installation of domestic wells within the plume boundaries.

Remedial Action Performance and Monitoring
Groundwater monitoring data indicate that the treatment systems for TCE and chloroform are close to meeting remedial action objectives for these chemicals. There are a few remaining wells that contain TCE concentrations above cleanup goals, including the south extraction well, CTS-TW1. It should be noted that continued extraction and hydraulic containment in Zones 1 through 3 is necessary to attain TCE and chloroform RAOs in Zone 4. Perchlorate is found throughout Zone 4; a FS is currently in progress to evaluate future remedial alternatives.

System Operations/Operations and Maintenance
The extraction systems appear to be well maintained and wells are inspected and rehabilitated as necessary. Water extracted from the D-Stream wells are treated at the LCTF and ultimately discharged to the SARI. E-Stream water is treated at the CWTS for VOCs and perchlorate and meets NPDES discharge limits for Pyrite Creek. There is full time O&M staff at the Site and EPA contractors perform bi-weekly site inspections.

Opportunities for Optimization
Opportunities for optimization have not been identified. The future Zone 4 FS will evaluate the need for optimization of the current remedy to treat perchlorate in groundwater.

Indicators of Potential Remedy Problems
Perchlorate has been detected in groundwater analytical samples collected at locations throughout Zone 4. Several known perchlorate sources are suspected to have contributed to this contamination including disposal activities at Zone 1, off-site quarry operations, and widespread use of Chilean fertilizers (Kleinfelder, 2010b). An FS is currently being developed, which will include an evaluation of remedial alternatives for perchlorate contamination in Zone 4.

Implementation of Institutional Controls and other Measures
Following the discovery of perchlorate in Zone 4 in 2001, the residents of Glen Avon were provided with bottled water and subsequent service to the public water supply. Existing private wells are only used for irrigation purposes. New well installations are permitted through the RDEH. Their currently policy is to restrict the installation of domestic wells within the plume boundary; however, wells for agricultural purposes or monitoring are allowed. DTSC provided an updated plume map to RDEH in 2010 (Appendix H).

7.4.2 Question B: Are the assumptions used at the time of remedy selection still valid?

Yes. The assumptions used at the time of remedy selection that would affect protectiveness for Zone 4 are still valid. The extent of perchlorate (new COC identified in 2001) in groundwater in Zone 4 was unknown during the remedy selection; however, the RI for Zone 4 has recently been completed and an FS is underway.

Changes in Standards and To Be Considered
No changes to chemical specific ARARs have occurred since they were promulgated in the fourth ROD (see Appendix F, Table 1). Remediation goals for Zone 4 were developed in the fourth ROD for TCE and chloroform. The Federal MCL for drinking water of 5 µg/L for TCE was identified as a cleanup goal. Since no federal MCL existed for chloroform at the time of the fourth ROD, the concentration of 6.0 µg/L, associated with an excess cancer risk of 10^{-6}, was identified as the cleanup goal for chloroform. A Federal MCL for chloroform has not been promulgated. Similarly, no Federal MCL exists for sulfate, although the secondary MCL remains unchanged. Although a federal MCL for nitrate (as nitrogen) was available at the time of the fourth ROD, it was not set as a remediation goal since background nitrate concentrations in many areas exceed this standard. Perchlorate was not identified in the fourth ROD, but is included here because it is a new COC that will be addressed in the future final ROD. Currently, there is no Federal primary or secondary MCL for perchlorate; however, EPA has made a determination to regulate perchlorate and there will be future rulemaking to establish an MCL for this contaminant. California's MCL of 6 µg/L for perchlorate became effective as of October 18, 2007.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics
A toxicity and risk assessment analysis was performed as part of this Five-Year Review to determine if the assumptions used in performing the baseline and subsequent HRAs remain valid for Zone 4. A summary is provided here and a more detailed assessment is presented in Appendix G.

All of the Zone 4 exposure pathways identified in the 1987 baseline health risk assessment are incomplete. However, the 2009 HRA identified several new exposure pathways concerning the ingestion of perchlorate via soil, groundwater, homegrown produce, and breast milk (Kleinfelder, 2009), but the conclusions from that assessment are that potential health risks are below a level of concern. Further, private, potable water supply wells were shut-down and residents are now supplied with a municipal drinking water supply, private wells may still be used for irrigation.

The 2009 HRA also identified indoor air inhalation of VOCs as an exposure pathway. However, the exposure pathway was not complete. There have been no significant changes to existing or anticipated land use on or near Zone 4 which would create new exposure pathways, and there have been no other newly identified contaminants or contaminant sources in Zone 4 since the last Five-Year review. According to the 2009 HRA, the hazard quotient for all VOCs was well under 1.0, indicating the likelihood of non-carcinogenic health effects from exposures to these chemicals is below a level of

concern. For carcinogenic effects, the estimated combined excess lifetime cancer risk (LCR) from VOCs exceeds the primary target risk level ($1x10^{-6}$) but is below the secondary target risk level ($1x10^{-5}$).

While there have been a few changes in toxicity values since the original baseline HRA and the 2009 HRA, most of the changes do not affect the protectiveness of the remedy since their associated exposure pathways are incomplete and/or associated toxicity values remained unchanged since the HRAs were finalized. Chloroform has a slightly higher non-carcinogenic inhalation toxicity value, and both 1,2-dichloroethane and chloroform have slightly higher carcinogenic inhalation toxicity values than previously considered in the 2009 HRA. However, both compounds are such small contributions to the total hazard quotient and combined excess lifetime cancer risk (LCR) that their relatively small changes in toxicity do not significantly affect the total calculated risks. The toxicity of 1,2-dichloroethane and chloroform should be monitored and re-evaluated during the next Five-Year Review.

7.4.3 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 calls into question the protectiveness of the remedy

7.4.4 Technical Assessment Summary

Overall, the selected remedy for Zone 4 is functioning as intended. Chloroform is no longer detected in groundwater in Zone 4, and TCE is only detected above cleanup goals at a few wells; the highest concentration of TCE detected in groundwater analytical samples from in 2010 was about 18 µg/L. Perchlorate was identified as a new COC in 2001, and is found in groundwater and soil analytical samples collected from throughout Zone 4. The RI for perchlorate in Zone 4 has recently been completed and an FS is underway to evaluate future remedial alternatives. In the interim, residents have been provided with water from the public water supply and the RDEH restricts the installation of domestic wells within the plume boundaries. The RI delineated the extent of perchlorate in Zone 4; however, an off-site source may add to the contamination through groundwater and surface water migration. There have been no changes to the assumptions utilized that would affect current remedy.

8.0 Issues

Table 6 Issues

Zone	Issue	Affects Protectiveness? (Y or N)	
		Current	Future
1, 2, and 3	The current monitoring network may be inadequate to monitor contaminants and assess extraction well capture zones in the weathered and unweathered bedrock.	N	Y
1	Alluvium is not completely dewatered to bedrock and weathered and unweathered bedrock along the western portion of the clay barrier dam may not be completely sealed by the grout curtain.	N	Y
2, 3, and 4	There are potential off-site sources of perchlorate in groundwater and surface water.	N	Y

9.0 Recommendations and Follow-Up Actions

Table 7 Recommendations and Follow-Up Actions

Zone	Issue	Recommendations/Follow-Up Action	Party Responsible	Oversight Agency	Planned Completion Date
1, 2, and 3	The current monitoring network may be inadequate to monitor contaminants and assess extraction well capture zones in the weathered and unweathered bedrock.	Optimize the monitoring program so that there are sufficient wells to assess containment at extraction systems and migration in weathered/unweathered bedrock. Modify the extraction systems as necessary.	DTSC	EPA	2013
1	Alluvium is not completely dewatered to bedrock and weathered and unweathered bedrock along the western portion of the clay barrier dam may not be completely sealed by the grout curtain.	Evaluate the need for additional monitoring and/or extraction wells or dewatering in Zones 1 and 1b.	DTSC	EPA	2013
2, 3, and 4	There are potential off-site sources of perchlorate in groundwater and surface water.	Complete additional investigations as necessary to verify off-site perchlorate sources.	DTSC	EPA	2013

The following are follow-up recommendations for items noted in this review that do not necessarily affect protectiveness but should be addressed:

- Evaluate additional background soil data and prepare a SLERA Addendum for inclusion in the final ROD.
- Finalize the groundwater monitoring program optimization and complete the revised Sampling and Analysis plan.
- Analyze pCBSA at Zone 1 wells using EPA Method 331/332 or an equivalent method that will accurately quantify the chemical.
- Complete the Biennial Evaluation Report within one year of completion of groundwater sampling or O&M activities to allow evaluation of the data in timely manner and complete recommended activities. The capture zone evaluation should be included in all future reports to compare temporal stresses and assess system effectiveness.

10.0 Protectiveness Statement

The interim remedies at the Stringfellow Superfund Site are currently protective because exposure pathways that could result in unacceptable risks are being controlled. However, to be protective in the longterm the following action should be completed:

- Optimize the existing monitoring and extraction well systems in Zones 1, 2 and 3 in order to determine if there are sufficient wells to assess containment and contaminant migration. Modify or augment the monitoring and extraction systems as necessary.
- Evaluate the need for additional monitoring and/or extraction wells in Zone 1.
- Complete additional investigations as necessary to verify the off-site perchlorate sources.

The selected remedy for the Site is protective of human health and the environment in the short-term because exposure pathways that could result in unacceptable risks are being controlled.

11.0 Next Five-Year Review

The next Five-Year Review should be performed in 2016. A report to document the results of the review shall be completed by September 2016.

Appendix A. Documents Reviewed

Bryan A. Stirrat & Associates (BAS), 2007. Cone Penetration Tests (CPT) Investigation Report. Stringfellow Hazardous Waste Site. September 28.

Bryan A. Stirrat & Associates (BAS), 2008. Surface Infilling of Sinkhole at the Stringfellow Hazardous Waste Site, Glen Avon, California Property. January 7,

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Appendix A. Documents Reviewed

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Geo-Logic Associates, 2010b. Surface Water Sampling Results Letter Report for December 7, 2010. February 8, 2010.

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Kleinfelder, 2010b. Final Zone 4 Remedial Investigation Report. Stringfellow Superfund Site. February 5.

Kleinfelder, 2010c. Revised Draft Work Plan, Investigation of Background Metals Concentrations in Soil, Stringfellow Superfund Site. November 8.

Kleinfelder, 2010d. Technical Memorandum, In-Situ Bioremediation Pilot Study Report, Stringfellow Superfund Site Zone 4, Riverside County, California. November 19, 2010.

Layne GeoSciences, 2010. Annual Report, Period: July 2008 thru June 2009 Report, Preventative Maintenance Program for Wells and Piezometers, Contract No. 02-T2534, Stringfellow Waste Site. August 4.

Santa Ana Regional Water Quality Control Board (RWQCB), 2007. General groundwater cleanup permit for discharges to surface waters of extracted and treated groundwater resulting from the cleanup of groundwater polluted by petroleum hydrocarbons, solvents, metals, and/or salts. Order No. R8-2007-0008; NPDES No. CAG918001; February 2.

Santa Ana Water Project Authority (SAWPA), 2009, Special Purpose Discharge Permit Issued by the Santa Ana Watershed Project Authority for Discharge of Wastewater. Permit No. 4D-98-S101. Expires December 31, 2011.

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Veolia, 2010c. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, March.

Veolia, 2010d. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, April.

Veolia, 2010e. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, May.

Veolia, 2010f. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, June.

Veolia, 2010g. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, July.

Veolia, 2010h. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, August.

Veolia, 2010i. Operations, Monitoring, and Maintenance Monthly Report, October 2010, Stringfellow Site, Riverside, California, September.

Veolia, 2010j. Operations, Monitoring, and Maintenance Monthly Report, January 2010, Stringfellow Site, Riverside, California, October.

Appendix B. Figures

Figure 1. Stringfellow Site Location Map
Source: Tetra Tech, Inc., 2010.

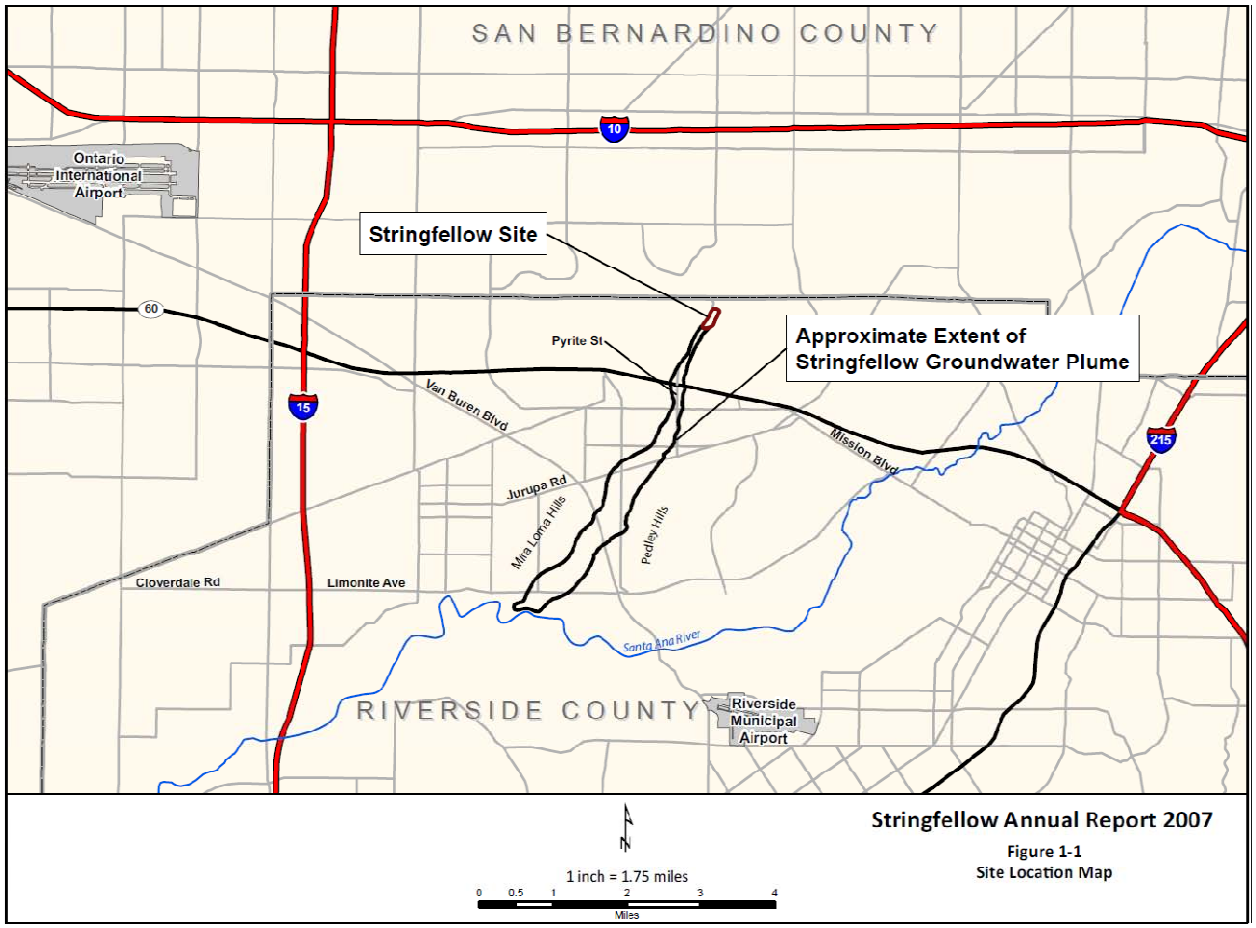

Figure 2. Site Map by Zone
Source: Tetra Tech, Inc., 2010

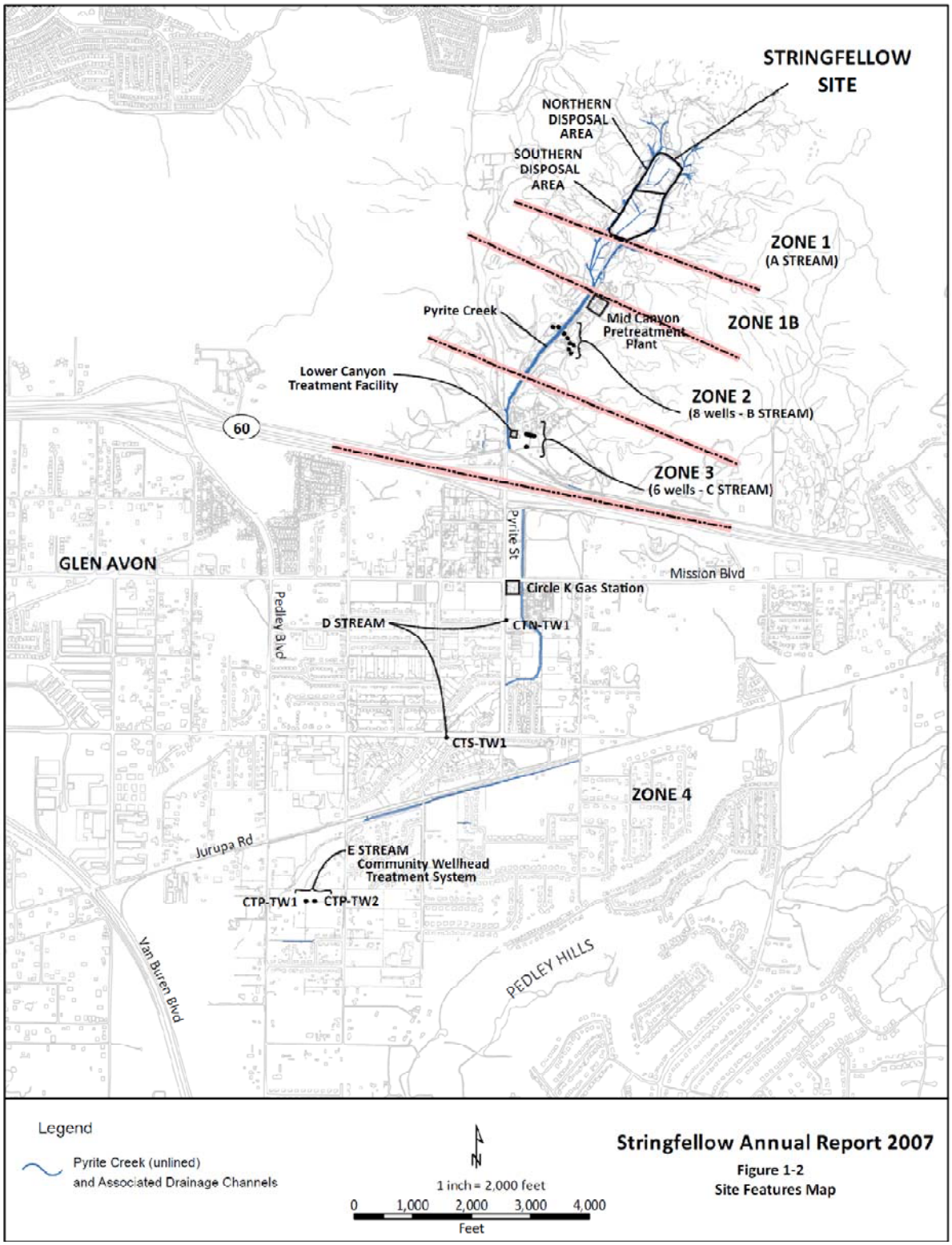

Figure 3. Site Features in Zone 1
Source: ENVIRON, 2009

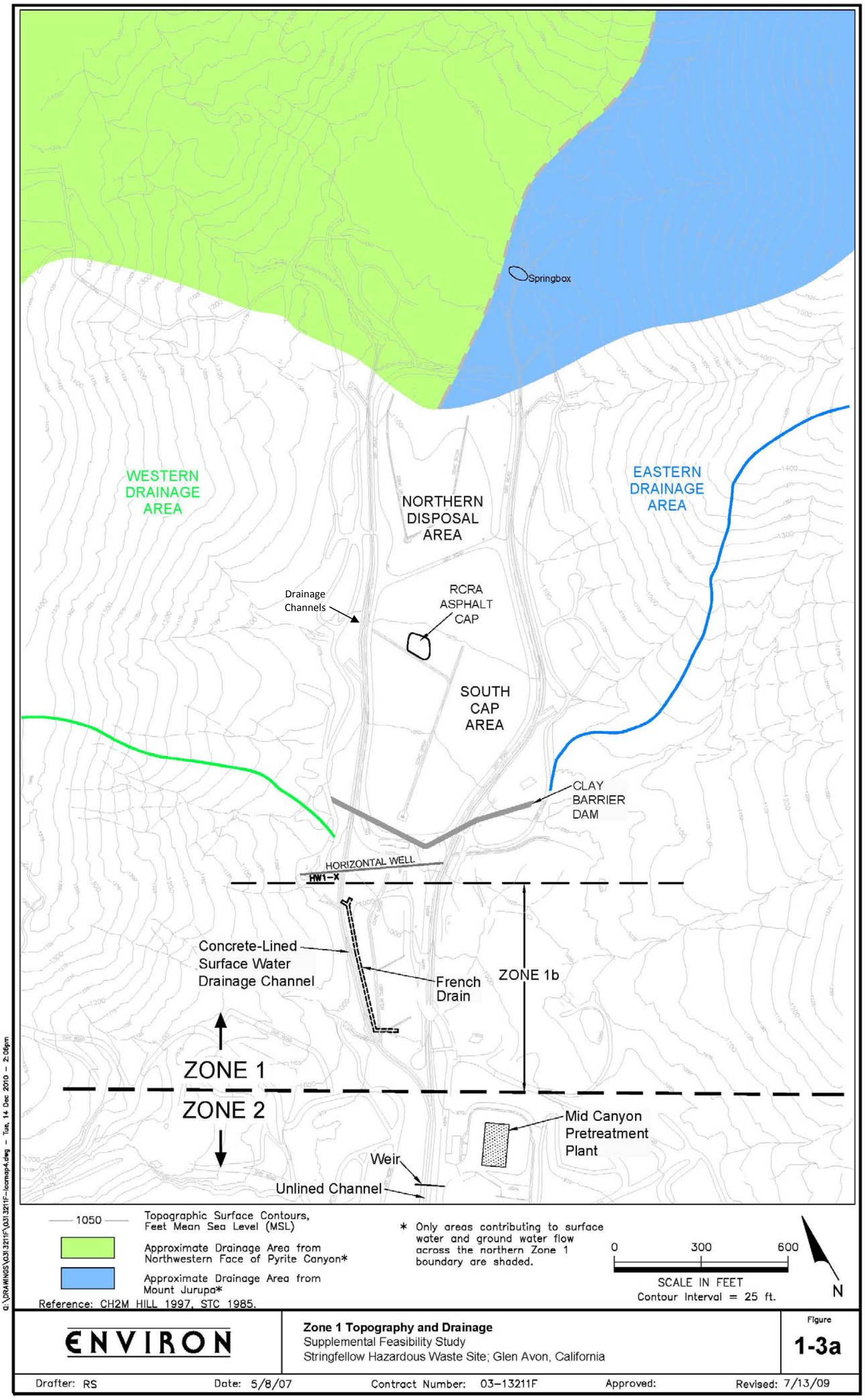

Figure 4. Geologic Cross-Section through Zone 1.
Source: Tetra Tech, Inc., 2010

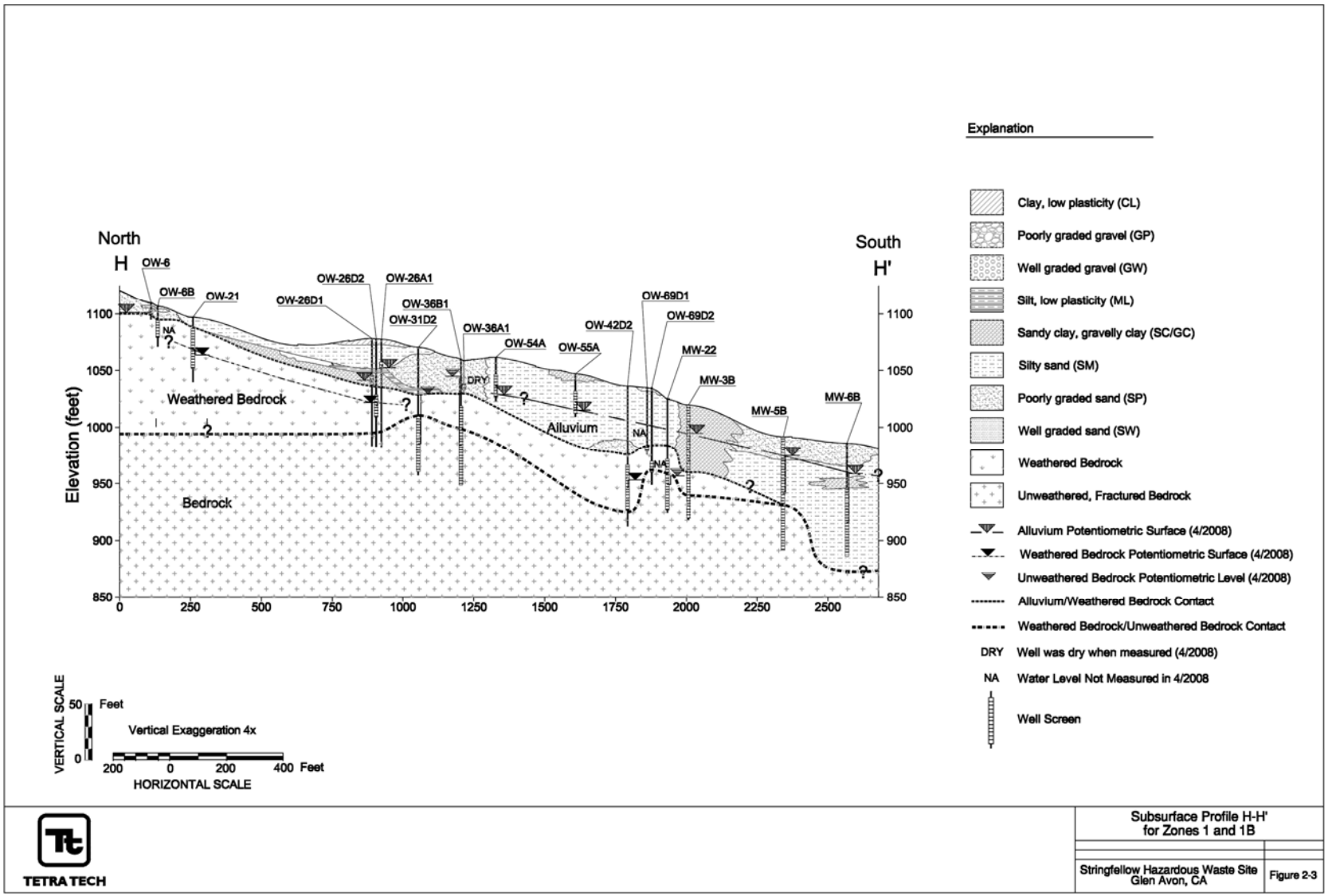

Figure 5. Geologic Cross-Section through Zones 2 and 3.
Source: Tetra Tech, Inc., 2010

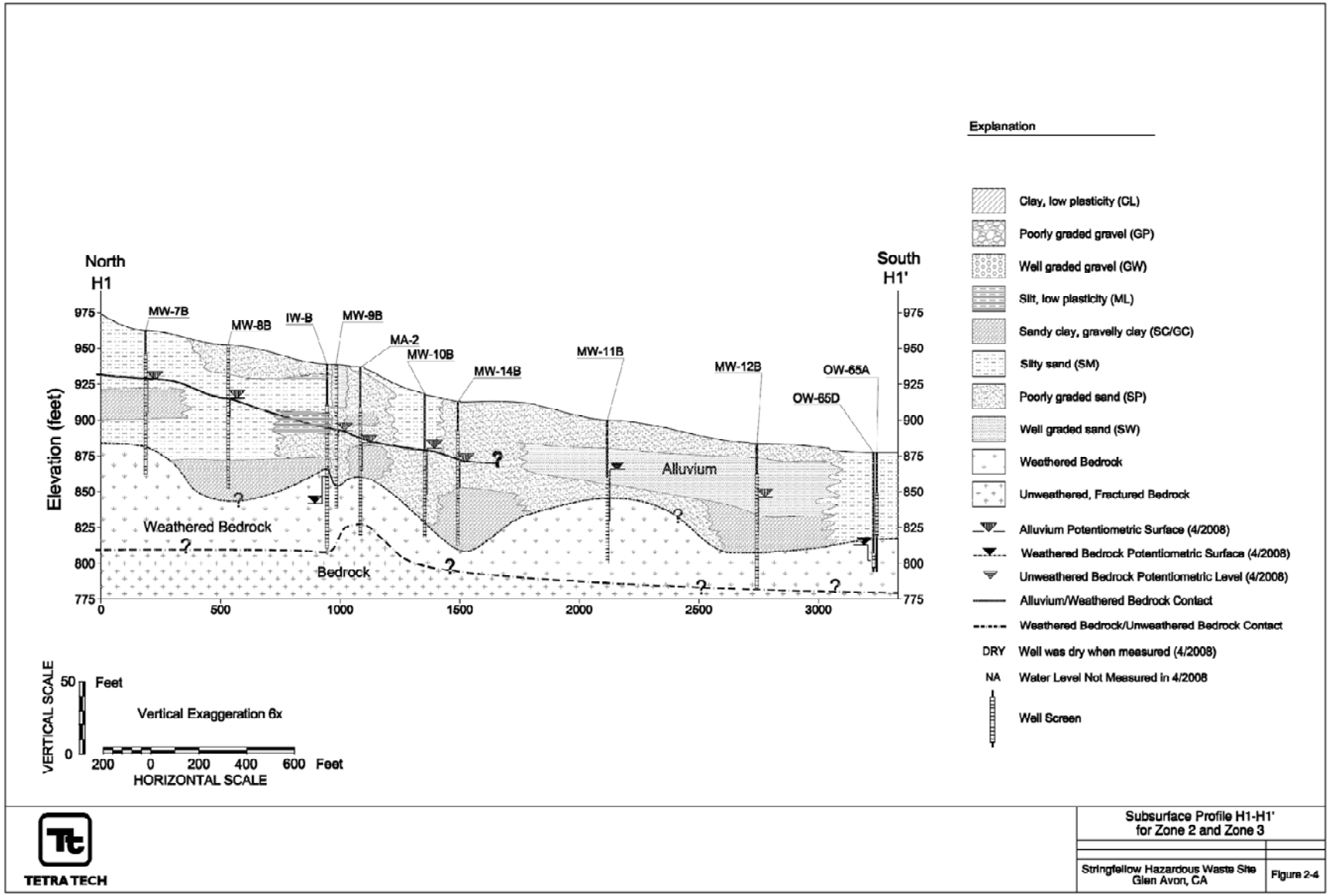

Figure 6. Stringfellow Site General Site Daily Checklist

VEOLIA WATER

Name: Juan A Ramos **STRINGFELLOW SITE**
Date: 2-1-11 **GENERAL SITE DAILY CHECKLIST**

STATION	ITEM/LOCATION	PARAMETER	METHOD	VERIFIED BY	REMARKS
Site					
Communication System	Telephones, Radios, etc	Integrity, Operation	Visual	JR	
First Aid Person	Site	Certified	Administrative	JR	
Signs/Signed Areas	Traffic, egress Caution/Danger, etc.	Safety	Visual	JR	
Emergency Equipment	Showers, eye-wash, fire protection, First Aid Kit, Personal Protective Equipment	Safety	Visual	JR	
Housekeeping					
Trailers		Cleanliness	Visual	JR	
Site (trash, weeds, etc.)		Cleanliness	Visual	JR	
Paved Areas	Zone 3 LCTF	Cleanliness	Visual	JR	
Painted Surfaces		Cleanliness	Visual	JR	
Portable Toilets	3 Toilets	Cleanliness/Health	Visual	JR	
Personnel Attire		Safety/Health	Visual	JR	
Personnel Protection Device(s)		Health/Safety	Visual	JR	
Site					
Access Roads	Zone 1	Accessibility, compaction, general condition	Visual	JR	
Perimeter Fence	Zones 1,2,3,4	Integrity	Visual	JR	

Figure 6 cont. Stringfellow Site General Site Daily Checklist

VEOLIA WATER

STRINGFELLOW SITE
GENERAL SITE DAILY CHECKLIST

Date: Jan A Ramos

STATION	ITEM/LOCATION	PARAMETER	METHOD	VERIFIED BY	REMARKS
Site					
Drainage Channels	Zones 1,2,3,4	Blockage	Visual	JR	
Site Cap	Zone 1	Erosion, Subsidence	Visual	JR	
EPA Rain Gauge (Manual)	Zone 1	Operation, Temperature	Visual		
Stream Gauges	Mid Canyon (2) Lower Canyon (1)	Integrity/Operation	Visual & Admin.	JR	
Lights	Zones 1,2,3,4	Operation	Visual	JR	
Clean Water Tanks (Decon pad, core shed, and any others	Zone 1	Corrosion and/or leaks, check piping and valves maintain water levels as required.	Visual	JR	
Holding Tank at Decon Pad	Zone 1	Corrosion, and/or leaks, check piping and valves pump water to "A" Stream line on an as-needed basis.	Visual	JR	
Extraction pumps and appurtenances	Zone 2	Hand Test		JR	
B-Stream Force Main Pumps	P-47, 48	Inspect force main		JR	

Figure 6 cont. Stringfellow Site General Site Daily Checklist

VEOLIA WATER

STRINGFELLOW HAZARDOUS WASTE SITE
GENERAL SITE DAILY CHECKLIST

Date: Juan A Ramos

STATION	ITEM/LOCATION	PARAMETER	METHOD	VERIFIED BY	REMARKS
Influent and Effluent Conveyance System					
Force Main Pumps	Zones 2, 3 tank areas	Operation	Visual, hand test	JR	
Valve Vaults	Stream C forced main	Security/repair	Visual	JR	
Fencing/Gates	Zones 2,3 tank areas	Security/repair	Visual	JR	
Tanks; Level Alarms	Zones 2,3 tank areas	Appearance/Integrity	Visual	JR	
Exposed Piping/Valves	Zones 2,3 tank areas	Appearance/Integrity	Visual	JR	
Gauges	Zones 2,3 tank areas	Operation	Visual	JR	
Extraction pumps and appurtenances	Zones 2,3	Operation	Visual, hand test	JR	
Stream D Pumps	Zone 4 (As required during operation of Zone 4 extraction system)	Operation	Visual, hand test	JR	
Stream D Pumps Vaults	Zone 4 (after takeover of Zone 4 extraction system)	Security/repair	Visual	JR	
Stream D Pump Vault Lighting, Ventilation	Zone 4 (after takeover of Zone 4 extraction system)	Operation	Visual, hand test	JR	
Manholes	Zones 2,3,4	Security, Leakage	Visual	JR	
Effluent Pipeline (Flow Gauge)	PTP	Flow Rate (<120 gpm)	Visual	JR	

Figure 7. Stringfellow Site Weekly Inspection Checklist

STRINGFELLOW SITE **WEEKLY INSPECTION CHECKLIST**

VEOLIA WATER

		INSPECTED BY Juan A Ramos	DATE INSPECTED 2-18-11
ITEM	**LOCATION**	**CONDITION**	**ACTION TO BE TAKEN & LEVEL OF URGENCY**
ZONE 1: UPPER CAP AREA			
INSPECTION OF DRAINAGE CHANNELS:		**MAINTENANCE:**	
Inspect for Leaks in the Channels	West Channel	Ok / Needs Repairs	
	East Channel	Ok / Needs Repairs	
INSPECTION OF CULVERT:			
Check Inlet & Outlet for Debris Build-Up	Culvert	Ok / Maintenance Needed	
INSPECTION OF SITE COVER:			
Inspect for Seepage and Subsidence	Site Cover	Ok / Maintenance Needed	
INSPECTION OF 2" PVC PIPELINE:	Pipeline connecting from/to:	**MAINTENANCE**	
Inspect Ground Surface (GS) for Wetness	Valve Box B	Ok / GS Wet Leak in VB	
& Valve Boxes (VB) & Valve Vault (VV)	Well Box C	Ok / GS Wet Leak in VB	
For Flooding Indicating Piping Leaks	Valve Box D	Ok / GS Wet Leak in VB	
	Stream A Valve Vault	Leak in Valve Vault	
	Wells OUM-1 & OUM-2	Ok / Ground Surface Wet	
	Well OC-1B	Ok / Ground Surface Wet	
	Well OW8	Ok / Ground Surface Wet	
	Well OW9	Ok / Ground Surface Wet	
INSPECTION OF 3" PVC PIPELINE:			
Inspect Ground Surface for Wetness	Pipeline Btwn. UW3 & E. Channel	Ok / Ground Surface Wet	
OTHER ITEMS OR OBSERVATIONS:		**MAINTENANCE FOR OTHER ITEMS:**	
		Ok / Maintenance Needed	

Page 1 of 3

Figure 7 cont. Stringfellow Site Weekly Inspection Checklist

STRINGFELLOW SITE **WEEKLY INSPECTION CHECKLIST**

VEOLIA WATER

ZONE 1: LOWER CAP AREA (INCLUDING FOUR ACRE AREA)			
INSPECTION OF DRAINAGE CHANNELS:		**MAINTENANCE:**	
Inspect for Leaks in the Channels	West Channel	Ok / Needs Repairs	
	East Channel	Ok / Needs Repairs	
INSPECTION OF DROP STRUCTURE & 18" VCP DRAIN PIPE:		**MAINTENANCE:**	
Check for Clogging or Debris Build-up	Drop Structure & 18" Drainage Pipe	Ok / Maintenance Needed	
INSPECTION OF SITE COVER:		**MAINTENANCE:**	
Inspect for Seepage & Subsidence	Site Cover	Ok / Maintenance Needed	
INSPECTION OF 2" PVC PIPELINE	2" Pipeline Connecting from/to:	**MAINTENANCE:**	
Inspect Ground Surface (GS) for Wetness &	Stream A Valve Vault to Box Tie-In	Ok / Ground Surface Wet	
Valve Boxes (VB) for Flooding Indicating	Well OW2 to Valve Box Tie-In	Leak in Valve Box	
Piping Leaks	Well OW2 to 4" Pipeline	Ok / Ground Surface Wet	
	2" Pipeline to Valve Box E	Ok / GS Wet Leak in VB	
	Well OW1 & OC-6D to	Ok / Ground Surface Wet	
	Valve Box E to 4" Pipeline	Ok / Ground Surface Wet	
	Pipeline Connect Well IW1 &	Ok / Maintenance Needed	
	French Drain to Existing Valve Box	Leak in Existing Valve Box	
INSPECTION OF 4" PVC PIPELINE:	Pipeline Connecting Existing	**MAINTENANCE:**	
Inspect Ground Service for Wetness	Valve Box to 2" Upper Site Pipeline	Ok / Maintenance Needed	
Indicating Piping Leaks	Existing Valve Box to PTP	Ok / Maintenance Needed	
INSPECTION OF 24" RCP DRAIN PIPE:		**MAINTENANCE:**	
Check for Clogging or Debris Build-up	24" RCP Drainage Pipe	Ok / Maintenance Needed	
OTHER ITEMS OR OBSERVATIONS:		**MAINTENANCE FOR OTHER ITEMS:**	
		Ok / Maintenance Needed	

Page 2 of 3

Figure 7 cont. Stringfellow Site Weekly Inspection Checklist

STRINGFELLOW SITE **WEEKLY INSPECTION CHECKLIST**

VEOLIA WATER

ZONE 2: MID CANYON AREA			
	WEST OF PYRITE STREET		
INSP. OF GUNITE & NATRL CHANL, DROP STRUCTURS & WEIR:		**MAINTENANCE:**	
Inspect for Debris in Channel & Drop	Drainage Channel, Drop	Ok / Clear Debris Remove Silt	
Structures & Silt Build-up Behind the Weir	Structures & Weir	Ok / Needs Repairs	
INSPECTION OF 1 ½" PVC PIPELINE:		**MAINTENANCE:**	
Inspect Ground Surface for Wetness &	Pipeline Connecting Extraction Wells	Ok / Maintenance Needed	
Pipe Bridge Over Channel for Leaks	IW2 & MB4 to Mid Canyon Tanks		
	EAST OF PYRITE STREET		
INSPECTION OF 4" PVC PIPELINE:	Pipeline Connect. Mid Canyon PTP to	**MAINTENANCE:**	
Inspect Ground Surface Along Shoulder	Valve Box #5	Ok / Maint.Needed Leak in VB #5	
of Pyrite St. for Wetness & Valve Boxes for	Valve Box #5 to Valve Box #4	Ok / Maint.Needed Leak in VB #4	
Flooding Indicating Piping Leaks; Inspect	Valve Box #4 to Valve Box #3	Ok / Maint.Needed Leak in VB #3	
Control Cable Splice Boxes for Damage	Valve Box #3 to Valve Box #2	Ok / Maint.Needed Leak in VB #2	
	Cable Splice Boxes	Ok / Maintenance Needed	
OTHER ITEMS & OBSERVATIONS:		**MAINTENANCE FOR OTHER ITEMS:**	
		Ok / Maintenance Needed	
ZONE 3: LOWER CANYON AREA			
	Mid Canyon Tanks to Freeway		
INSP. OF GUNITE & NATURAL CHANL & DROP STRUCTURES:		**MAINTENANCE:**	
Inspect for Debris in Channel & Drop Structures	Channel & Drop Structures	Ok / Clear Debris	
INSPECTION OF 4" PVC PIPELINE:	Pipeline Connecting Valve Box #2 to	**MAINTENANCE:**	
Inspect Ground Surface for Wetness & Valve	Valve Box #1	Ok / Maint.Needed Leak in VB #1	
Boxes for Flooding Indicating Piping Leaks	Valve Box #1 to Lower Canyon Tanks	Ok / Maintenance Needed	
OTHER ITEMS & OBSERVATIONS:		**MAINTENANCE FOR OTHER ITEMS:**	
		Ok / Maintenance Needed	

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Figure 8. Stringfellow Pretreatment Plant (PTP) Process Flow Diagram (as of 2007)
Source: Tetra Tech, Inc., 2010

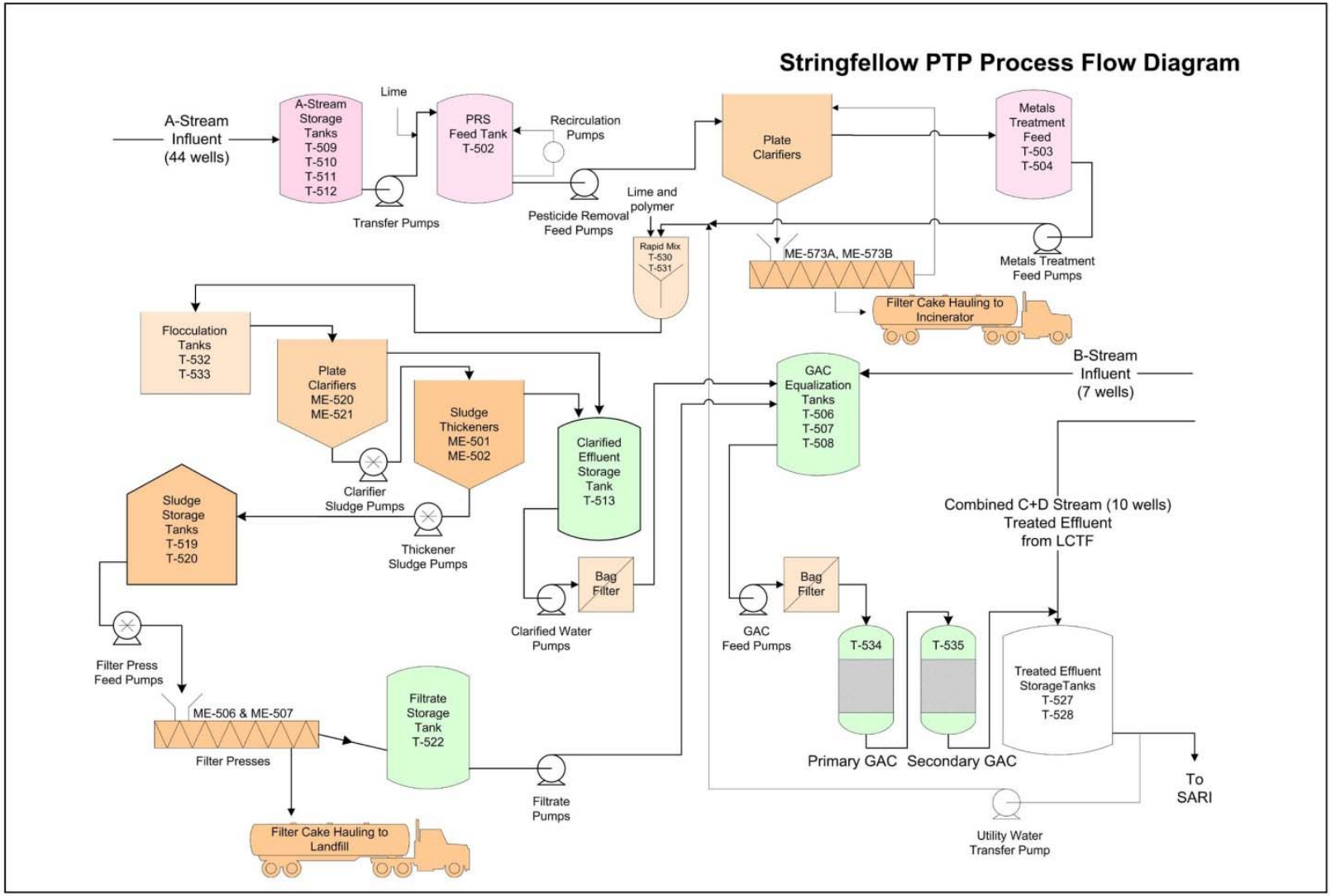


Figure 3-1
Stringfellow Pretreatment Plant (PTP) Process Flow Diagram

Figure 9. Stringfellow Lower Canyon Treatment Facility (LCTF) Flow Diagram
Source: Tetra Tech, Inc., 2010

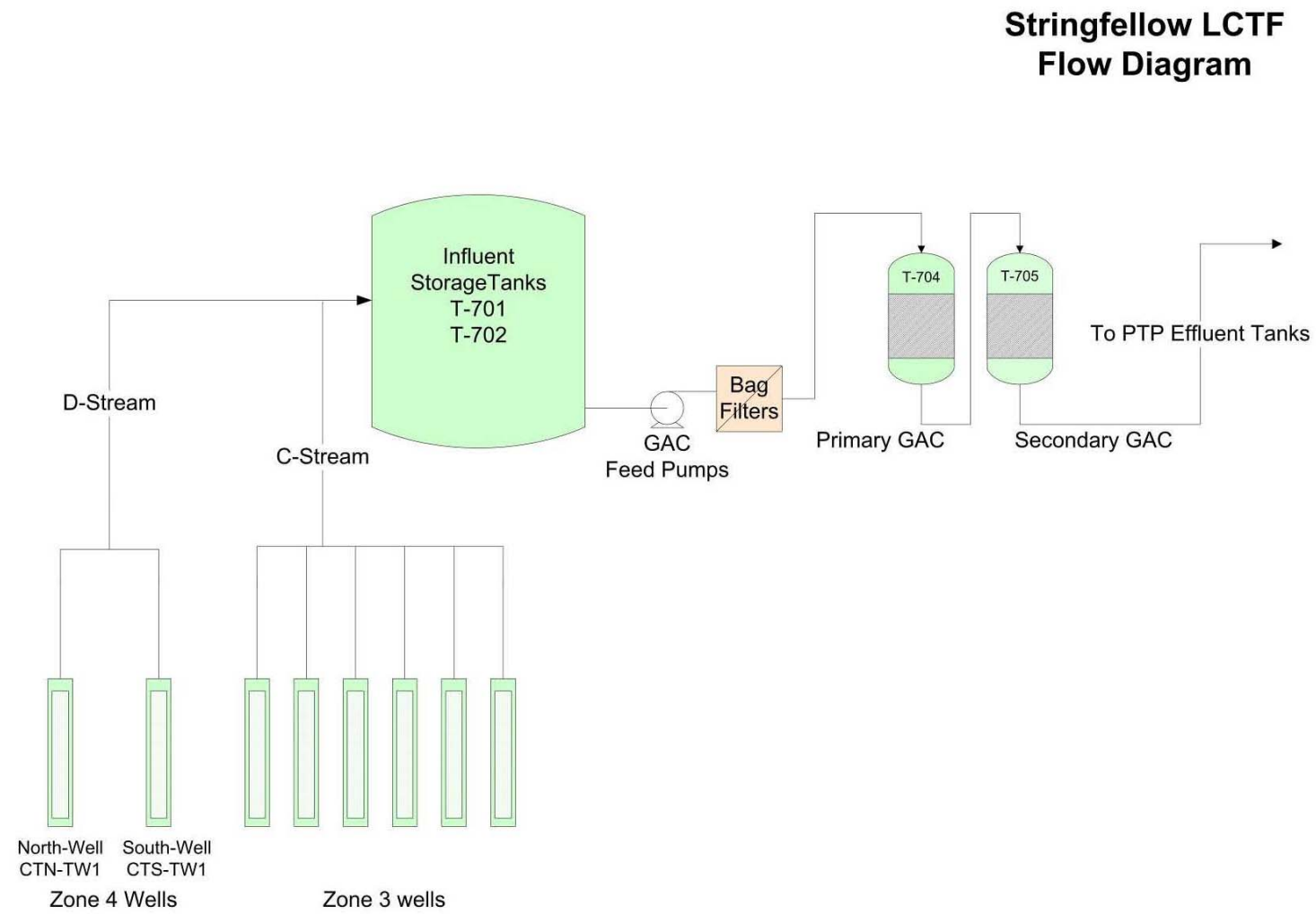


Figure 3-2
Stringfellow Lower Canyon Treatment Facility (LCTF) Flow Diagram

Figure 10. Stringfellow Community Wellhead Treatment System (CWTS) Flow Diagram
Source: Tetra Tech, Inc., 2010

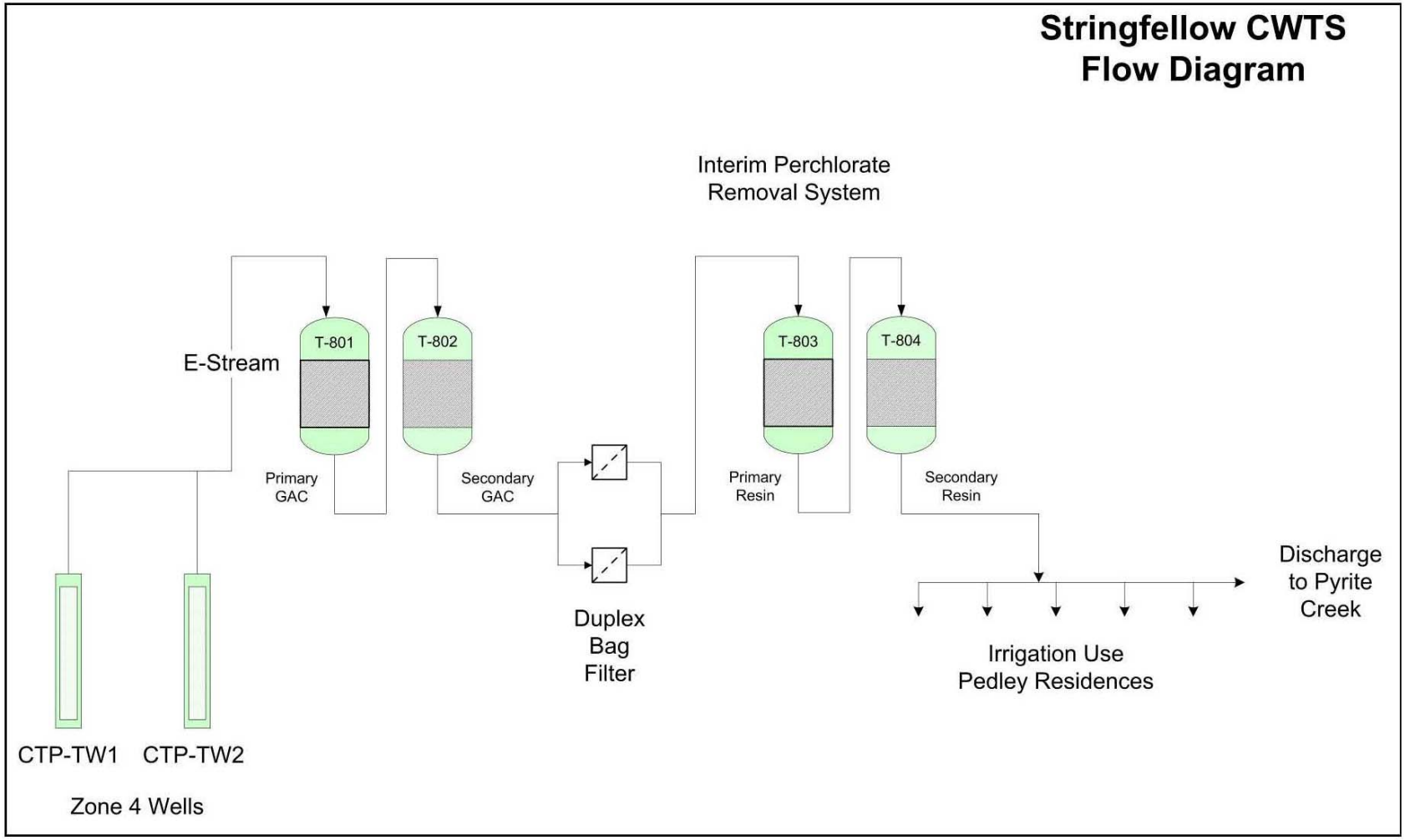


Figure 3-3
Stringfellow Community Wellhead Treatment System (CWTS) Flow Diagram

Figure 11. TCE distribution in alluvial groundwater, Zones 1, 2, and 3.
Source: Tetra Tech, Inc., 2010

Appendix B - Figures

Figure 12. TCE distribution in weathered bedrock groundwater, Zones 1, 2, and 3.

Source: Tetra Tech, Inc., 2010

Appendix B - Figures

Figure 13. TCE distribution in unweathered bedrock groundwater, Zones 1, 2, and 3.

Source: Tetra Tech, Inc., 2010

Figure 14. TCE distribution in alluvial groundwater, Zone 4
Source: Tetra Tech, Inc., 2010

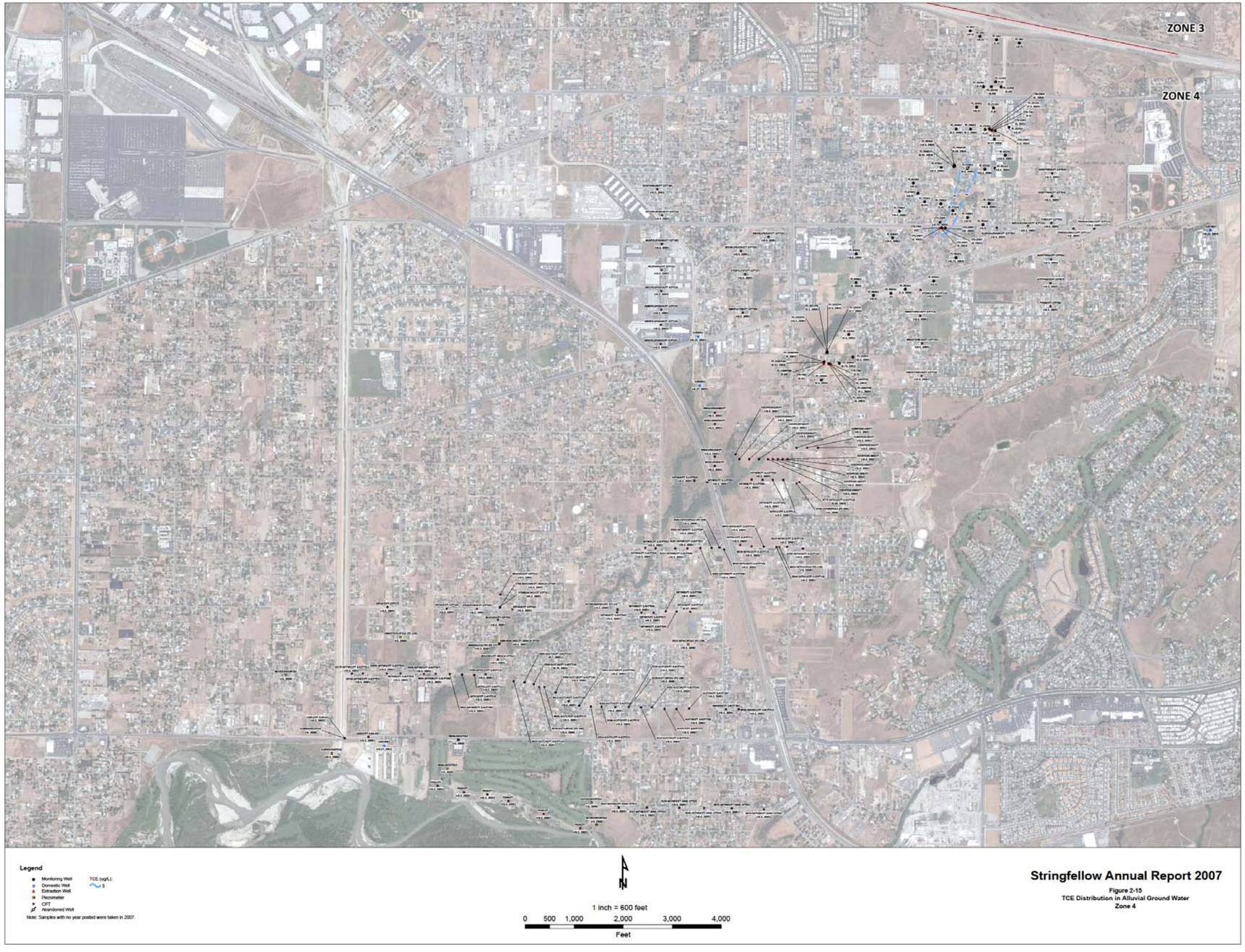


Figure 15. Perchlorate distribution in alluvial groundwater, Zones 1, 2, and 3
Source: Tetra Tech, Inc., 2010

Figure 16. Perchlorate distribution in alluvial groundwater, Zone 4.
Source: Tetra Tech, Inc., 2010

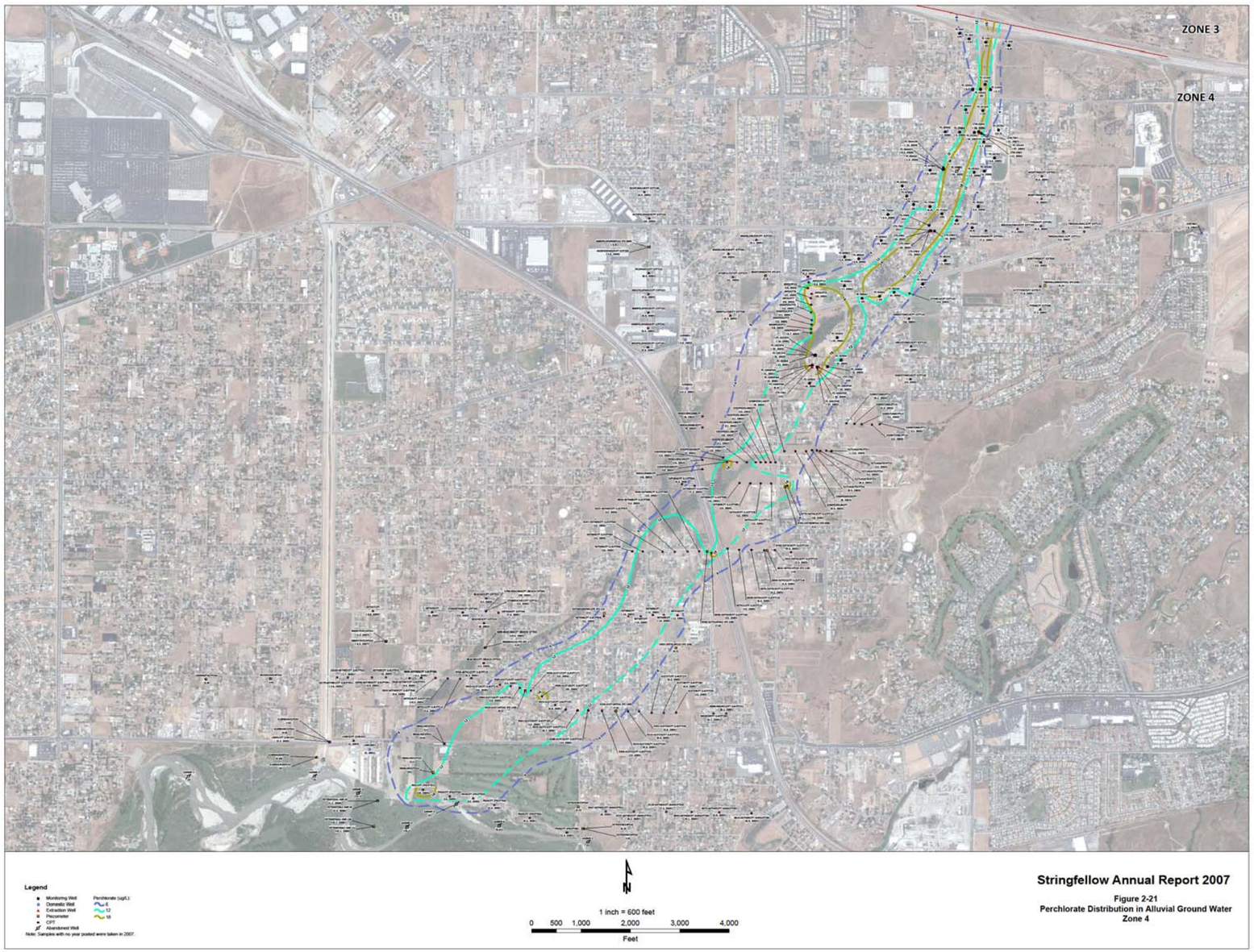


Figure 17. Zone 1 Alluvium Saturated Thickness
Source: Tetra Tech, Inc., 2010

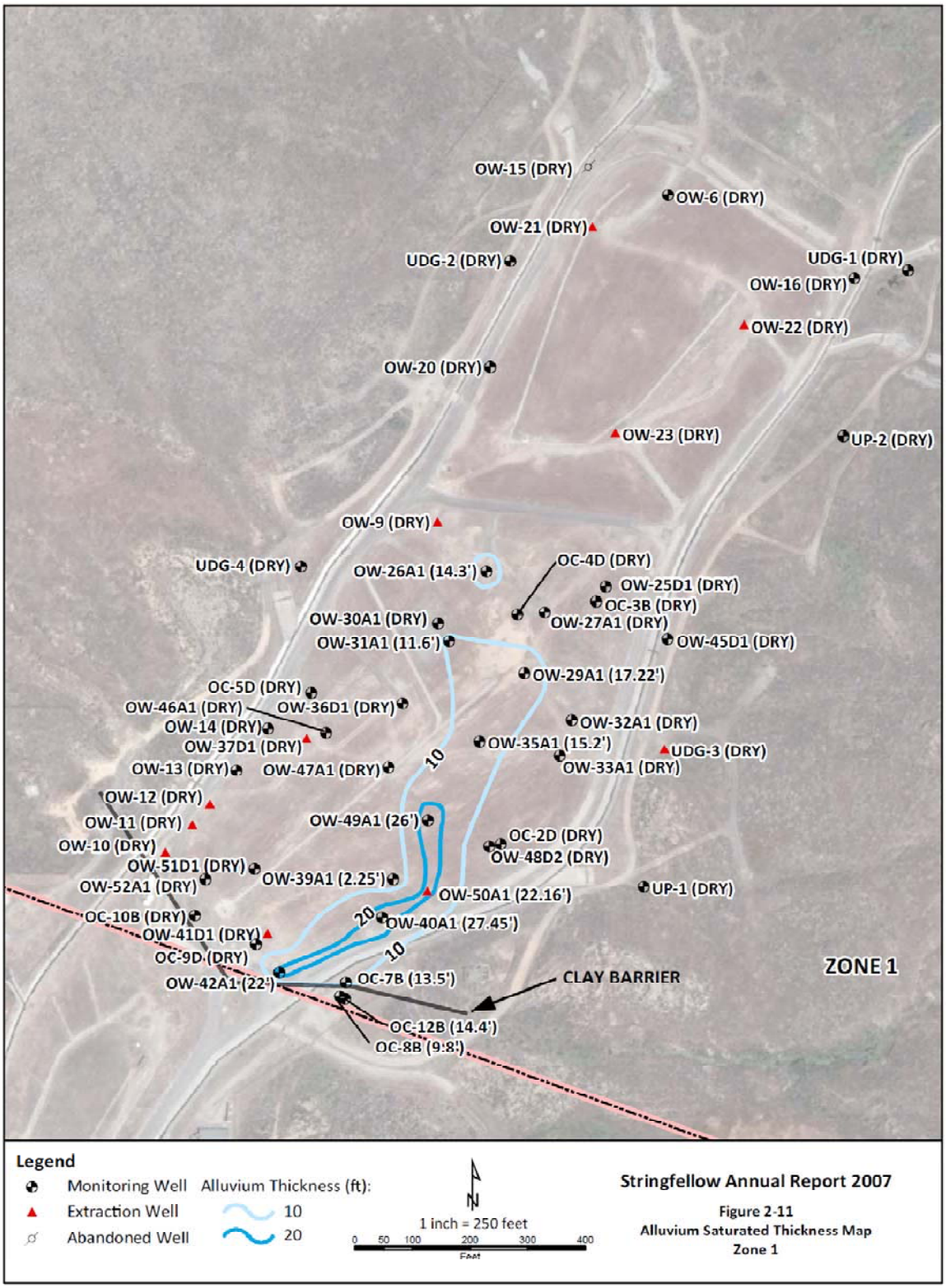


Figure 18. Comparison of TVOC Results Upgradient and Downgradient of the Clay Barrier Dam
Source: ENVIRON, 2010c

TABLE 2. COMPARISON OF TVOC RESULTS UPGRADIENT AND DOWNGRADIENT OF THE CLAY BARRIER DAM AT WELL CLUSTERS OC-10 AND OC-11 (Updated through April 2010)
Stringfellow Hazardous Waste Site; Glen Avon, California

UPGRADIENT WELLS					DOWNGRADIENT WELLS				
Well	Screened Unit [a]	Screen Interval (ft bgs)	Sample Date	TVOCs (µg/l)	Well	Screened Unit [a]	Screen Interval (ft bgs)	Sample Date	TVOCs (µg/l)
~0-30 Feet Depth Interval where the Clay Barrier Dam Is Present									
OC-10A	AL	11.0 - 24.0	4/11/97	**24,200**	OC-11A	AL	12.5 - 27.5	4/11/97	**6,700**
			4/24/98	**12,160**				4/27/98	**1,180**
			4/25/05	**3,000**				4/25/05	**575**
			ns	--				4/27/10	**1,925**
OC-10D	WB/B	25.4 - 29.4	4/24/98	**19,200**	OC-11D	AL	21.1 - 27.6	4/27/98	**4,100**
			4/25/05	**6,610**				4/25/05	**3,240**
			4/28/10	**4,570**				4/28/10	**2,430**
~30- >60 Feet Depth Interval - Well Screens Extend Beneath the Clay Barrier Dam									
OC-10B	B	27.5 - 78.4	4/16/97	**23,000**	OC-11B	B	29.5 - 80.1	4/16/97	**58,000**
			4/24/98	**2,270**				4/27/98	**1,510**
			7/12/00	**10,570**				7/12/00	**10,170**
			4/24/03	**31,100**				4/24/03	**36,500**
			10/8/07	**14,930**				3/17/08	**5,770**
			11/26/08	**8,020**				11/26/08	**4,800**
			ns	--				4/17/09	**5,120**
			4/28/10	**4,080**				4/21/10	**5,050**

Notes:
[a] AL = Fill/Alluvium, WB = Weathered Bedrock, B = Bedrock
ft bgs = feet below ground surface
TVOCs = Total Volatile Organic Compounds
µg/l = micrograms per liter, or parts per billion
ns = not sampled

Clay Barrier Dam is present between the upgradient and downgradient wells

Clay Barrier Dam is not present between the upgradient and downgradient wells; a grout curtain was injected below the barrier in this depth interval.

Figure 19. Concentrations of TCE in Groundwater at Zone 2 Extraction Wells, MA-1, MB-1, and MW-19B

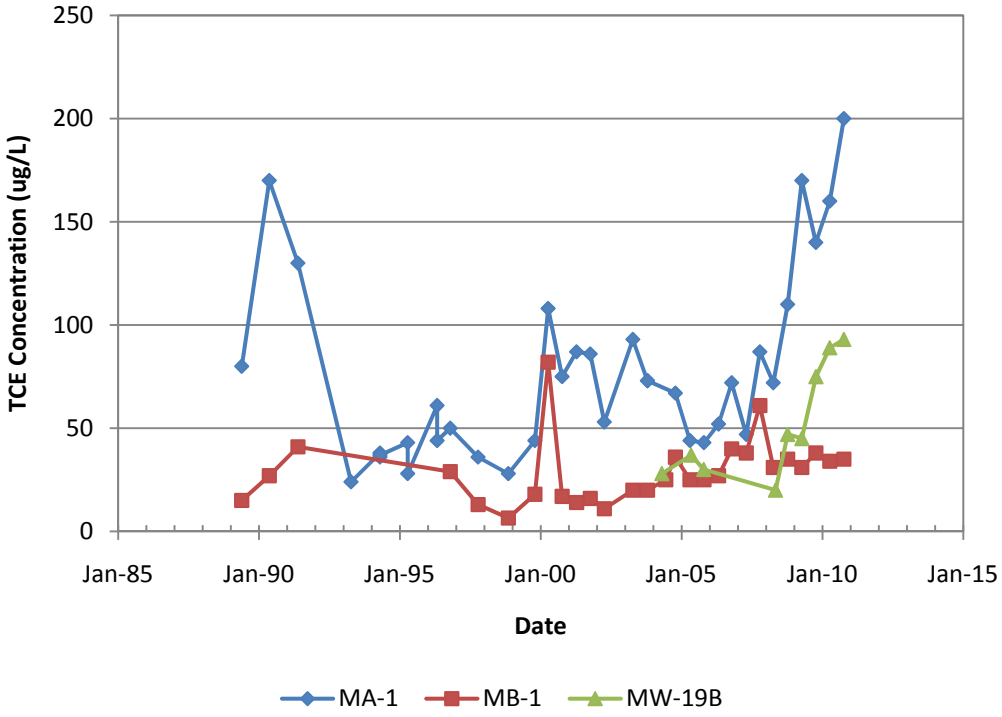


Figure 20. Concentrations of Chloroform in Groundwater at Zone 2 Extraction Wells, MA-1, MB-1, and MW-19B

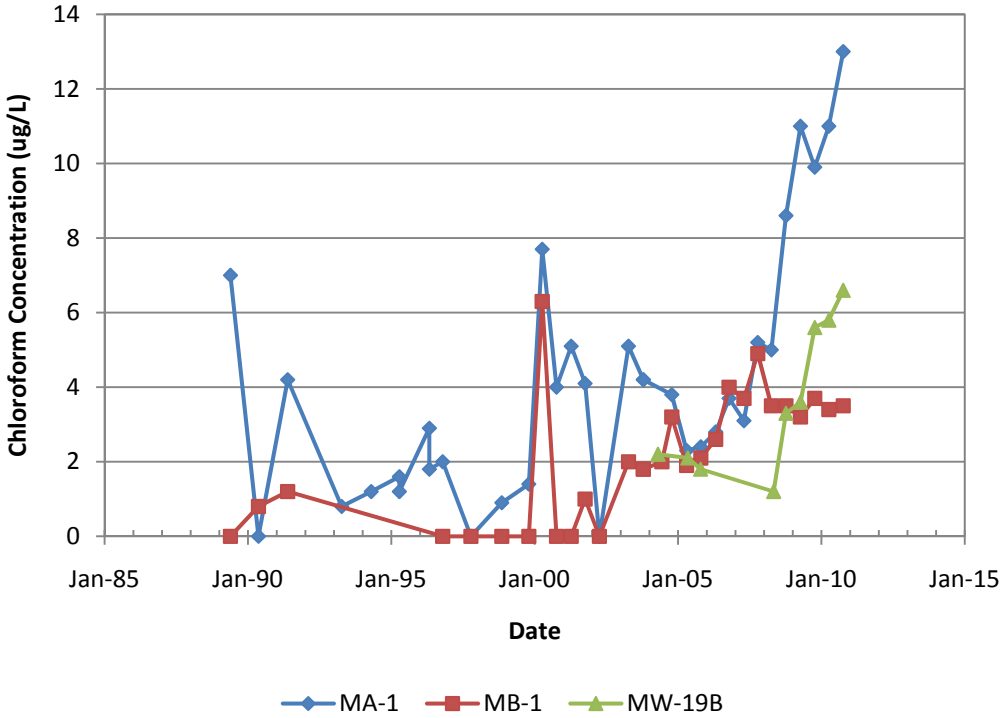


Figure 21. Zone 2 Well Locations.
Source: ENVIRON, 2009

Figure 22. Comparison of 1996 TCE plume (in purple) with the smaller 2010 TCE plume (in blue) in Zone 4.
Source: California DTSC, 2011

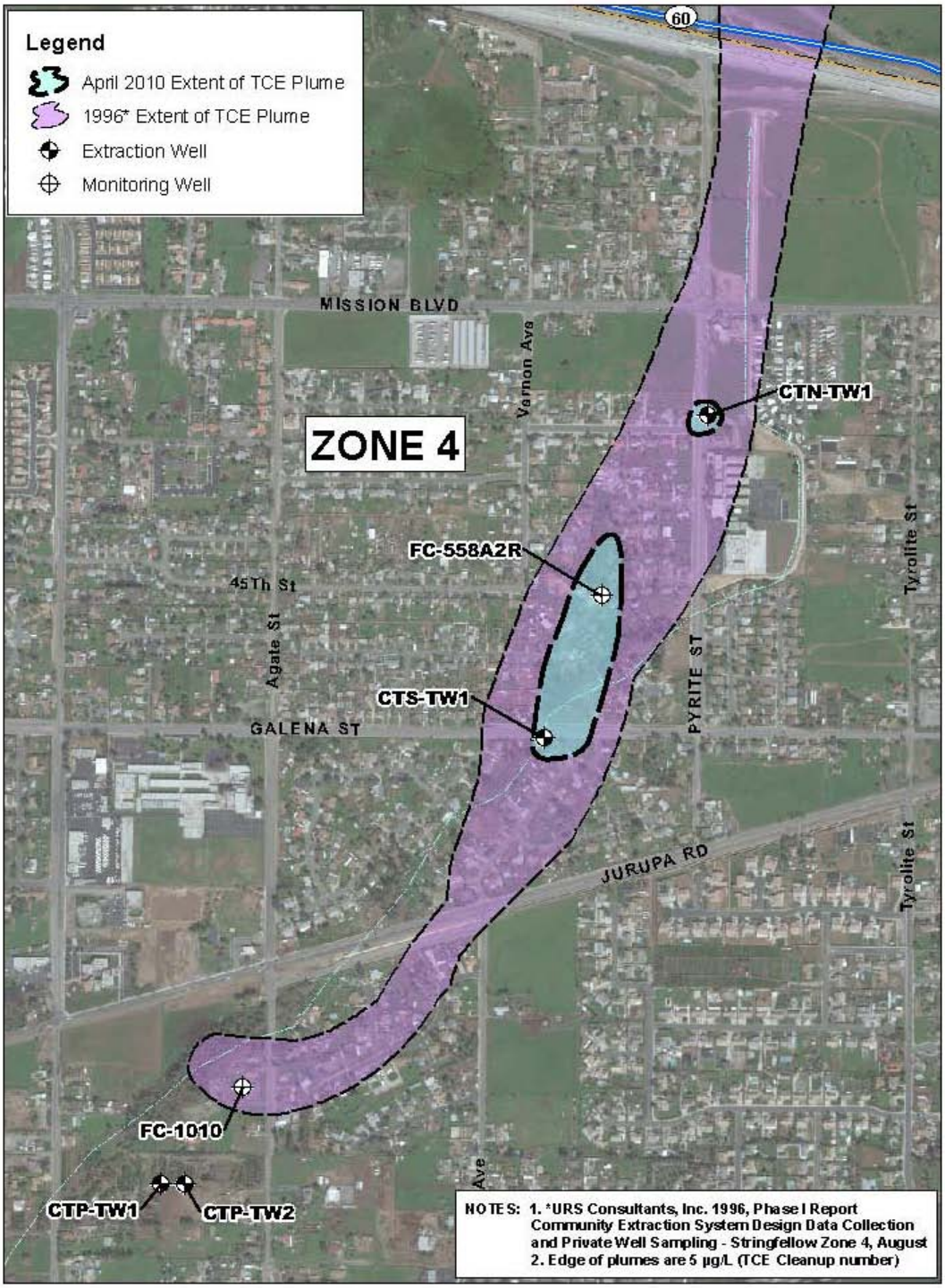
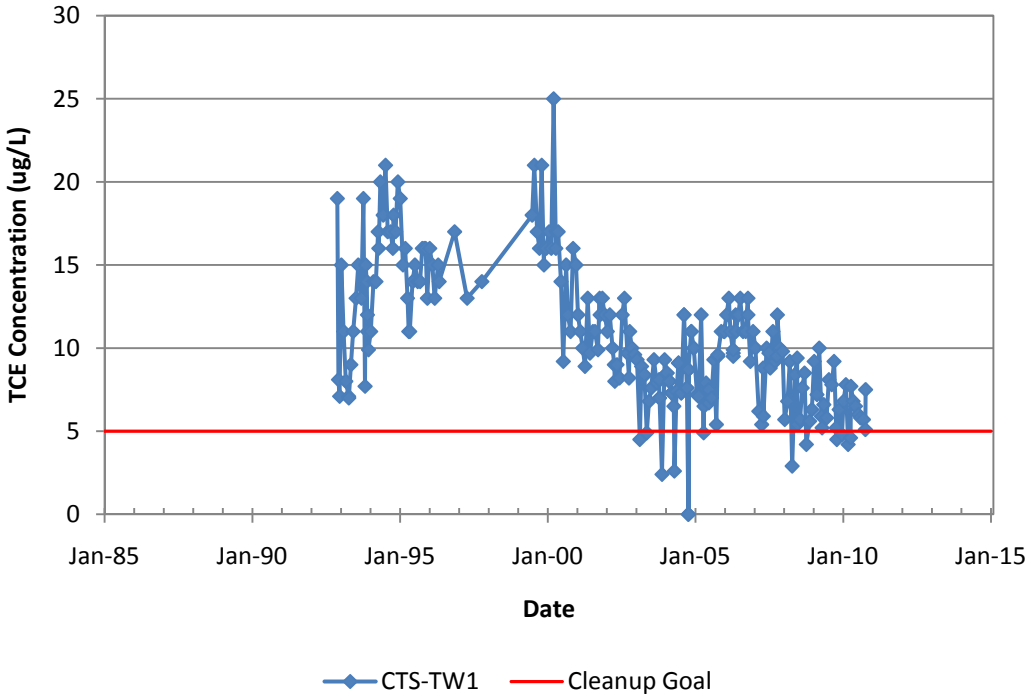


Figure 23. Concentrations of TCE in Groundwater at Zone 4 Extraction Well, CTS-TW1.



Appendix C. Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Stringfellow Superfund Site	**Date of inspection: 11/5/2010**
Location and Region: Riverside, CA/EPA Region 9	**EPA ID: CAT080012826**
Agency, office, or company leading the Five-Year Review: USACE	**Weather/temperature: 85 ºF, sunny**

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☒ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☒ Vertical barrier walls
- ☐ Other_____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Ziggy Kostecki (Name) Hazardous Substances Engineer, DTSC (Title) 11/5/10 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached _____
   Ziggy is the site engineer from DTSC.

2. **O&M staff** Tom Perina (Name) Senior Hydrogeologist, CH2MHill (Title) 11/5/10 (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached _____
   Tom is the project manager for EPA oversight at project.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency DTSC
Contact Allen Wolfenden Chief, San Joaquin Legacy Landfill Office 11/5/10
Name Title Date Phone no.
Problems; suggestions; ☒ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

4. **Other interviews** (optional) ☐ Report attached.

Appendix C. Five-Year Review Site Inspection Checklist

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☒ O&M manual — ☒ Readily available — ☐ Up to date — ☐ N/A
   - ☐ As-built drawings — ☐ Readily available — ☐ Up to date — ☐ N/A
   - ☐ Maintenance logs — ☐ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

2. **Site-Specific Health and Safety Plan** — ☒ Readily available — ☐ Up to date — ☐ N/A
   G Contingency plan/emergency response plan — ☐ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

3. **O&M and OSHA Training Records** ☐ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

4. **Permits and Service Agreements**
   - ☐ Air discharge permit — ☐ Readily available — ☐ Up to date — ☒ N/A
   - ☒ Effluent discharge — ☐ Readily available — ☐ Up to date — ☐ N/A
   - ☒ Waste disposal, POTW — ☐ Readily available — ☐ Up to date — ☐ N/A
   - ☐ Other permits_____ — ☐ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

5. **Gas Generation Records** ☐ Readily available — ☐ Up to date — ☒ N/A

   Remarks_____

6. **Settlement Monument Records** ☒ Readily available — ☐ Up to date — ☐ N/A

   Remarks_For sinkhole monitoring only.

7. **Groundwater Monitoring Records** ☒ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

8. **Leachate Extraction Records** ☒ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

9. **Discharge Compliance Records**
   - ☐ Air — ☐ Readily available — ☐ Up to date — ☒ N/A
   - ☐ Water (effluent) — ☐ Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

10. **Daily Access/Security Logs** ☐ Readily available — ☐ Up to date — ☐ N/A

    Remarks_____

IV. O&M COSTS

1. **O&M Organization**

☒ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: Cost of GAC and other supplies has gone up.
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks_____
_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks 24/7 guard service and security patrols of Zone 1 when O&M contractor not present.
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) 24/7 on-site security guard

Frequency _____

Responsible party/agency DTSC

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A

Violations have been reported ☐ Yes ☐ No ☐ N/A

Other problems or suggestions: ☐ Report attached

_____

_____

_____

_____

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks Zone 1 site access controls adequate. _____

_____

_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks_____

_____

2. **Land use changes on site** ☒ N/A

Remarks_____

_____

3. **Land use changes off site** ☒ N/A

Remarks_____

_____

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks_____

_____

B. Other Site Conditions

Remarks _____

_____

_____

_____

_____

_____

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface (soil cover at Zone 1)

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent_____ Depth_____
Remarks_____
_____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
Lengths_____ Widths_____ Depths_____
Remarks_____
_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_____ Depth_____
Remarks Erosion area at northern end of Zone 1 recently re-graded
_____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
Areal extent_____ Depth_____
Remarks Sinkhole in Zone 1 has been filled.
_____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks No vegetative cover, some weeds present
_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks_____
_____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Areal extent_____ Height_____
Remarks_____
_____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
- ☐ Wet areas ☐ Location shown on site map Areal extent_____
- ☐ Ponding ☐ Location shown on site map Areal extent_____
- ☐ Seeps ☐ Location shown on site map Areal extent_____
- ☐ Soft subgrade ☐ Location shown on site map Areal extent_____

Remarks_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent_____
Remarks_____

B. Benches ☐ Applicable ☒ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks_____

C. Letdown Channels ☐ Applicable ☒ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____
_____

5. **Obstructions** Type_____ ☐ No obstructions
☐ Location shown on site map Areal extent_____
Size_____
Remarks_____
_____

6. **Excessive Vegetative Growth** Type_____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks_____
_____

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance
☒ N/A
Remarks_____
_____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks_____
_____

3. **Monitoring Wells** (within surface area of site)
☐ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks_____
_____

5. **Settlement Monuments** ☐ Located ☒ Routinely surveyed ☐ N/A
Remarks Settlement monuments only present near former sinkhole. Surveying may be discontinued or reduced since there has been no movement._____
_____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____
   _____

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____
   _____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs Maintenance ☐ N/A
   Remarks_____
   _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
   Remarks_____
   _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
   Remarks_____
   _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A
   ☐ Siltation not evident
   Remarks_____
   _____

2. **Erosion** Areal extent_____ Depth_____
   ☐ Erosion not evident
   Remarks_____
   _____

3. **Outlet Works** ☐ Functioning ☐ N/A
   Remarks_____
   _____

4. **Dam** ☐ Functioning ☐ N/A
   Remarks_____
   _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   ☒ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** ☒ Functioning ☐ N/A
   Remarks Weir located down-gradient of Zone 1 _____

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. **Settlement** ☐ Location shown on site map ☒ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring sampling for contaminants, measure water levels
   ☐ Performance not monitored
   Frequency semi-annual/annual ☐ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
   Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Collection Structures, Pumps, and Electrical**
   ☒ Good condition ☐ Needs Maintenance
   Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Spare Parts and Equipment**
   ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks_____

Appendix C. Five-Year Review Site Inspection Checklist

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   - ☒ Metals removal ☐ Oil/water separation ☐ Bioremediation
   - ☒ Air stripping ☒ Carbon adsorbers
   - ☐ Filters_____
   - ☐ Additive (*e.g.*, chelation agent, flocculent)_____
   - ☒ Others pesticide removal
   - ☒ Good condition ☐ Needs Maintenance
   - ☐ Sampling ports properly marked and functional
   - ☐ Sampling/maintenance log displayed and up to date
   - ☒ Equipment properly identified
   - ☐ Quantity of groundwater treated annually_____
   - ☐ Quantity of surface water treated annually_____
   - Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - ☐ N/A ☐ Good condition ☐ Needs Maintenance
   - Remarks_____

3. **Tanks, Vaults, Storage Vessels**
   - ☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
   - Remarks_____

4. **Discharge Structure and Appurtenances**
   - ☐ N/A ☒ Good condition ☐ Needs Maintenance
   - Remarks_____Surface water channels are in good condition._____ _____

5. **Treatment Building(s)**
   - ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
   - ☐ Chemicals and equipment properly stored
   - Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   - ☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition
   - ☐ All required wells located ☐ Needs Maintenance ☐ N/A
   - Remarks_____

D. Monitoring Data

1. Monitoring Data
   - ☐ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
   - ☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The current remedy is containment at Zone 1, removal and treatment at Zones 2, 3, and 4 with the final goal of cleanup to maximum beneficial use in Zone 4. The current remedy appears to be functioning as intended and has adequate O&M procedures and contractor oversight. Additional actions may be necessary to treat the perchlorate plume, which will be addressed in the final remedy/ROD for the site.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

In general O&M at the site is adequate. The new pre-treatment plant is being designed to replace the current aging plant and will have capacity for any new treatment processes. Potential issues with proceeding with the new plant include finalizing purchase of the land for construction.

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. Cost for GAC and other supplies have been increasing. The RI/FS for the perchlorate plume is on-going. One potential source of perchlorate, the adjacent quarry, has not been investigated due to access limitations. There is also indication that perchlorate contamination may be migrating through the fractured bedrock beneath Zone 1 to down-gradient zones.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Opportunities for optimization include increasing extraction in the fractured bedrock near the clay barrier dam and in Zone 3 and optimizing the groundwater monitoring program.

Appendix D. Site Inspection Photographs, November 5, 2010

Date of Visit: November 5, 2010

	
Looking north onto Zone 1 cap from east end of clay barrier dam	View of Zone 1 cap (about midway; looking west)
	
North cap (view looking south towards clay barrier dam)	Wells and drainage channels north of cap (outside of fenced area)

Appendix D. Site Inspection Photographs, November 5, 2010

Road on north end of cap, looking west

Drainage area northwest of cap (outside of fenced area)

North cap, looking east

North cap, looking east. French drain in foreground.

Sinkhole, filled.

North cap (looking northeast)

Weir below Zone 1

Hydrograph adjacent to weir.

Looking upstream from weir towards clay barrier dam.

B-Stream Storage tanks next to PTP.

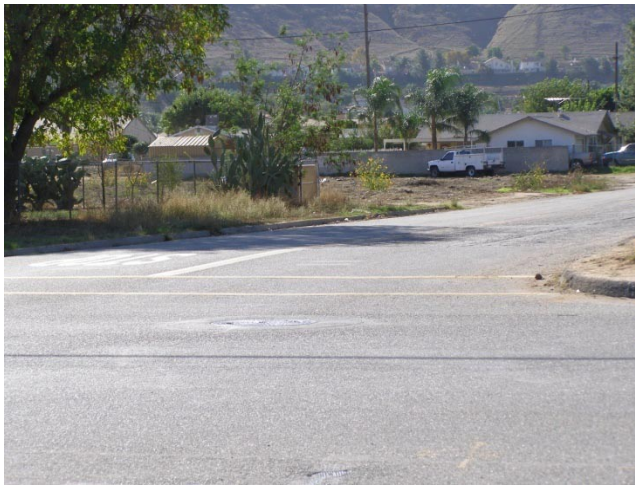
Appendix D. Site Inspection Photographs, November 5, 2010

Auto recycling lot in Zone 3.

LCTF (left) and line of extraction wells (right)

North Well in Zone 4.

Access point to SARI discharge line in Zone 4.



Manhole access to confluence with main SARI line in Zone 4.

South Well in Zone 4.

Appendix D. Site Inspection Photographs, November 5, 2010

Lower Canyon Treatment Facility

PreTreatment Plant A-Stream storage tanks

PreTreatment Plant effluent storage tanks

View of PTP from Site Engineer's office

Appendix E. Interview Summary Forms

Five Year Review Interview Record

Site Name:	Stringfellow Superfund Site
EPA ID No.	CAT080012826
Interviewee:	Allen Wolfenden, DTSC, awolfend@dtsc.ca.gov
Date:	November 5, 2010
Interview Method:	In person
Interview Contacts:	Sharon Gelinas, USACE Seattle, Sharon.l.gelinas@usace.army.mil Heather Whitney, USACE Seattle, heather.r.whitney@usace.army.mil

Interview Questions

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site? What is your overall impression of the work conducted at the site to date?

   A: I am Chief of the San Joaquin Legacy Landfill Office and have been involved since 1995. The site is well run.

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

   A: Ziggy (DTSC site engineer) is on-site full-time. DTSC in Sacramento sends staff as necessary to assist.

3. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc). If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   A: Veolia is on-site 5 days a week to run the treatment plant.

4. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy that show wear or may need additional focus during O&M? Please describe how improved efficiency has or has not occurred.

   A: The 4th ROD objectives have been met. TCE in Zone 4 is now under control. Perchlorate is still an issue in alluvium and fractured and weathered bedrock. The perchlorate plume drives the sampling program.

5. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?
   - What is the status of the Zone 3 extraction optimization?

     A: Zone 3 is currently being optimized for perchlorate extraction. South of the freeway, TCE is gone. The next ROD will deal with the perchlorate problem.

- What is the status of the new PreTreatment Plant?

  A: The new PTP is at 30% design stage. Its expected date of completion is 2012 or 2013. The State of California is currently trying to purchase the land on which the new PTP will be located.

- Are there any other significant construction activities proposed?

A: A new cap redesign for Zone 1 is planned/being discussed, but will be pursuant to the final ROD.

6. What does the monitoring data show?
   - Are there any trends that show contaminant levels are increasing or decreasing?

     A: Generally speaking, all contaminants of concern are decreasing in Zones 2, 3, and 4. Zone 1 has no clear trend. There is just a lot of waste still there. Zone 2 has shown decreases in perchlorate and TCE with time, but the decrease is not consistent. Zone 4 contaminants (TCE and perchlorate) have both shown decreases. TCE is down to MCL levels in most of Zone 4. In Zone 3, perchlorate is still present in the alluvium. The extent of perchlorate in weathered bedrock has not been fully characterized.

   - Besides the continued detections of COCs in weathered bedrock and fractured bedrock in Zone 3, are there any other areas that may indicate potential problems with the remedy?

     A: Not answered

   - Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy?

     A: No.

7. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.
   A: There have been no unexpected O&M costs. The Stringfellow site has operated within the DTSC budget. Repairs have been made, which include new pipe racks, new electrical systems, redesigned clarifiers. These are probably the last repairs that will be made to the existing PTP until the new PTP is constructed.

8. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

   A: The quarry next door will stop mining in the near future. The quarry owner says he will use the land for industrial uses. We are having ongoing issues with the quarry. The quarry owns the land where the new PTP is proposed. One of our biggest problems has been negotiating land purchases from the quarry. The state of CA is planning to buy 33 acres on which to expand their activities (which includes the site of the new PTP). There is a continuing moratorium on drinking

well installation in Zone 4 (administered by Riverside County).

9. Are you aware of any ongoing community concerns regarding the site or its administration? The community feels like the work that has been done has been adequate, but they are still interested. (Charnjit stated that CA publishes a fact sheet once a year to update the community.)

10. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

    A: There has been no vandalism in last 5 years in Zone 1 and surroundings.

11. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

    A: The discovery of perchlorate will require changes to the final remedy.

12. Do you have any comments, suggestions, or recommendations regarding the site?

    A: We would like EPA to come to a decision on what they want done at Stringfellow.

Appendix E. Interview Summary Forms

Five Year Review Interview Record

Site Name:	Stringfellow Superfund Site
EPA ID No.	CAT080012826
Interviewee:	Ziggy Kostecki, DTSC, zkosteck@dtsc.ca.gov
Date:	November 5, 2010
Interview Method:	In person
Interview Contacts:	Sharon Gelinas, USACE Seattle, Sharon.l.gelinas@usace.army.mil Heather Whitney, USACE Seattle, heather.r.whitney@usace.army.mil

Interview Questions

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site? What is your overall impression of the work conducted at the site to date?

   A: I am the site engineer. I started working for DTSC in 2000.
   [Overall impression:] Good. We are making progress. Slow, but going ahead.

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

   A: I am on-site 5 days a week and on call. Any community problems come to me and then I contact DTSC. I am the only DTSC person on site all the time.

3. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc). If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   A: Not asked.

4. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy that show wear or may need additional focus during O&M? Please describe how improved efficiency has or has not occurred.

   A: Yes, O&M/sampling efforts have been optimized. No, I am not aware of any portions that show wear or need additional focus. There are always places for improvement as much has budget allows. We do whatever needs to be done to keep things working.

5. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?
   - What is the status of the Zone 3 extraction optimization?

     A: These are ongoing improvements and installations.

   - What is the status of the new PreTreatment Plant?

A: We already discussed this.

- Are there any other significant construction activities proposed?

A: The biggest problem is the quarry. They are delaying the purchase of the land by state of CA for the new PTP. They are delaying additional work in Zone 2. We cannot install wells and sample groundwater on the quarry property.

6. What does the monitoring data show?
   - Are there any trends that show contaminant levels are increasing or decreasing?

   A: It varies seasonally. For example, as water level rises, contamination increases.

   - Besides the continued detections of COCs in weathered bedrock and fractured bedrock in Zone 3, are there any other areas that may indicate potential problems with the remedy?

     A: No, not that I am aware of.

   - Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy?

     A: No.

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

   A: Fuel and energy prices are going up. Supply prices are all going up. In particular, the price of activated charcoal price has increased dramatically. We are still within budget, but these rising costs need to be considered in the next contract.

8. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

   A: No.

9. Are you aware of any ongoing community concerns regarding the site or its administration?

   A: The community has been kept informed. We issue annual news releases. The newcomers sometimes express concerns. The longer-lived residents are aware of the site.

10. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

    A: Copper wire was stolen from the south well about 3 years ago. Trespassing to the north of the Zone 1 north cap (outside of fence) occurred more than 5 years ago, but nothing recently.

11. Have any problems been encountered which required, or will require changes to this remedial

design or ROD?

A: I am not aware of any.

12. Do you have any comments, suggestions, or recommendations regarding the site?

A: We can continue to operate as long as we have money and the budget is passed! We are funded through the state of CA's general fund.

Appendix E. Interview Summary Forms

Five Year Review Interview Record

Site Name:	Stringfellow Superfund Site
EPA ID No.	CAT080012826
Interviewee:	Tom Perina, CH2M Hill, tom.perina@ch2m.com
Date:	November 5, 2010
Interview Method:	In person
Interview Contacts:	Sharon Gelinas, USACE Seattle, Sharon.l.gelinas@usace.army.mil Heather Whitney, USACE Seattle, heather.r.whitney@usace.army.mil

Interview Questions

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site? What is your overall impression of the work conducted at the site to date?

   A: I am a contractor to US EPA. EPA is oversight agency and CH2M Hill is their contractor. I have been involved since 2004. Overall, I think the work conducted is not bad.

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

   A: Yes, we do bi-weekly site inspection visits. These routine visits involve questioning the site manager (Ziggy Kostecki) about what happened over last 2 weeks, reviewing shipping records, and conducting a physical inspection. We also attend Stringfellow site meetings (every 2 months or so) and technical meetings.

3. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc). If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   A: CH2M Hill sends out a coworker or sub-contractor to perform the bi-weekly site visits.

4. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy that show wear or may need additional focus during O&M? Please describe how improved efficiency has or has not occurred.

   A: O&M of the treatment facilities has been optimized. There are continuous upgrades and repairs occurring. Monitoring is being optimized as the site evolves. We recommended an overhaul optimization review of the GW monitoring program because there are hundreds of wells on the site. It has not been optimized yet. State is working on the optimization. Our recommendation was made about a year ago.
   The extraction wells are being maintained and are functioning as intended. Over past 5 years, assessments and evaluations in Zones 1, 2, 3 were conducted. The conclusions recommended converting existing wells to extraction wells, deepening some wells, etc. This is an ongoing process. The issue was that there was some underground flow beneath the clay barrier, so deeper wells were being recommended to capture this leakage. This recommendation was

made in the last 5 Yr Review. There were some wells converted in Zone 3 just this year. This is all being done for perchlorate. Before this, VOCs were already contained.

5. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

   A: We are expecting to see the 30% design in November 2010. The design is being done by Tetra Tech. CH2M Hill will be reviewing the design.

   - What is the status of the Zone 3 extraction optimization?
   - What is the status of the new PreTreatment Plant?
   - Are there any other significant construction activities proposed?

   A: The biggest proposed construction activity is the new PTP. There will be some remedy implemented in Zone 4 eventually. We don't know what that will be at this point.

6. What does the monitoring data show?
   - Are there any trends that show contaminant levels are increasing or decreasing?

   A: My overall recollection is what Allen said earlier. Zone 1 has a lot of variation in COC concentrations depending on water levels. Zone 3 and 4 trends are largely decreasing for TCE. We don't have a long time series for perchlorate in Zone 4. The concentrations of COCS in Zone 1 are very variable depending on which extraction wells are being pumped and when. The clay barrier and injected barrier at its base is also not completely sealing. DTSC plans to install additional extraction wells to capture what's going through. I don't know when that may happen.

   - Besides the continued detections of COCs in weathered bedrock and fractured bedrock in Zone 3, are there any other areas that may indicate potential problems with the remedy?
   - Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy?

     A: There are no new COCs that we know of.

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

   No. There is now sufficient evidence that shows that the quarry is contributing perchlorate from explosives used in its operation. DTSC has asked EPA for help gaining access to the quarry for investigation. This will likely impact the overall schedule. The quarry uses quite a lot of explosives (that contain perchlorate) for blasting. The explosives are not completely burned in the blast and the residue contains perchlorate. There is also a perchlorate plume identified in Zone 1. There is also perchlorate all over in Zone 4 that may come from a variety of historical processes (not just Stringfellow and the Quarry). The perchlorate in Zone 4 is of mixed origin.

8. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site?

If so, please describe in detail.

A: No, I am not aware of any known land use changes. There is a moratorium on drinking water wells. To my knowledge, there is compliance. There will likely be some IC regarding the quarry, but that is to be determined.

9. Are you aware of any ongoing community concerns regarding the site or its administration?

A: Concerns, no. I am aware of community interest. They do not actively come to the meetings. I interpret that to mean that they are satisfied with what is being done.

10. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

A: I am aware of the copper wire theft at the south well (in Zone 4). I recall an electrical box was vandalized. These were minor incidents.

11. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

Yes, perchlorate was discovered in Zone 4 (2001). Also, the quarry (Riverside mining) has been identified as a secondary source of perchlorate. I think that Zone 1 will need a waiver since it will never be clean. Groundwater concentrations of perchlorate will likely not be restored to pre-contamination levels in Zones 2 and 3, so a waiver will likely be needed for these zones as well. We don't know yet if a waiver will be needed for Zone 4 since the perchlorate appears to be of mixed origin and the background concentration is still uncharacterized.

12. Do you have any comments, suggestions, or recommendations regarding the site?

A: We need a new realistic overall schedule for the site. The plan for the final and amendment ROD continues to be pushed back. The current schedule is unrealistic. The enforcement of the quarry investigation could also take a long time.

Appendix F. Applicable or Appropriate and Relevant Requirements

Table 1. Zone 4 Remediation Goals identified in the fourth ROD and current standards

Compound	Zone 4 Remediation Goals from Fourth ROD (ug/L)	Citation	New Standard	Current Federal and State MCLs			
				Federal MCLs (ug/L)	Federal Secondary MCLs (ug/L)	California MCLs (ug/L)	California Secondary MCLs (ug/L)
Trichloroethylene (TCE)	5	Federal MCL	Unchanged	5	none	5	none
Chloroform	6[a]	10^-6 cancer risk	Unchanged[f]	None	none	none	none
Sulfate	Not established[b]	None	Unchanged	None	250,000	none	250,000
Nitrate[c]	Not established[d]	None	Unchanged	10,000	none	45,000	none
Perchlorate[e]	Not established			None	none	6	none

Notes:
MCL – Maximum Contaminant Level; TCE – Trichloroethylene.
Remediation Goals were set in the fourth ROD based on MCLs.
[a]Since no federal MCL existed for chloroform at the time of the fourth ROD, the concentration of 6.0 ug/L, associated with an excess cancer risk of 10^-6, was identified as the cleanup goal for chloroform. This concentration coincided with the State of California Action Level (known as "notification levels" since 2004). Chloroform is no longer listed on either the current list of notification levels or the archived list of notification levels. There is a Federal primary MCL of 80 ppb for total trihalomethanes (TTHM) as a disinfection byproduct. TTHM includes chloroform; however, this is not significant because the cancer risk for chloroform set the cleanup goal in the Zone 4 groundwater.
[b]There is no Federal or State MCL for Sulfate.
[c]Federal Secondary MCL for Nitrate (as N), 40 CFR 141.62; California MCL for Nitrate (as NO_3).
[d] The 10 mg/L (10,000 ug/L) Federal MCL for Nitrate (as Nitrogen) was not set as a Remediation Goal since background Nitrate concentrations in many areas exceed this standard. Finalization of the Nitrate Remediation Goal was deferred in the fourth ROD (Reference: ROD 4, page 26).
[e]Perchlorate was not identified in the fourth ROD, but it is an emerging contaminant of concern that will be addressed in a future ROD. Currently, there is no Federal primary or secondary MCL for perchlorate; California's MCL became effective as of 10/18/2007.
[f]The carcinogenic oral slope factor (SFo) actually decreased from the cleanup goal determination, implying that chloroform is less toxic than previously thought. The cleanup goal stated in the fourth ROD is thus still protective. (See Appendix G, Table 1 for a comparison of past and current SFo's.)

References:
USEPA MCLs and secondary MCLs in drinking water; http://water.epa.gov/drink/contaminants/index.cfm
California state MCLs: Title 22 CCR; http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx
California state notification levels (current and archived): http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NotificationLevels.aspx
Table values were based on numeric values publicly available as of December 2010.

Appendix F. Applicable or Appropriate and Relevant Requirements

Table 2. Action-Specific ARARs

ROD / Zone	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
Second ROD / Zone 2	POTWs & Hazardous Waste / Hazardous Waste Permit Program	ROD 2, Page 23: 40 CFR ss270.60(c)	Applicable	Provides assurance that receiving POTW facility meets RCRA requirements.	No changes have occurred to this regulation since the last five year review.
Second and Third RODs / Zones 2 & 3	Liquid discharge / Clean Water Act	ROD 2, Page 22; ROD 3, Page 32 Federal – CWA. No specific sections; however, SAWPA permit water quality limitations for discharge to the SARI sewer line are listed in ROD 3, Table 5.	Applicable	Substantive requirements of the federal Clean Water Pretreatment Standards (40 CFR Part 403) are ARARs for discharges of treated groundwater to POTWs. Requirements are administered though discharge permits issued by the SAWPA.	Discharge of treated effluent from the PTP and Lower Canyon Treatment Facility (LCTF) to the SARI is ongoing under SAWPA Permit No. 4D-98-S101. No changes have been made to the existing permit water quality requirements in Table 5. Five additional constituents have been added since the ROD: Sulfide (total and dissolved), Oil & Grease, BOD, TSS, and pH (see Table 5)
Third ROD / Zone 3	Tank Systems / RCRA	ROD 3, Page 32. 40 CFR Part 264 Subpart J	Applicable	Requires on-site storage tanks for the Early Implementation Actions (EIAs) in the third ROD to be in compliance with Tank Systems specifications for containment, operation, maintenance, inspections, and spill response.	Two on-site C-Stream holding tanks are located adjacent to the LCTF in Zone 3. In 2006, revisions were made to streamline information collection requirements, reflected in small changes to many sections. The revised regulation is still applicable to the tank systems on the site. No problems have been reported with the tanks, and they have had regular draining and maintenance.
Fourth ROD / Zone 1	Liquid Discharge / Clean Water Act	CWA, 40 CFR Part 403	Applicable	Substantive requirements of the federal Clean Water Pretreatment Standards (40 CFR Part 403) are ARARs for discharges of treated groundwater to POTWs. Requirements are administered through discharge permits issued by the SAWPA.	Zone 1 dewatering in fractured and weathered bedrock is ongoing. Treated effluent is discharged to the SARI under SAWPA Permit No. 4D-98-S101. No changes have been made to the existing permit water quality requirements in Table 5. Five additional constituents have been added since the ROD: Sulfide (total and dissolved), Oil & Grease, BOD, TSS, and pH (see Table 5)
Fourth ROD / Zone 1	Liquid Discharge / National Pollutant Discharge Elimination System (NPDES)	ROD 4, page 22: NPDES, under section 311, 33 USC section 1317	Applicable	Substantive requirements of the NPDES are ARARs for discharges of treated groundwater to POTWs. Requirements are administered through discharge permits issued by the SAWPA.	Zone 1 dewatering, treatment, and effluent discharge to the SARI is ongoing.

Appendix F. Applicable or Appropriate and Relevant Requirements

ROD / Zone	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
Fourth ROD / Zone 1	Land disposal restrictions / RCRA	ROD 4, page 22: 42 USC section 6924(m) and 40 CFR Part 268.	Applicable	Identifies hazardous wastes that are restricted from land disposal and defines circumstances under which an otherwise prohibited waste may continue to be land disposed.	Generation of contaminated sludge from treatment of extracted groundwater from Zones 1 and 2 at the PTP is ongoing. The contaminated sludge is currently disposed off-site. Since 2005, some site-specific changes were introduced to the regulation that do not affect the Stringfellow site.

Table 3. Chemical-specific ARARs

ROD / Zone	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
Fourth ROD / Zone 4	Public drinking water supply systems / Safe Drinking Water Act (SDWA)	ROD 4, Page 25-26; SDWA / Maximum Contaminant Levels (MCLs)	Relevant and appropriate	40 CFR Part 141 establishes federal MCLs that were used to establish groundwater remediation goals in Zone 4. Because MCLs are applied at the tap, they are not applicable; however, they are considered to be relevant and appropriate for groundwater zones that are potential sources of drinking water supply.	Groundwater remediation goals for TCE, chloroform, and nitrates are based on federal MCLs. Groundwater remediation goal has not been determined. No changes to federal MCLs. Minor revisions were made to Subparts B & G, but these changes do not affect the MCLs. These requirements are still relevant and appropriate.

Table 4. Location-specific ARARs

ROD / Zone	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
No location-specific ARARs were identified					

Appendix F. Applicable or Appropriate and Relevant Requirements

Table 5. SAWPA Permit Water Requirements for Discharge to SARI Line from Third ROD and current SAWPA permit (No. 4D-98-S101; expires 12/31/2011)

Constituent	Third ROD Max. Conc. Limits (mg/L)	Current Permit Limits Daily Max (mg/L)	Current Permit Limits Daily Max (lbs/day)
Arsenic	2.0	2.0	n/a
Cadmium	0.064	0.064	n/a
Chromium (total)	2.0	2.0	n/a
Copper	3.0	3.0	n/a
Cyanide (total)	1.2	1.2	n/a
Cyanide (free)	1.0	1.0	n/a
Lead	0.58	0.58	n/a
Mercury	0.03	0.03	n/a
Nickel	3.51	3.51	n/a
Silver	0.43	0.43	n/a
Zinc	0.7	0.7	n/a
Total Toxic Organics	0.58	0.58	n/a
PCBs and Pesticides	0.02	0.02[a]	n/a
Sulfide (total)	n/a	5.00	n/a
Sulfide (dissolved)	n/a	0.5	n/a
Oil & Grease (Mineral or Petroleum)	n/a	100	n/a
Biological Oxygen Demand (BOD)	n/a	n/a	15,000
Total Suspended Solids (TSS)	n/a	n/a	n/a
pH	n/a	6-12	n/a

Notes:
No changes have occurred to the existing SAWPA permit water quality requirements for discharge to SARI line presented in the third ROD. Additional constituents have since been added.
[a]PCBs and Pesticides are listed individually as 0.01 mg/L on the current SAWPA permit.
Sampling and analysis of treated effluent for discharge to the SARI from the October 2010 OM&M manual (Veolia, 2010) showed that the effluent is within permit limitations.
n/a – not applicable

Appendix G. Risk Assessment and Toxicity Analysis

Changes in Exposure Pathways

Baseline Health Risk Assessment (HRA) by Science Applications International Corporation (SAIC)

A Health Risk Assessment (HRA) for the site was prepared by SAIC in 1987. The scope of this evaluation was to perform a baseline public health evaluation in the absence of remedial actions to provide as complete a picture as possible of the magnitude of problems associated with the site.

The following potential pathways of exposure were identified:

- Exposure to contaminated groundwater via consumption
- Exposure to contaminated surface water (i.e., runoff originating at the site) via contact or consumption
- Exposure to contaminated soils via ingestion of soil and inhalation of airborne soil particulates.

The analysis concluded that the combined maximum lifetime risk from exposure to groundwater contaminated with trichloroethylene (TCE) and chloroform in the community area, if used for drinking water, exceeds the United States Environmental Protection Agency (USEPA) risk guidelines. Furthermore, without site remediation and groundwater cleanup, the contaminants may continue to migrate down-gradient in the Glen Avon aquifers, adding to the risk of exposure for the local community.

The analysis determined that the potential exposure to contaminated surface water is considered limited because the site is capped, drainage improvements have been completed on-site and in the up-gradient areas, and normal rainfall amounts are relatively small. In addition, exposure to contaminated soils is only a concern at the Stringfellow site itself (Zone 1).

Because of mitigative measures that have taken place at the site, none of these exposure pathways are currently complete. In 2002, residents of Glen Avon in the proximity of the groundwater plume were connected to municipal water supply in 2002 and a county ordinance prevents installation of any new drinking water wells. Since groundwater is not used for drinking water consumption in Zones 1, 2, 3 or 4, oral ingestion of contaminated groundwater remains an incomplete exposure pathway. Ongoing cap maintenance and access restrictions continue to control these potential pathways of exposure. Therefore, all significant pathways of exposure identified in this HRA are currently incomplete.

1995 Supplemental Health Risk Assessment (ChemRisk)

A supplemental health risk assessment for Zone 4 was prepared by the ChemRisk Division of McLaren/Hart Environmental Engineering Corporation with the concurrence of Region 9 of the USEPA in 1995. This HRA was not available for review and has been superseded by the 2009 Health Risk Assessment performed by Kleinfelder.

2009 Health Risk Assessment by Kleinfelder

A new human HRA was performed for Zone 4 with the following reasoning regarding the Stringfellow site (Kleinfelder, 2009):

- Perchlorate was detected in 2001 in the groundwater at the site and down-gradient. A groundwater treatment plant (the CWTF) has significantly lowered perchlorate concentrations in Zone 4 groundwater. Perchlorate is also present in Zone 4 soil.
- As a result of extraction and treatment, concentrations of most volatile organic compounds (VOC) in Zone 4 groundwater have dropped below their respective MCLs. However, 13 VOCs were detected in Zone 4 groundwater monitoring well samples in 2007. Because VOCs may migrate from groundwater to indoor air and may be inhaled by a building's occupants, these 13 VOCs were identified as Contaminants of Potential Concern (COPC) and addressed in the HRA.

Although previously detected in Zone 4, sulfate and nitrate were excluded from consideration in the 2009 HRA. Zone 4 data showed that all but three of 131 groundwater samples contained concentrations of sulfate below the 250 mg/L secondary MCL for sulfate. The distribution of elevated nitrate concentrations throughout Zone 4 was attributed to a regional source of nitrate. Therefore, no apparent elevated "plume" of nitrate, or increased load of nitrate, is associated with the Stringfellow perchlorate plume (Kleinfelder, 2010).

The potential pathways of exposure to the Zone 4 COPCs evaluated in the 2009 HRA include the following:

- Exposure of residents and workers via ingestion of contaminated soil, groundwater, homegrown produce, or breast milk (nursing infants only)
- Exposure to VOCs consequent to migration of VOCs from groundwater to indoor air
- Exposure of livestock to contaminated soil and groundwater via ingestion

Currently, residents receive drinking water from the municipal supply, such that all potential pathways that are associated with consuming groundwater are hypothetical and do not exist. Actual exposure of residents to perchlorate under current conditions might result from consumption of water from the municipal supply, consumption of homegrown produce irrigated with Zone 4 groundwater, or consumption of produce imported from areas irrigated with water containing perchlorate.

In summary, there have been some new potential exposure pathways identified that could affect the protectiveness of the remedy.

Changes in Toxicity Values

The 1987 Remedial Investigation included a Health Risk Assessment (HRA) that used toxicity information from the 1986 USEPA Superfund Public Health Evaluation Manual. The fourth ROD (USEPA, 1990) summarized the toxicity information in the 1987 Remedial Investigation (RI) for the consumption of contaminated groundwater pathway for TCE and chloroform. Table 1 provides a direct comparison between the 1987 toxicity values and current USEPA Regional Screening Levels (RSLs).

Since the baseline Health Risk Assessment in 1987, there have been a number of changes to toxicity values for certain chemicals at the Stringfellow site. For noncarcinogenic ingestion effects, a decreased oral reference doses (RfDo) for hexavalent chromium (Cr VI) indicates a greater hazard index from exposure to Cr (VI) than previously considered, whereas an increased RfDo for nickel indicates a lower risk from exposure than previously considered. For carcinogenic ingestion effects, both chloroform and TCE now have lower oral slope factors (Sfo), indicating a reduced excess cancer risk. Noncarcinogenic

inhalation effects were not evaluated for any compounds in the 1987 HRA. Carcinogenic inhalation inhalation slope factors (SFi) provided in the baseline HRA were converted to Inhalation Unit Risk (IUR) values using the following formula:

$$IUR\ (ug/m^3)^{-1} = \frac{SF_i\ (mg/kg\text{-}day)^{-1} \times 20\ m^3/day \times 0.001\ mg/ug}{70\ kg}$$

Comparison of the 1987 IURs (calculated) to USEPA RSLs reveals that the 1987 Baseline HRA values are less than current USEPA values, suggesting that TCE, cadmium, chromium, and nickel may be less toxic than previously considered. Although some toxicity values have changed, none of the exposure pathways presented in the baseline HRA are complete given the current mitigative measures, access restrictions, and implemented institutional controls.

Table 2 provides a direct comparison of toxicity values between the 2009 HRA (Kleinfelder, 2009) and current RSLs available as of November 2010. The Toxic Criteria Database of the California Office of Environmental Health Hazard Assessment (OEHHA) was also referenced for several compounds for more current information than was available in the EPA RSLs table. In cases where both USEPA and OEHHA Database had values for the same chemical, the more stringent value was used for comparison with the 2009 HRA toxicity values.

Carcinogenic and noncarcinogenic ingestion toxicity values for perchlorate remain unchanged. For noncarcinogenic inhalation effects, all toxicity values (RfCi's) remain unchanged except for 1,2-dichloroethane and chloroform. OEHHA no longer has a chronic inhalation Recommended Exposure Limit (REL) for 1,2-dichloroethane, but the RSL table has a higher RfCi for 1,2-dichloroethane, indicating that 1,2-dichloroethane has a lower noncarcinogenic risk than previously considered. The RSL table lists a lower RfCi for chloroform than in the 2008 HRA, indicating that chloroform has a higher noncarcinogenic risk of exposure than previously considered. Current California Department of Toxic Substances (DTSC) or IRIS RfCi's were not included in the RSL screening tables for bromodichloromethane, bromoform, or dibromochloromethane, and thus noncarcinogenic toxicity changes could not be evaluated for these compounds.

According to the 2009 HRA, the noncarcinogenic hazard quotient for all 13 VOCs is well under 1.0 in Zone 4, indicating that the likelihood of noncancer health effects from exposures to these chemicals is below a level of concern in Zone 4. Chloroform contributes less than 1% of the hazard quotient, whereas carbon tetrachloride (28%) and tetrachloroethylene (54%) are far larger contributors. It is unlikely that the increased noncarcinogenic inhalation toxicity value for chloroform in the RSL table will produce a change significantly large enough to produce a total hazard quotient greater than 1.0.

For carcinogenic inhalation effects, most of the IUR values are unchanged, except for 1,2-dichloroethane and chloroform. For these two compounds, the IRIS IUR is actually greater than the 2009 HRA OEHHA value, suggesting that 1,2-dichloroethane and chloroform may be more toxic carcinogens than previously considered. The estimated combined Lifetime Cancer Risk (LCR) for all thirteen VOCs exceeds the primary target risk level ($1x10^{-6}$) but is below the secondary target risk level ($1x10^{-5}$). The contribution of 1,2-dichloroethane and chloroform to the excess lifetime cancer risk (LCR) in the 2009 HRA was estimated at only 6%, such that small changes in their toxicity are unlikely to significantly affect the calculated excess LCR. The majority of the excess LCR was attributed to carbon tetrachloride (64%), tetrachloroethylene (15%), and TCE (13%), of which no changes to toxicity were identified. However, the toxicity of 1,2-dichloroethane and chloroform should be monitored and re-evaluated during the next

Five-Year Review.

In summary, although new exposure pathways were identified in the 2009 HRA, the calculated risks are generally below a level of concern. The majority of toxicity values have remain unchanged and/or the changes are insignificant and do not affect the protectiveness of the remedy.

References

ChemRisk, 1995. Supplemental Health Risk Assessment for Zone 4, Stringfellow NPL Site in Riverside County, California. December.

Kleinfelder, 2009. Health Risk Assessment, Stringfellow Site, Zone 4, Glen Avon, California. June 30.

Kleinfelder, 2010. Technical Memorandum, In-Situ Bioremediation Pilot Study Report, Stringfellow Superfund Site Zone 4, Riverside County, California. November 19.

Science Applications International Corporation (SAIC), 1987. Stringfellow Hazardous Waste Site Remedial Investigation, Draft Final Report, Sections 4, 5, 6, 7. June 1.

U.S. Environmental Protection Agency (USEPA), 1990 Record of Decision: Decision Summary, Stringfellow Hazardous Waste Site. September 30.

USEPA. 2010. Regional Screening Level (RSL) Tapwater Supporting Table November 2010. Accessed January 2011 at http://www.epa.gov/region9/superfund/prg/index.html.

APPENDIX G. RISK ASSESSMENT AND TOXICITY ANALYSIS

Table 1. Comparison between 1987 HRA[a] toxicity values and current USEPA Regional Screening Levels (RSLs)[b].

Chemical	**Ingestion Exposure**				**Inhalation Exposure**					**Evaluated Media & Exposure Pathways**
	RfDo mg/kg/day		**Sfo** $(mg/kg/day)^{-1}$		**RfDi**		**SFi**	**Inhalation Unit Risk (IUR)**		
	1987 HRA	**Current[b]**	**1987 HRA**	**Current[b]**	**1987 HRA** (mg/kg/day)	**Current[b,c]** (mg/m^3)	**1987 HRA** $(mg/kg/day)^{-1}$	**1987 HRA[d]** $(ug/m^3)^{-1}$	**Current** $(ug/m^3)^{-1}$	
Chloroform	Not evaluated.	1.0E-02 IRIS	8.1E-02	**3.10E-02** CalEPA	Exposure pathway not evaluated.					Groundwater
Trichloroethene	Not evaluated.	NA	1.1E-02	**5.90E-03** CalEPA	Not evaluated.	NA	4.6E-03	1.3E-06	2.0E-06 CalEPA	Groundwater, air
Cadmium	2.9E-04	5.0E-04 IRIS	Not evaluated.	NA	Not evaluated.	1.00E-05 ATSDR	6.1	1.7E-03	1.80E-03 IRIS	Surface water, soils (ingestion and particulate inhalation)
Chromium (VI)	5.0E-3	**3.00E-03** IRIS	Not evaluated.	5.0E-01 New Jersey	Not evaluated.	1.0E-04 IRIS	4.1E01	1.2E-2	8.4E-02 S	Soils (ingestion and particulate inhalation)
Nickel (as Nickel soluble salts)	1E-02	**2.00E-2** IRIS	Not evaluated.	NA	Not evaluated.	9.0E-05	1.9E-01	5.4E-05	2.6E-04 CalEPA	Soils (ingestion and particulate inhalation)
PCB-1248	NA	NA	4.34	2 OEHHA	Exposure pathway not evaluated.					Soils (ingestion only)
4,4'-DDT (as DDT)	5.0E-04	5.0E-04 IRIS	3.4E-01	3.4E-01 IRIS						Soils (ingestion only)

HRA – Health Risk Assessment; IUR – Inhalation Unit Risk; NA – not available; RfCi – inhalation Reference Concentration; RfDi – inhalation Reference Dose; RfDo – Oral Reference Dose; RSL – Regional Screening Levels; SFi – inhalation Slope Factor; SFo – oral Slope Factor; TCE - Trichloroethene

Notes

Relevant changes to toxicity values are indicated in **bold.**

[a]SAIC, 1987. Stringfellow Hazardous Waste Site Remedial Investigation, Draft Final Report, Sections 4, 5, 6, 7. June 1.

[b]Toxicity values taken from USEPA Regional Screening Level tables (updated November 2010) and confirmed with cited source; citation listed with each value represents original source.

[c]Inhalation noncarcinogenic toxicity is currently provided as a Inhalation Reference Concentration (RfCi); RfDi's are no longer in use.

[d]Slope factors were converted to IURs using the following formula:

$$IUR\ (ug/m^3)^{-1} = \frac{SF_i\ (mg/kg\text{-}day)^{-1} \times 20\ m^3/day \times 0.001\ mg/ug}{70\ kg}$$

Appendix G. Risk Assessment and Toxicity Analysis

Table 2. Comparison between 2009 HRA toxicity values and current USEPA RSLs.

Chemical	Ingestion Exposure				Inhalation Exposure							
	RfDo mg/kg/day		SFo (mg/kg/day)$^{-1}$		RfCi (mg/m^3)				Inhalation Unit Risk (ug/m^3)$^{-1}$			
	2009 HRA	**Current[b]**	**2009 HRA**	**Current[b]**	**2009 HRA[a]**	**Source Cited in HRA**	**Current[b]**	**OEHHA TCDB[c]**	**2009 HRA[a]**	**Source Cited**	**Current[b]**	**OEHHA TCDB[c]**
Perchlorate	7.0E-4	7.0E-4	NA	NA	Exposure pathway not identified in the 2009 HRA.							
1,2-dichloroethane	Exposure pathway not identified in the 2009 HRA.				4.0E-01	OEHHA	**2.4E+00** ATSDR	NA	2.1E-05	OEHHA	**2.6E-05** IRIS	2.1E-05
Bromodichloromethane					7.0E-02	DTSC	NA	NA	3.7E-05	OEHHA	3.75E-05 Cal EPA	3.7E-05
Bromoform					7.0E-02	DTSC	NA	NA	1.1E-06	IRIS	1.1E-06 IRIS	NA
Carbon tetrachloride					4.0E-02	OEHHA	1.0E-01 IRIS	4.0E-02	4.2E-05	OEHHA	6.0E-06 IRIS	4.2E-05
Chloroform					3.0E-01	OEHHA	**9.8E-02** ATSDR	3.0E-01	5.3E-06	OEHHA	**2.3E-05** IRIS	5.3E-06[a]
Chloromethane					9.0E-02	IRIS	9.0E-02 IRIS	NA	1.0E-06	IRIS	NA	NA
Dibromochloromethane					7.0E-02	DTSC	NA	NA	2.7E-05	OEHHA	2.7E-05 Cal EPA	NA
Methyl tert-butyl ether					3.0E+00	IRIS	3.0E+00 IRIS	NA	2.6E-07	OEHHA	2.6E-07 Cal EPA	2.6R-07
Methylene chloride					4.0E-01	OEHHA	1.00E+00 ATSDR	4.0E-01	1.0E-06	OEHHA	4.7E-07[b] IRIS	1.0E-06
Tetrachloroethylene					3.5E-02	DTSC	2.7E-01 ATSDR	NA	5.9E-06	OEHHA	5.9E-06 Cal EPA	5.9E-06
Toluene					3.0E-01	IRIS	5.0E+00 IRIS	3.0E-01	NA	NA	NA	NA
Trichloroethylene (TCE)					6.0E-01	OEHHA	NA	6.0E-01	2.0E-06	OEHHA	2.0E-06 Cal EPA	2.0E-06
M,p-xylenes					1.0E-01	IRIS	1.0E-01[d] IRIS	7.0E-01[d]	NA	NA	NA	NA

ATSDR – Agency for Toxic Substance & Disease Registry; Cal EPA – California EPA; DTSC – California Department of Toxic Substances Control; IRIS – Integrated Risk Information System; IUR – Inhalation Unit Risk; HRA – Health Risk Assessment; OEHHA – California Office of Environmental Health Hazard Assessment; RfCi – Inhalation Reference Concentration; RfDo – Oral Reference Dose; RSL – Regional Screening Level; SFo – Oral Slope Factor; TCDB – Toxic Criteria Database.

Notes: Relevant changes to toxicity values are indicated in **bold.**

[a]VOC RfCi's and IURs from Tables 6-1 and 6-2, respectively, of the 2009 HRA by Kleinfelder.

[b] Values taken from USEPA Regional Screening Level tables (updated November 2010) and confirmed with cited source; citation listed with each value represents original source.

[c]Value from OEHHA Toxic Criteria Database (Accessed February 2011).

[d]Listed as a mixture of p-, m-, and o-isomers.

Appendix H. Updated Proposed Boundaries of Zone 4 Institutional Controls

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December 22, 2010

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Certified Mail: 7002 2030 0005 4277 5321

UPDATED MAP, PERCHLORATE CONCENTRATIONS IN GROUNDWATER, ZONE 4
STRINGFELLOW SUPERFUND SITE, RIVERSIDE COUNTY, CALIFORNIA

Dear Mr. Riha:

In accordance with our telephone communication, please find enclosed one copy of Plate 6-1 titled the "Proposed Boundaries of Zone 4 Institutional Controls" for the Stringfellow Superfund Site. The attached diagram shows the extent of the Stringfellow perchlorate plume south of Highway 60. This revised Plate 6-1 should be used to restrict potable well installations in accordance with Section 15 Riverside County Ordnance 682 and it replaces any former Stringfellow plume boundary or well restriction maps.

Please note that this document is available in several formats, so please contact me if you need shape files for GIS, larger scale printed maps, or any other document format that would be useful to you and/or your staff. I can be reached via telephone at (916) 255-6546 or via e-mail at lracca@dtsc.ca.gov. Thank you for your assistance.

Sincerely,

Laurie Racca

Laurie Racca, P.G.
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Enclosure (1)
CCs: Next Page

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Appendix H. Updated Proposed Boundaries of Zone 4 Institutional Controls