Third Five-Year Review Report for the Teledyne Wah Chang Superfund Site

Prepared by

United States Environmental Protection Agency
Region 10

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ACRONYMS

µg/kg	microgram per kilogram
µg/L	microgram per liter
µrem/hour	micro-roentgen equivalent man per hour
ARARs	Applicable or Relevant and Appropriate Requirements
ARS	Ammonium Recovery System
ATI	Allegheny Technologies, Inc.
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BNSF	Burlington Northern Santa Fe Railroad
CB	catch basin
CCA	Crucible Cleaning Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIC	Community Involvement Coordinator
cm/sec	centimeters per second
COC	contaminant of concern
CoGen	Co-Generation
CRP	Chlorinated Residue Pile
CSM	conceptual site model
CT	cooling tower
CVOC	chlorinated volatile organic compound
CWD	Central Wastewater Drain
CWTS	Central Wastewater Treatment System
cy	cubic yards
DCA	dichloroethane
DCE	dichloroethene
DEQ	Oregon Department of Environmental Quality
EER	Environmental Evaluations Report
EFSC	Energy Facility Siting Council
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences

ACRONYMS (CONTINUED)

EW	extraction wells
fpd	feet per day
GAC	granular activated carbon
GEM	gamma-emitting material
GETS	Groundwater Extraction and Treatment System
gpm	gallons per minute
HI	Hazard Index
I-5	Interstate 5
IDW	investigation derived waste
LRSP	Lower River Solids Pond
MCL	maximum contaminant levels
MCLG	maximum contaminant level goals
mg/kg	milligram per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligram per liter
mgd	million gallons per day
MIBK	methyl isobutyl ketone
MNA	monitored natural attenuation
MRRP	Magnesium Resource Recovery Pile
NCP	National Oil and Hazardous Substances Contingency Plan
NGVD	National Geodetic Datum
NON	Notice of Noncompliance
NORM	naturally occurring radioactive materials
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OAR	Oregon Administrative Rule
OPRD	Oregon Parks and Recreation Department
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
PCE	tetrachloroethene

ACRONYMS (CONTINUED)

pCi/g	picoCuries per gram
ppb	parts per billion
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RFA	RCRA Facility Assessment
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SEA	South Extraction Area
SF	slope factors
SLEP	Schmidt Lake Excavation Project
SOW	Scope of Work
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TCA	trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TOPO	Task Order Project Officer
TSCA	Toxic Substance Control Act
TWCA	Teledyne Wah Chang Albany
VC	vinyl chloride
VOC	volatile organic compound
WMP	Willamette Memorial Park

EXECUTIVE SUMMARY

This report presents the findings of the third Five-Year Review performed for the Teledyne Wah Chang (Wah Chang) Superfund Site located in Millersburg, Oregon. The purpose of this review is to confirm that human health and the environment are being protected through the implementation of the remedy for the Site. This Five-Year Review was conducted in accordance with the U.S. Environmental Protection Agency's June 2001 Comprehensive Five-Year Review Guidance.

Wah Chang is an operating zirconium and other non-ferrous metals manufacturing plant; it employs approximately 1,100 people. The Site is located in the industrial-based community of Millersburg, Oregon, approximately 2 miles north of downtown Albany and approximately 20 miles due south of Salem, Oregon. The Site is adjacent to the Willamette River, with portions of the property within the river's 100- and 500-year flood plains.

SITE FEATURES

Site features include:

- The Main Plant, which is composed of:
  - The Extraction Area: a 40-acre triangular-shaped parcel located south of Truax Creek.
  - The Fabrication Area: a 50-acre parcel located north of Truax Creek and bounded to the south by Murder Creek.
- The Farm Ponds Area: a 75-acre parcel north of the Main Plant. Four 2.5-acre storage ponds at one time held the plant's wastewater treatment lime solids. The farm ponds, historically used to hold wastewater treatment lime solids, are located approximately 0.75-mile north of the main plant.
- The Solids Area: a 20-acre parcel west of the Fabrication Area. It contains the Lower River Solids Pond (LRSP), Schmidt Lake, Chlorinated Residue Pile (CRP), and the Magnesium Resource Recovery Pile (MRRP). This area received solids from Wah Chang's wastewater treatment system.
- The Soil Amendment Area: an approximately 40-acre parcel of property currently owned by the City of Millersburg, but part of the Site. In 1975 and 1976, Wah Chang applied lime solids from the LRSP in a DEQ-permitted action as a soil enhancement to the Soil Amendment Area. In the early 1990s the property was exchanged with the City of Millersburg for a piece of property contiguous with Wah Chang's Farm Ponds Area.

Site features are linked to the manufacturing process and support or have supported zirconium and/or non-ferrous metal production. The zirconium manufacturing process involves a number of physical, chemical and electrochemical steps which concentrate zircon, hafnium, vanadium, niobium, titanium, and radioactive byproduct such as uranium and thorium. Current and historic waste management programs include process wastewater treatment, lime solid storage, solid waste management, hazardous waste management, and radioactive waste management.

BASIS FOR TAKING ACTION – SLUDGE PONDS OPERABLE UNIT (OU1)

The basis for taking action was prompted by concerns that the unlined sludge ponds were located in the Willamette River floodplain and that hazardous materials from the Sludge Pond Operable Unit (OU1) would migrate to soil, surface water, and groundwater. This led to EPA to formally place Wah Chang on the National Priorities List (NPL) in October 1983. The Record of Decision (ROD) for OU1 was signed by EPA on December 28, 1989 (EPA 1989). Remedial actions have consisted of removal, solidification, and off-site disposal of sludge material with the intent to effectively reduce risk to human health and the environment, and to ensure that contaminants are not transported to groundwater, surface water and/or air. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds Operable Unit remedial action to Wah Chang.

In response to releases or a substantial threat of a release of a hazardous substance at or from their Site, Wah Chang commenced a Remedial Investigation/ Feasibility Study (RI/FS) for the Site in 1987 under Consent Order (Docket No. 1086-02-19-106). In 1993, Wah Chang completed an RI/FS Report, and in 1995, completed an Addendum 1-Radiological Survey incorporating external gamma and ambient outdoor radon measurements.

After the RI/FS was completed, EPA selected the remedy for groundwater, sediments, and soils. The groundwater remedy was modified from the proposed plan in response to public comment, and remediation of surface and subsurface soils was deferred to a separate operable unit. The decisions by EPA on remedial actions for OU2 and OU3 are embodied in two final RODs on which the State of Oregon gave its concurrence:

- The Groundwater and Sediments Operable Unit (OU2), executed on June 10, 1994 (EPA 1994).
- The Surface and Subsurface Soils Operable Unit (OU3), executed on September 27, 1995 (EPA 1995).

GROUNDWATER AND SEDIMENT OPERABLE UNIT (OU2)

Remedial actions for OU2 identified in the ROD consist of a groundwater extraction and treatment system (GETS), monitored natural attenuation (MNA), treatment or removal of subsurface source material near the Feed Makeup Building, slope erosion protection along the banks of Truax Creek, sediment removal, and site-wide actions.

The findings of the Five-Year Review indicate that the groundwater remedy has been implemented and is currently being evaluated for its effectiveness. Data indicate that estimated excess lifetime carcinogenic and non-carcinogenic risk to human health in groundwater has been reduced in the Main Plant Area since the initiation of the GETS system. However, opportunities for optimizing GETS are being conducted and/or discussed between EPA and Wah Chang. Institutional controls are in place to prevent on-site and off-site use of contaminated groundwater, and to ensure that site use remains industrial.

The Five Year Review identified the following issues:

Groundwater – Main Plant Area

- GETS will not likely reduce chemicals of concern (COCs) concentrations to below ROD cleanup levels within the 15-year time frame in the Feed Makeup Area. Constituents include fluoride, manganese, and radium (Section 9.6.2). Following

implementation of GETS, pH was not raised to be within acceptable range (6.5-8.5) in accordance with the ROD.[1]

- GETS will not likely reduce volatile organic compounds (VOCs) to below ROD cleanup levels within the 15-year time frame in the South Extraction Area (SEA) (Section 9.6.3).
- Apparent limited hydraulic control of the hot spot area in the vicinity of FW-3 (Section 9.6.3); extraction well FW-6 is not functioning as intended (Section 5.2.2); and data show increasing and/or persistent concentrations of VOCs in northern perimeter wells (Section 8.6.3).
- Apparent limited hydraulic control of the hot spot area in the vicinity of FW-2 and FW-5 (Section 9.6.3).
- GETS may be limited in its ability to achieve remedial action objectives (RAOs) and ROD cleanup levels in the projected 15-year time frame as indicated by persistent concentrations of 1,1-dichloroethene (DCE) and trichloroethene (TCE) above the ROD cleanup levels in groundwater from noted hot spot wells (Section 9.6.3).
- Conditions for natural attenuation in the Fabrication Area may not be conducive for the full dechlorination of TCE and DCE, as observed by increasing concentration of vinyl chloride (VC) and cis 1,2-dichloroethene (cis 1,2-DCE) in groundwater from perimeter and non-hotspot wells, and in surface water. The data set used to evaluate monitored natural attenuation (MNA) is limited (Section 9.6.3).
- Wah Chang is further investigating the Crucible Cleaning Area (CCA) Solid Waste Management Unit (SWMU) in order to further define the nature and extent of historical trichloroethane (TCA) contamination in soils and groundwater in the Fabrication Area. Existing soil sample results collected between 1991 and 2005 suggest that there is a deep source of VOCs in soil.
- Discovery of non-aqueous phase liquid (NAPL) and/or high concentration of VOCs in groundwater in the Fabrication area during drilling of proposed extraction well FW-8. Contamination may stem from a release from an unidentified source.
- Surface water in Truax Creek has exceeded ROD cleanup levels for TCE and VC (Section 9.6.3).
- Potential threat to human health and the environment from consumption of fish or organisms in Second Lake.
- Chemical specific applicable or relevant and appropriate requirements (ARARs) taken from Oregon's ambient water quality criteria (AWQCs) (a potential indicator of the level of protection of human health via the water and fish ingestion exposure routes) have been updated from Oregon Administrative Rule (OAR) 340-41-0445 to OAR 340-41-0033 (Adopted by the Environmental Quality Commission on May 20, 2004 to become effective February 15, 2005). Updated AWQCs have not been recognized by EPA; however, they appear to be consistent with the Federal 2006 Clean Water Act AWQCs for human health consumption of water and organisms.

[1] The ROD for OU2 states that pH of the groundwater at Wah Chang shall be between 6.5 and 8.5 pH units in accordance with the secondary maximum contaminant level.

Groundwater – Solids Area

- Natural attenuation processes may be limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of manganese and fluoride above the ROD cleanup levels in groundwater (Section 9.6.4).

Groundwater – Farm Ponds Area

- Natural attenuation processes may be limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of tetrachloroethene (PCE), TCE and VC above the ROD cleanup levels in groundwater from noted monitoring (Section 9.6.5).

Sediment – Main Plant Area

- Determine if the remedial action for sediment is functioning as intended.

SURFACE AND SUBSURFACE OPERABLE UNIT (OU3)

Remedial actions for OU3 identified in the ROD combined source removal with institutional controls to reduce risk to human health and the environment posed by contamination in surface and subsurface soils at the site.

Summary of Findings

The findings of the Five-Year Review indicate that the remedy is functioning for OU3 as intended by the decision documents. Short-term protectiveness is in place through the Broad Scope Materials Radioactive License and is being implemented as part of the Wah Chang ongoing safety program. Final site closure for radionuclides will be conducted pursuant to Wah Chang's Oregon Radioactive Materials License and the Energy Facility Siting Council Administrative Rules. This work will be conducted under the oversight of the Oregon Health Services Division and in consultation with DEQ and EPA. Currently, site safety is in place through Wah Chang's radiation management programs.

No additional work by EPA is currently planned for the Soil Amendment Area, and institutional controls are in place. The Soil Amendment Area is currently being used for agriculture. Re-use opportunities for this area are currently being explored by DEQ in coordination with EPA.

This Five-Year Review identified the following issues for OU3:

- The site controls required in the September 2001 Soil ESD need to be incorporated into the Scope of Work (SOW) for long-term protectiveness.
- Construction of the CoGen Building may not comply with institutional controls requiring that future buildings be constructed using radon-resistant construction methods.

PROTECTIVENESS STATEMENTS

OU1 Sludge Ponds: The remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

OU2 Groundwater and Sediment: Progress to meet the groundwater RAOs are being made through an operating groundwater extraction and treatment system (GETS); and institutional controls (ICs) are in place to restrict on-site and off-site beneficial use of groundwater.

However, in order for the groundwater remedy to be protective in the long term, the following actions need to be taken:

- Implement further response actions to treat source area groundwater contamination in the Feed Makeup Area stemming from fluoride and manganese and acidic pH conditions that are above ROD criteria. Groundwater quality conditions in the Feed Makeup Area are unlikely to achieve RAOs within the estimated 15-year time frame. Additional response actions that were not considered in the ROD are being evaluated. Implementation of the remedy would require a modification to the groundwater ROD.
- Continue to evaluate effectiveness of the existing remedy and take necessary further response actions to meet RAOs within the estimated 15-year time frame. Response actions could include optimization of GETS, modification of the groundwater remedy, and/or reevaluation of the estimated time frame.
- Further evaluate detections of COCs in surface water from Truax and Murder Creeks. Take necessary actions to address unacceptable exposure impacts.
- Evaluate potential risk to human health and the environment from the consumption of fish and/or organisms at Second Lake.
- Monitor groundwater near buildings occupied by workers. If groundwater concentrations increase, evaluate the potential exposure to current on-site workers from indoor air vapor intrusion associated with contaminated groundwater. Advise building occupants of the results. Take necessary actions to address unacceptable exposure impacts.
- Incorporate relevant revised toxicity factors for COCs into the groundwater remedy.
- Conduct ongoing evaluations of residual PCB concentrations left behind during environmental excavations of uninvestigated areas in order to assess risk to human health as well as the effects on the groundwater remedy.
- Ensure that the remedy for sediments is protective through sampling and analysis and long-term maintenance.

A protectiveness determination for the remedy at OU2 cannot be made at this time until further information is obtained. Further information will be obtained by evaluating the above actions. It is expected that by the end of fiscal year 2010 the evaluation for the above actions will be complete and a protectiveness determination can be made.

OU3 Surface and Subsurface Soil: The remedy for OU3 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. Existing buildings built on areas of the plant with unacceptable concentrations of soil radiation will be monitored.

SITE-WIDE: Protectiveness determination is being deferred until end of fiscal year 2010.

Other Comments: None

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site name: Teledyne Wah Chang		
EPA ID : ORD050955848		
Region: 10	**State: Oregon**	**City/County: Millersburg, Linn County**
SITE STATUS		
NPL status: ☒ Final ☐ Deleted ☐ Other (specify)		
Remediation status (choose all that apply): Under Construction ☒ Operating Complete		
Multiple OUs?* YES	**Construction completion date:** 9/13/02	
Has site been put into reuse? Yes		
REVIEW STATUS		
Lead agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency		
Author name: Ravi Sanga		
Author title: Remedial Project Manager	**Author affiliation:** US EPA Region 10	
Review period:**January 2007 to December 2007		
Date(s) of site inspection: April 3, and September 18, 2007		
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)		
Triggering action: ☐ Actual RA Onsite Construction at OU #____ ☐ Actual RA Start at OU# 1____ ☐ Construction Completion ☒ Previous Five-Year Review Report ☐ Other (specify) 5 years have elapsed since signing of last 5 year review		
Triggering action date: 7/12/91		
Due date: 1/08/08		

* [OU refers to operable unit.]

** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form (Continued)

Issues, Follow up Actions and Recommendations:

OU1

None

OU2

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
GROUNDWATER			
Extraction Area			
Groundwater Extraction and Treatment System (GETS) will not likely reduce chemicals of concern (COCs) concentrations to below ROD cleanup levels within the 15-year time frame in the Feed Makeup Area. COCs include fluoride, manganese, and radium, which are likely mobilized by acidic conditions. Acidic conditions are not effectively addressed by GETS. (Section 9.6.2).	Evaluate the use of groundwater flushing as a new remedial action. Groundwater flushing would use a weak basic solution (lime) to raise groundwater pH and decrease the mobility of inorganic constituents. Evaluation would include bench scale testing and a pilot test under an approved Work Plan. Any use of groundwater pH neutralization will be contingent on EPA's determination that it does not adversely affect the protectiveness of the groundwater remedy. If this technology is determined feasible, a modification to the Record of Decision (ROD) would be expected to occur before the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
GETS will not likely reduce VOCs concentrations to below ROD cleanup levels within the 15-year time frame in the South Extraction Area (SEA) and within the Fabrication Area (Section 9.6.2).	Evaluate the use of enhanced bioremediation as a new remedial action in the SEA. Enhanced bioremediation would likely use a series of temporary borings to deliver a lactate (or equivalent) solution to the subsurface to create anaerobic conditions to facilitate bio-dechlorination of trichloroethene (TCE) and tetrachloroethene (PCE). Evaluation would include a pilot test under an approved Work Plan. The use of enhanced bioremediation is contingent on EPA's determination that it does not adversely affect the protectiveness of the groundwater remedy If this technology is determined feasible; a modification to the ROD would be expected to occur before the end of the fiscal year 2009.	No/Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Fabrication Area			
Apparent limited hydraulic control of the hot spot area in the vicinity of FW-3 (Section 9.6.3); extraction well FW-6 is not functioning as intended (Section 5.2.2); and increasing and/or persistent concentrations of VOCs exist in northern perimeter wells (Section 9.6.3).	Enhance GETS by installing new extraction well FW-8 (Section 8.2). Optimize GETS by increasing groundwater pumping rates at FW-3 due to change in VOC treatment from granular activated carbon (GAC) to cooling tower (Section 5.2.4). Continue semi-annual groundwater sampling and analysis. Evaluation of this issue is anticipated to be completed by the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
Apparent limited hydraulic control of the hot spot area in the vicinity of FW-2 and FW-5 (Section 9.6.3).	Optimize GETS by increasing discharge at FW-2 by replacing existing pneumatic pump with a new electric submersible pump (Section 8.2); change VOC treatment from GAC to cooling tower (Section 5.2.4); and conduct maintenance and development on extraction well's well screens. Evaluation of this issue is anticipated to be completed by the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
GETS may be limited in its ability to achieve RAOs and ROD cleanup levels in the projected 15-year time frame as indicated by persistent concentrations of DCE and TCE above ROD cleanup levels in groundwater from noted hot spot wells (Section 9.6.3).	Continued groundwater monitoring on a semi-annual basis through 2010.	No/Yes	Wah Chang with EPA oversight
Conditions for natural attenuation in the Fabrication Area may not be conducive for the full dechlorination of TCE and DCE, as observed by increasing concentration of VC and cis 1,2-DCE in groundwater from perimeter and non-hotspot wells, and in surface water. The data set used to evaluate monitored natural attenuation (MNA) is limited (Section 9.6.3).	Continue groundwater monitoring semi-annually. Sample and analyze for applicable and relevant water quality indicators to evaluate MNA through 2010.	No/Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Chemical-specific applicable or relevant and appropriate requirements (ARARs) for Oregon's AWQCs for protection of human health water and fish ingestion have been updated from Oregon Administrative Rules (OAR) 340-41-0445 to 340-41-0033 (adopted by the Environmental Quality Commission on May 20, 2004 to become effective February 15, 2005) (Section 10.2). Updated AWQCs have not been recognized by EPA; however, appear to be consistent with 2006 Clean Water Act AWQCs for human health, consumption of water, and organisms.	Compare criteria between OAR 340-41-0445 and 340-41-0033. Use criteria which are most stringent to evaluate COCs in groundwater and surface water.	No/Yes	Wah Chang and EPA
Wah Chang is further investigating the Crucible Cleaning Area (CCA) Solid Waste Management Unit (SWMU) in order to further define the nature and extent of historical trichloroethane (TCA) contamination in soils and groundwater in the Fabrication Area (Section 10.2). Existing soil sample results collected between 1991 and 2005 suggest that there is a deep source of VOCs in soil.	Work with DEQ RCRA Program to ensure that SWMUs closures are consistent with the groundwater remedy.	No/Yes	DEQ/EPA and Wah Chang with EPA oversight
Discovery of non-aqueous phase liquid (NAPL) and/or high concentration of VOCs in groundwater in the Fabrication area during drilling of proposed extraction well FW-8. Contamination may stem from a release from an unidentified source and may affect the groundwater remedy.	Determine the nature and extent of VOCs in soil and groundwater using reconnaissance borings. Assess source of contamination and release mechanism. Prepare a feasibility study evaluating appropriate remedial options. Expedite a decision on implementing a remedial action if determined that a release has occurred. Revise installation location for FW-8. Should additional response action be needed regarding this issue, a decision document will be completed before end of fiscal year 2009.	No/ Yes	Wah Chang with EPA oversight
Ensure that contaminated groundwater does not pose a risk to building occupants through vapor intrusion (Section 10.2.3).	Continue to evaluate groundwater VOCs concentrations in areas where potential exposures could occur. Should groundwater VOCs concentrations increase in these areas, vapor intrusion pathway will be assessed. Advise building occupants of the results. Take necessary actions to address unacceptable exposure impacts.	No/ Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Solids Area			
Natural attenuation processes maybe limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of manganese and fluoride above the ROD cleanup levels in groundwater from noted monitoring (Section 9.6.6).	Continued groundwater monitoring on a semi-annual basis through 2010.	No/Yes	Wah Chang with EPA oversight
Farm Ponds Area			
Natural attenuation processes maybe limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of PCE, TCE and VC above the ROD cleanup levels in groundwater from noted monitoring (Section 9.6.7).	Continued groundwater monitoring on an annual basis through 2010. EPA will require that Wah Chang analyze groundwater for chloride and specific conductance from identified wells (WS, PW-43S/43A, PW-44S/44A) in future sampling events. EPA believes these results may help better understand advective movement of groundwater and the role of natural attenuation for VOCs.	No/Yes	Wah Chang with EPA oversight
SURFACE WATER			
Surface water in Truax Creek has exceeded ROD cleanup levels for TCE and vinyl chloride (VC) (Section 9.6.3).	Conduct supplemental surface water sampling at Truax Creek and groundwater sampling from applicable western perimeter wells in March of 2008 (Section 8.2). Evaluate risks of exposure to human health and the environment via the surface water pathway.	No/Yes	Wah Chang with EPA oversight
Potential threat to human health and the environment from consumption of fish or organisms in Second Lake (Section 3.9.1).	Evaluate if exposure pathway is complete by end of calendar year 2008.	No/Yes	Wah Chang with EPA oversight
SEDIMENT			
Determine if the remedial action for sediment is functioning as intended (Section 5.2.7).	Conduct sediment sampling and analysis in a manner consistent with approved Work Plan. Results of sampling demonstrate that the sediment remedy is protective.	No/Yes	Wah Chang with EPA oversight
Historic impacts to soil from polychlorinated biphenyl (PCBs) in the vicinity of the Emergency Services Building may affect the protectiveness to the groundwater remedy (Section 9.6.8).	Work with Wah Chang to further assess potential PCBs impacts to groundwater. Sample and analyze groundwater from monitoring wells PW-30A and PW-46A for Total PCBs by the applicable EPA method. Should PCBs be detected in groundwater from these wells, Wah Chang may have to take further remedial actions or conduct modifications to GETS to meet remedial action objectives (RAOs) and ensure the protectiveness of the groundwater remedy.	No/Yes	Wah Chang and EPA

OU3

Issue	Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party
The Scope of Work (SOW) and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors (Section 10.3.1).	Amend the SOW to incorporate applicable requirements of the Soil ESD by calendar year 2009.	No/Yes	Wah Chang and U.S. and State of Oregon
Construction of the CoGen Building may not comply with institutional controls that require that future buildings be constructed using radon-resistant construction methods (Section 10.3.3).	Radon testing will be conducted in the CoGen Building by end of calendar year 2008. All other buildings constructed on areas of the main plant where residual radiological contamination would lead to an increased risk of radon exposure will require testing. Radon testing will be conducted to evaluate risk to human health and if mitigation is necessary.	No/Yes	Wah Chang and EPA

SITE WIDE

Issue	Recommendation/Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party
Verify that all institutional controls (ICs) are in place	Complete Title Search for all parcels for entire site by end of calendar year 2008. .	No/Yes	EPA

1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Region 10 prepared this Five-Year Review of completed and ongoing remedial actions (RAs) at the Teledyne Wah Chang (Wah Chang) Superfund Site (the Site) in Albany, Oregon. This is a "statutory" review and is the third Five-Year Review for the Site, covering the period of August 2003 through December 2007. EPA, as lead agency for the Site, conducted this review in coordination with the Oregon Department of Environmental Quality (DEQ).

This Five-Year Review was conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 40 Code of Federal Regulations (CFR) §121(c), as amended by §300.430(f)(4)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP).

CERCLA §121 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] of the NCP, 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 actions taken as a result of such reviews."

The EPA further interpreted this requirement in NCP §300.430(f)(4)(ii), which 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."

For the purpose of conducting RAs at the Site, three Operable Units (OUs) were organized as follows:

- Operable Unit 1 (OU1); Sludge Ponds (EPA 1989)

  The OU1 remedy includes: removal, solidification, and off-site disposal of sludge in the Lower River Solids Pond (LRSP) and Schmidt Lake. A special monocell was constructed by Wah Chang at the Finley Buttes Landfill in Boardman, Oregon for the radioactive sludge removed from the LRSP and Schmidt Lake.

- Operable Unit 2 (OU2); Groundwater and Sediment (EPA 1994)

  The OU2 remedy includes: groundwater extraction and treatment in the Main Plant Area for "hot-spot" areas exceeding $1x10^{-4}$ risk; monitored natural attenuation in the Main Plant for those non-hotspot areas not exceeding $1x10^{-4}$ risk (but exceeding $1x10^{-6}$); monitored natural attenuation for the farm ponds and solids areas formerly used to store waste sludges; environmental investigations of uninvestigated areas to ensure that CERCLA remedial action decisions remain effective; contaminated sediment removal from Truax Creek and bank stabilization of material left behind; and institutional controls for those areas where existing contamination does not allow unrestricted use.

- Operable Unit 3 (OU3); Surface and Subsurface Soil (EPA 1995)

  The OU3 remedy includes: excavation of soil from the sand unloading area and front parking lot areas, and institutional controls.

The triggering action for the five-year review process was the initiation of on-site construction activities for OU1 in August 1991. Five-year reviews are required because of the presence of contaminants remaining above levels that allow for unlimited land use and unrestricted exposure at the Site. This Third Five-Year Review was conducted pursuant to the Office of Solid Waste and Emergency Response Directive 9355.7-03B-P. The review took place between January and December 2007, and was conducted by the EPA site manager with the assistance of the Oregon Department of Environmental Quality (DEQ).

It is the purpose of this Third Five-Year Review to confirm that threats to human health and the environment have been addressed through the implementation of the selected remedy; and to evaluate specific elements of the remedy to verify that design, implementation, and operation of the remedy are functioning and/or performing as intended. Methods, findings, and conclusions of this review are documented in this report.

2. SITE CHRONOLOGY

The following table summarizes the chronology of events at the Site.

Event	Date
Production of zirconium begins	1957
Melting and fabrication facilities added	1959
Wah Chang purchased by Teledyne Industries, Inc.	1967
Teledyne Wah Chang Albany established as separate corporation	1971
Chlorinator residues disposed of at Teledyne Wah Chang Albany (TWCA)	1972-1978
Application of lime solids to Soil Amendment Area	1976
Confirmation of radioactive materials in unlined sludge ponds (OSHD)	1977
NORM license granted to TWCA	3/1978
Use of V-2 Pond discontinued	1979
Farm Ponds constructed	1979
TWCA facility proposed for inclusion on National Priorities List (NPL)	1982
TWCA listed on NPL	10/1983
Magnesium Resource Recovery Pile (MRRP) project	1983-1988
All underground storage tanks removed	1987
V-2 pond emptied	1989
Record of Decision (ROD) for Sludge Ponds Unit is signed	12/28/1989
Schmidt Lake soil removal	6/19-11/6/1991
Removal action for Lower River Solids Pond (LRSP) and Schmidt Lake	1991-1993
RI/FS completed by TWCA	3/1993
Supplemental radioactive material removal action for Schmidt Lake	8/1992-1/1993
Polychlorinated biphenyl (PCB) soil removal in the building 114 area	11/1992
Remedial Investigation and Feasibility Study (RI/FS)	3/1993
EPA issued certification of completion for the Sludge Ponds Unit	6/1993
Ownership of Soil Amendment Area transferred to the City of Millersburg	1994
Groundwater and Sediments ROD signed	6/10/1994
Surface and Subsurface Soil ROD signed	9/27/1995
Remedial actions for the OU2 and OU3 RODs were implemented in accordance with Scope of Work (SOW)	9/19/1996
Groundwater Explanation of Significant Differences (ESD)	10/8/1996
Consent Decree lodged with U.S. District Court and State of Oregon	1/31/1997
Sediment cleanup of Truax Creek complete	1997
Sand Unloading Area removal	10/1997
First Five-Year Review	1997
Access Agreement signed for (b) property	9/18/1998
TWCA becomes Allegheny Technologies Inc. (ATI) Wah Chang	1999
Front Parking Lot Certificate of Completion	8/1999
Operation of South Extraction Area Groundwater Extraction and Treatment System (GETS) begins	10/2000
Soil and Subsurface Soil ESD	9/28/2001
Operation of Fabrication Area GETS begins	4/2001-8/2001
Operation of Feed Makeup Area GETS begins	4/2002

Event	Date
Construction Completion Milestone achieved	9/13/2002
Second Five-Year Review	2003
Land Transfer of Solids Area to City of Albany	2004
Soil Amendment ICs implemented	2006
Proposed Consent Decree for the Soil Amendment ICs lodged with U.S. District Court: 3/27/06.	3/27/2006
Three-Year Groundwater Remedy Evaluation Reports for the Fabrication, Extraction, Solids and Farm Ponds Areas submitted.	2/2007 -9/2007

3. BACKGROUND

This chapter presents a brief overview of the Site's physical characteristics, current and future land and resource use, contamination history, initial agency response, and the basis for taking action.

3.1 SITE LOCATION AND DESCRIPTION

Wah Chang is an operating zirconium and other non-ferrous metals manufacturing plant in Oregon. The Site is located in the industrial-based community of Millersburg, 2 miles north of downtown Albany and approximately 20 miles due south of Salem (Figure 1).[2]

The Site is adjacent to the Willamette River, with portions of the property within the river's 100- and 500-year flood plains. Riparian areas along the Site's western boundary are densely vegetated. In addition, the Site is bounded to the east by Old Salem Road and Interstate 5 (I-5) (CH2M Hill 1993). The farm ponds, historically used to hold wastewater treatment lime solids, are located approximately 0.75 mile north of the main plant.

As of 2005, Millersburg had a population of about 700 and Albany had a population of approximately 45,360. The Wah Chang Site is located within an area in Millersburg that is zoned for heavy industry and employs approximately 1,100 people. Approximately 85 percent of the property is occupied by buildings and is paved or has gravel-covered areas.

3.2 SITE FEATURES AND PLANT MANUFACTURING PROCESSES

Site features are displayed on Figure 2. These features include:

- The Main Plant, which is composed of:
  - The Extraction Area: a 40-acre triangular-shaped parcel located south of Truax Creek.
  - The Fabrication Area: a 50-acre parcel located north of Truax Creek.
- The Farm Ponds Area: a 75-acre parcel located north of the Main Plant. Four 2.5-acre storage ponds at one time held the plant's wastewater treatment lime solids.
- The Solids Area: a 20-acre parcel located west of the Fabrication Area. It contains the Lower River Solids Pond (LRSP), Schmidt Lake, Chlorinated Residue Pile (CRP), and the Magnesium Resource Recovery Pile (MRRP). This area received solids from Wah Chang's wastewater treatment system. These solids were the subject of the OU1 RA.
- The Soil Amendment Area: an approximate 40-acre parcel of property currently owned by the City of Millersburg, but part of the Site. In 1975 and 1976, Wah Chang applied lime solids from the LRSP in a DEQ-permitted action as a soil enhancement to the Soil Amendment Area. The enhancement was later found to result in contamination that could cause an unacceptable risk of radon exposure to occupants of future buildings built on the property. In the early 1990s the property was

[2] The Teledyne Wah Chang Albany plant name was changed to Wah Chang Albany following a 1997 merger with Allegheny Technologies, Inc. Although the official site name remains Teledyne Wah Chang Albany, the designated abbreviation is Wah Chang.

exchanged with the City of Millersburg for a piece of property contiguous with Wah Chang's Farm Ponds Area. In accordance with the terms of a CERCLA Consent Decree, the City of Millersburg has put in place institutional controls for radon mitigation applicable to construction of future buildings on the site.

Site features are linked to the manufacturing process, and support or have supported zirconium or non-ferrous metal production. The zirconium manufacturing process involves a number of physical, chemical and electrochemical steps which concentrate zircon, hafnium, vanadium, niobium, titanium, and radioactive byproducts such as uranium and thorium.

These processes and associated steps are displayed in Figure 3. In general, steps 1 through 9 are conducted in the Extraction Area; and steps 9 through 14 are conducted in the Fabrication Area. Current and historic waste management programs include process wastewater treatment, lime solid storage, solid waste management, hazardous waste management, and radioactive waste management (EPA 1994; CH2M Hill 1993).

3.2.1 Main Plant Process

Extraction Area

Zircon sand concentrate is combined with petroleum coke and mixed in a ball mill, then fed to a chlorination reactor where, at high temperatures, the zirconium orthosilicate is converted to zirconium-hafnium tetrachloride and silicon tetrachloride. The hafnium and zirconium are separated by mixing the zirconium-hafnium tetrachloride with methyl isobutyl ketone (MIBK), which contains ammonium thiocyanate. This portion of the process separates the hafnium into an organic phase and the zirconium into an aqueous phase.

Hafnium is removed from the organic phase through stripping with sulfuric acid, then formed into a solid by precipitation with ammonium hydroxide. The precipitate is filtered and heated to form hafnium oxide. Zirconium is removed from the aqueous phase by precipitation with sulfuric acid. The zirconium precipitate is also filtered and heated to form zirconium oxide. MIBK and ammonium thiocyanate are purified and recycled.

The zirconium and hafnium oxides follow similar paths as those for metal production. Zirconium oxide is mixed with petroleum coke and fed to a chlorination reactor to form zirconium tetrachloride. Elemental magnesium is then reacted with the zirconium tetrachloride to form a sponge-like material consisting of magnesium chloride and zirconium. The magnesium chloride is physically removed from the zirconium sponge and sold as a byproduct.

Fabrication Area

The zirconium sponge is consolidated into ingots by first crushing, blending, and pressing the sponge into briquettes. The briquettes are then welded together with an electron beam to form an electrode which is melted and cast into homogenized ingots in a vacuum arc furnace. The cast zirconium ingots are then fabricated into numerous shapes and forms such as forgings, plate, sheet, foil, tubing, rod, and wire. The fabrication process can involve caustic cleaning, degreasing, and/or pickling.

3.2.2 Waste Management Programs

Waste management programs include process wastewater treatment, lime solid separation, solid waste management, hazardous waste management, and radioactive waste management.

Process Wastewater Treatment

The wastewater treatment plant is located in the northeastern corner of the Extraction Area. The facility's central wastewater treatment system consists of a continuous chemical precipitation and clarification system. Metals are currently removed by neutralization with lime, caustic, or sulfuric acid, and/or carbon dioxide to form hydroxide and sulfate precipitate. Fluoride, ammonia, and radium are removed prior to neutralization in separate pretreatment facilities.

Effluent water is discharged from the treatment plant to Truax Creek at the northwest corner of Pond 2 under a National Pollutant Discharge Elimination System (NPDES) wastewater discharge permit.

Precipitated metals and lime solids are removed in a clarifier by settling and the solids dewatered in the Sludge Treatment System. These wastes are managed under Wah Chang's Waste Program.

Lime Solids Storage

Lime solids generated prior to 1979 were contained in the LRSP, Schmidt Lake, Arrowhead Lake, and the V2 Ponds (Figure 2). In addition, some of these solids were also used as a beneficial soil amendment in the Soil Amendment Area under a permit from DEQ.

Process modification in 1978 allowed for the reduction of radioactive compounds in wastewater treatment solids. The process modification directed the radioactive materials into a separate solid waste stream, referred to as chlorinator residue. Implementation of this process modification permitted the remaining solids, referred to as lime solids, to be contained in the newly constructed Farm Ponds Area.

In October 1979, lime solids were piped as slurry to the south end of the Farm Ponds for additional settling and dewatering. Solids-free return water was decanted from the north end of the ponds and sent back to the wastewater treatment plant. Removal and disposal of the solids was regulated under an NPDES permit.

In 1994, the Farm Ponds were closed and replaced with an advanced solids handling system in the Main Plant area. Closure was conducted in accordance with a DEQ Water Quality-approved closure plan (Wah Chang 1994) by draining and returning the free water to the wastewater treatment system, excavating and drying the lime solids on an asphalt pad, and transporting the dried solids to a Waste Management, Inc. Subtitle D disposal facility in Arlington, Oregon. The pond area was then re-graded to restore the natural topography. The closure work was performed between 1995 and 2000.

Solid Waste

Solid waste management programs at Wah Chang have been developed to comply with the requirements of the Resource Conservation and Recovery Act (RCRA) and the Toxic Substance Control Act (TSCA). Materials are initially delivered to a centralized area on the Main Plant known as the Dumpmaster Area for temporary storage. Solid waste is inspected by Wah Chang to ensure proper disposal to public landfill disposal facilities or a hazardous waste material storage and/or treatment facility.

Prior to May 1983, some solid material produced during development and operation of the facility's nonferrous metals manufacturing processes was placed in the former Magnesium Resource Recovery Pile (MRRP), located adjacent to the LRSP (Figure 2). An estimated 44,000 cubic yards (cy) of magnesium chloride solids were stored in the MRRP. These solids were removed from the MRRP in 1988. The area was capped with asphalt and used for material handling.

Radioactive Waste

Wah Chang currently manages chlorinator residue as NRC-exempt NORM radioactive waste and disposes it in the U.S. Ecology Low Level Radioactive Waste Site in Hanford Reservation, Washington or the U.S. Ecology facility in Grandview, Idaho. A Naturally Occurring Radioactive Materials (NORM) license to transfer, receive, possess, and use zircon sand and byproducts containing licensable concentrations of radioactive material was issued to Wah Chang in March 1978.

Between 1972 and 1978, solid material from sand chlorination processes was placed in the Chlorinator Residue Pile (CRP), located north of Schmidt Lake (Figure 2). The material stored in the pile contained 80-90 percent carbon, small amounts of zircon sand, and low levels of radionuclide constituents. Radionuclide constituents included uranium, thorium, and their daughter products. In 1978 the chlorinator residue, made up of approximately 5,430 cy of solid material, was removed from the CRP and transferred to the U.S. Ecology low-level radioactive waste facility in Richland, Washington. After removal, 22 tons of barium sulfate solution was applied over the area to help chemically bind any remaining radium (CH2M Hill 1993). The Memtek Facility was constructed over the CRP in 1979.

3.3 PHYSICAL CHARACTERISTICS

The following section describes the Site's physical characteristics, including topography, surface water drainage, geology, and the hydrogeologic strata underlying the Site.

3.3.1 Physical Setting and Topography

Wah Chang is located within the broad and relatively flat Willamette Valley, which lies between the Coast Range Mountains to the west and the Cascade Mountains to the east. The ground surface in the vicinity of the Site slopes westward toward the Willamette River, with an approximate gradient of approximately 11 feet per mile.

3.3.2 Surface Water Features

Figure 2 displays surface water features in and adjacent to Wah Chang. Pertinent surface water features include the Willamette River, Conser Slough, Truax and Murder Creeks, and Second, Third and Fourth Lakes. Also included are Wah Chang's three site retention ponds: Cooling Water Pond, Pond 1B, and Pond 2. Surface water is an important feature at the Site because of its influence on groundwater flow, contaminant transport, and remedial actions.

The Willamette River borders the Site's western property boundary. The river is a major surface water feature that flows northward from the Cascade Mountains and discharges to the Columbia River near Portland, Oregon. As such, the river is a regional discharge point for the Willamette Valley. Flows are controlled to some extent by releases from upstream reservoirs and vary seasonally ranging from 5,000 to 28,000 cubic feet per second (cfs). River water level elevations have been observed to range from 167.1 feet National Geodetic Vertical Datum (NGVD) in July 1990, to 179.8 feet NGVD in January 1990 (CH2M Hill 1993).

Second, Third, and Fourth Lakes are remnant features from the ancestral Willamette River. Surface water flows into the Willamette River from Conser Slough, which in turn receives water from Second, Third, and Fourth Lakes. Third Lake receives discharge from Murder and Truax Creeks.

The Murder Creek drainage forms a topographic and hydrologic boundary between Wah Chang and the City of Millersburg public and semi-public lands to the north. Discharge in the creek is generally low during most of the year, with measurable flows in the reach adjacent to the Site ranging from 0.5 to 4.0 cfs. Upstream of Wah Chang, the creek receives recharge from forested and agricultural lands that originates from Knox Butte. Immediately upstream of Wah Chang, the creek passes by a Weyerhaeuser wood product and resin plant, and other light industrial facilities.

The Truax Creek drainage forms a topographic and hydrologic boundary between the Extraction and Fabrications Areas, flowing through the central portion of the Site. The creek originates southeast of Wah Chang in a basin of approximately 9 square miles consisting of residential, agricultural, and forested lands. During winter months (November–May), creek flows have been measured from 0.5 to 15 cfs in the reach that passes through the Wah Chang Site upstream of the Pond 2 weir. During the summer months (June–October), there is no measurable flow in Truax Creek upstream of the Wah Chang NPDES outfall. Sapp Ditch flows beneath Old Salem Road and into Truax Creek. In addition to natural surface water run-off, Truax Creek receives approximately 3 million gallons per day (mgd) of permitted discharge water from Pond 2, and approximately 150 gallons per minute (gpm) of water from the Cooling Water Pond.

Wah Chang's Cooling Water Pond is approximately 1 acre in size and 5 feet deep; and is located in the southeast corner of the Fabrication Area (CH2M Hill 2005). Wah Chang pumps surface water from the Willamette River, then treats the water and stores it in the pond for industrial process use.

Two wastewater ponds, Pond 1B and Pond 2, are operated by Wah Chang under an NPDES permit. The ponds are located south of Truax Creek at the north end of the Extraction Area. Water from the Pond 1B, which originates from the clarifier, is gravity-fed to Pond 2, and from there to Truax Creek.

3.3.3 Site Geology

Geologic deposits underlying Wah Chang are similar to those found in much of the central Willamette Valley (CH2M Hill 1993).

Site stratigraphy of these units, from youngest to oldest, is as follows:

- Fill: A sub-angular gravel, poorly sorted, with lenses of sand and silt, colored brown. Fill may contain wood and metal debris. Fill is primarily encountered in the Fabrication Area and along the steep banks of Truax and Murder Creeks. Thickness of the fill ranges from approximately 1 to 25 feet. Earthen material along the northern bank of Truax Creek is referred to as Truax Fill, which was placed from 1958 to 1978.
- Recent Alluvium: A dark silty loam, 2 to 3 feet thick, and continuous throughout the Site except in the areas of the retention ponds. In areas of Truax and Murder Creeks the alluvium has been observed to be up to approximately 15 feet thick. In the Solids Area, alluvium ranges from 10 to 25 feet thick.

- Willamette Silt: A stiff, fine-grained silt, with varying amounts of clay, colored reddish-brown, with tan and red mottling. A distinct layer of massive gray clay is present at the base of the deposit, noted in the Farm Ponds. Thickness ranges from 4 to 30 feet. The Willamette Silt is Pleistocene deposit associated with catastrophic Lake Missoula floods of the Columbia River Basin and Willamette Valley.
- Linn Gravel: A well-sorted gravel, sub-rounded, with occasional interbeds of sand, silt, and clay, colored brown to black. Thickness varies from 10 feet to over 40 feet, and appears to be linked to undulations in the underlying Spencer Formation and erosional surfaces in the Murder and Truax Creeks drainage. Linn gravel is a Pleistocene deposit associated with outwash from the Cascade Mountains.
- Blue Clay: A silty clay, stiff, with fine sand lenses, colored blue-gray to brown. The Blue Clay is a lakebed or river overbank deposit, Pliocene in age, which has filled troughs and depression in the surfaces of the Spencer and Eugene Formations. The thickness of the Blue Clay is variable, ranging from not encountered in portions of the Site to over 145 feet thick.
- Spencer Formation: The shallowest bedrock formation in the Albany area. It is composed of shallow marine indurated siltstone to fine grain sandstone, colored green-gray, micaceous, with some layers of volcanic tuff or flows. The Spencer Formation is estimated to be approximately 1,500 feet thick.

3.3.4 Site Hydrostratigraphy

The hydrostratigraphy underlying Wah Chang consists of the following units, and is related to site geology:

- Fill: A poor water-bearing unit with limited saturated thickness, which is composed of gravel with wood and metal debris. Groundwater within the unit locally discharges to Truax Creek.
- Recent Alluvium/Willamette Silt: A poor water-bearing zone composed of an upper silt unit and a silty clay-clay unit, unconfined conditions, with yields less than 1 gpm. Groundwater within this unit locally discharges to Truax Creek and the Willamette River. Observed hydraulic conductivities range from 3.2×10^{-4} to 4.5×10^{-3} centimeters per second (cm/sec) (CH2M Hill 1993), or 0.9 to 12.6 feet per day (fpd).
- Linn Gravels: Predominant water-bearing zone, composed of gravel and sands, confined or semi-confined conditions, with yields up to 25 gpm. Yields are dependent on depth, location, and saturated thickness. Groundwater within this unit locally discharges to Murder and Truax Creeks, Second Lake and the Willamette River. Hydraulic properties of the Linn Gravels are displayed in Table 1.
- Blue Clay: Confining layer composed of silty clay that is not laterally continuous throughout the Site. Observed hydraulic conductivity values are on the order of 10^{-9} cm/sec.
- Spencer Formation: A poor, water-bearing, indurated silt stone. Yields may be dependent on fractures and jointing within the unit. Observed values of hydraulic conductivity value are on the order of 10^{-8} cm/sec.

3.3.5 Groundwater Elevation and Flow

Groundwater flow on a regional scale is toward the Willamette River (CH2M Hill 2005). Vertical groundwater flow is upward in the vicinity of the Willamette River. However, a significant downward gradient is observed from the Linn Gravel to the Spencer Formation in the immediate vicinity of the Site. Localized downward flow is associated with infiltration of precipitation, and retention pond seepage (CH2M Hill 1993).

Groundwater flow in the Fabrication Area under non-stressed conditions (non-pumping) extends in a radial pattern from the northeast corner to the southwest. Groundwater elevations in the Linn Gravel beneath the Fabrication Area range approximately between 190 and 205 feet NGVD. An apparent groundwater divide extends across the northwest portion of the Fabrication Area. North of the divide, groundwater flows to Murder Creek, while south of the divide groundwater flows to Truax Creek. The location of the divide shifts seasonally with the annual climate cycle. Under low water level conditions during summer months, the divide moves closer to Murder Creek. Under high water level conditions, the divide moves further south towards Truax Creek.

Groundwater flow under non-stressed conditions (non-pumping) in the Extraction Area is to the west, towards Second Lake. Groundwater elevations in the Linn Gravel beneath the Extraction Area generally range approximately between 185 and 200 feet.

Groundwater flow in the Solids Area is generally to the southwest towards Truax Creek and the Willamette River. In the vicinity of Weyerhaeuser's primary settling ponds, there is a localized area with a radial groundwater flow regime. Groundwater elevations in the Linn Gravel beneath the Solids range approximately between 170 feet to 194 feet NGVD.

Groundwater flow in the Farm Ponds Area is generally to the west-southwest towards Third Lake and the Willamette River. Groundwater elevations in the Linn Gravel beneath the Farm Ponds range approximately between 194 feet to 220 feet NGVD.

3.3.6 Groundwater – Surface Water Interaction

Surface water and groundwater generally flow in a westerly direction, towards the Willamette River. However, within this region, local variations occur as a result of seepage from industrial ponds and natural groundwater discharge to Murder and Truax Creeks (CH2M Hill 2005).

In the southeastern portion of the Fabrication Area, seepage from Cooling Water Pond forms a localized groundwater elevation mound that creates an east-to-southeast groundwater flow direction. In the northern portion of the Extraction Area, seepage from Ponds 1B and 2 creates localized groundwater flow regime to the north and south of the ponds. Surface water seepage from retention ponds is a source of groundwater recharge to the Linn Gravels. In the Solids Area, seepage from the Weyerhaeuser settling ponds also forms localized mounds, which create a radial groundwater flow that extends across the Solids Area to the south and west. Influence from the settling ponds is also evident from temperature data, which shows an average groundwater temperature that is 2 to 4 degrees Celsius higher than surface water temperatures.

3.4 CURRENT AND POTENTIAL FUTURE LAND USE

Figure 4 displays land use in the vicinity of the Site. Wah Chang, Weyerhaeuser, and Simpson Timber own the majority of land within the Millersburg city limits. Wah Chang's Main Plant and surrounding properties are used primarily for industrial purposes, with some recreational and residential use.

The property north of the Site is owned by Willamette Memorial Park (WMP) and Weyerhaeuser. The WMP owns a cemetery immediately north of the Fabrication Area that occupies approximately 100 acres. Flakeboard's Duraflake Plant occupies approximately 20 acres at the northeastern corner of the Fabrication Area. Georgia Pacific's Resin Plant occupies approximately 5 acres to the east of the Fabrication Area. Weyerhaeuser operates a large wastewater treatment system spanning several hundred acres north of the Solids Area, and a paper mill located east of the Farm Ponds.

To the east, several small parcels of land are owned by Wah Chang, Georgia Pacific, and private landowners. The privately owned parcels are currently used for residential and rental housing.

To the west, a parcel of land is owned by the Oregon Parks and Recreation Department (OPRD) and is a designated Willamette River Greenway. In addition, Simpson Timber owns property that encompasses Second Lake. The City of Albany maintains the area along the west side of Second Lake as Simpson Park. The park contains hiking trails, a boat ramp, and recreational areas.

Future land use is anticipated to be Heavy Industrial or Limited Industrial-Commercial, and in accordance with a conservation easement in order to prevent future industrial activities in the flood plain of the Willamette River. Current zoning designations are consistent with the City of Millersburg comprehensive plan. Rezoning of surrounding properties is not anticipated and would require approval by the Millersburg City Council and Planning Commission. The residential area between I-5 and Old Salem Road is zoned as Limited Industrial, and is anticipated to be phased out with the use of this area becoming more industrial. A conservation easement for the Simpson Timber property granted by the City of Albany in 1997 is intended to retain this property as natural and scenic open space.

3.5 CURRENT AND POTENTIAL FUTURE USE OF GROUNDWATER

Current groundwater use at Wah Chang includes base flow recharge to Murder and Truax Creeks, Second Lake and the Willamette River based on the Wah Chang Main Plant industrial water use, hydrogeologic characteristics, institutional controls (deed restrictions), and local development codes. In addition, two supply wells – one owned by Wah Chang, the other owned by Georgia Pacific – are used for fire suppression (CH2M Hill 2005).

No domestic water wells are anticipated to be installed in the future at Wah Chang, given the availability of potable water from the City of Albany. The City of Albany requires that all new developments connect to municipal water lines if service is available within 150 feet.

The Wah Chang facility is subject to a declaration of restrictive covenants that specifically prohibits the construction of water supply wells. Therefore, future use of groundwater under the Wah Chang facility is not expected to be potable.

3.6 HISTORY OF CONTAMINATION

3.6.1 Ownership and Operation

Teledyne Wah Chang operations at the Wah Chang Site began in 1956 when, under contract with the U.S. Atomic Energy Commission, Wah Chang Corporation reopened the U.S. Bureau of Mines Zirconium Metal Sponge Pilot Plant. Construction of new facilities, at the location of the existing plant, began in 1957. These facilities were established primarily for the production of zirconium and hafnium sponge; however, tantalum and niobium pilot

facilities were also included. Melting and fabrication operations were added in 1959. Wah Chang was established in 1967 after Teledyne Industries, Inc. purchased the Wah Chang Corporation of New York. In 1971, the plant became a separate corporation, Teledyne Wah Chang Albany.

3.6.2 Main Plant

This section presents information on historical contamination in areas on the main plant.

Extraction Area

The Extraction Area of the Wah Chang main facility is made up of the Feed Makeup Area and the South Extraction Area. The Extraction Area contains the physical and chemical processes that isolate and extract target metals (zirconium and hafnium) from the zircon sand concentrate. From a waste management perspective, the most relevant processes are sand chlorination, feed make-up, separations, pure chlorination, and reduction.

Feed Makeup Area

In the Feed Makeup Area, zirconium tetrachloride was dissolved in water, resulting in a solution of very low pH that contained various other metals and minor amounts of MIBK. The solution was ultimately transferred to the Separations Building via underground pipes. Leaks from the pipes and tanks containing the feed solution affected soil and groundwater in the vicinity. In 1978, a process change was implemented that modified the chemistry of the feed solution. At the time of remedy implementation, the groundwater had a pH unit of approximately 1 and contained several concentrations of inorganic chemicals, most notably zirconium, thorium, and radium.

This area was the focus of a treatability study during the Phase 2 Remedial Investigation (RI) (CH2M Hill 1993) to determine the feasibility of groundwater extraction and to assess the treatment requirements for this groundwater. Soil borings in preparation for the study determined that the plume of the impacted groundwater was limited to an area beneath the paved parking area in the northeast portion of the facility.

South Extraction Area

Shop areas within the southern portion of the Extraction Area have been identified during the RI/FS as suspected source areas of chlorinated solvents found in groundwater (CH2M Hill 1993). Chlorinated solvents that may have been released from the maintenance shop areas were detected in groundwater during the RI at concentrations up to approximately 600 parts per billion (ppb). The activities in this area included routine plant maintenance, including the use of cleaning solvents trichloroethene (TCE) and 1,1,1 trichloroethane (TCA). The use of TCE was discontinued in 1982, and the use of TCA, in 1988. No documented spills occurred in the area; therefore, a soil gas survey was conducted in the area to identify source areas.

The results of the survey indicated the presence of TCE and TCA in soil beneath the asphalt pavement. Sampling of wells in the area during the RI/FS documented the existence of a solvent plume composed of TCE and TCA.

Soils in the chemical unloading areas were found to be contaminated with semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and radionuclides.

Fabrication Area

The Fabrication Area contained the manufacturing facilities that processed the finished products, mainly the metal sponge produced during the extraction process. The principal activities in this area are consolidation of the sponge by pressing into briquettes, which are subsequently welded into electrodes suitable for arc-furnace melting. Ingots produced in the melting process are finished into various forms such as plates, sheets, foil, tubing, and wire. The intermediate and final cleaning process involves caustic cleaning and pickling with a hydrofluoric-nitric acid mixture. TCA is still used for a degreasing process, and its use is regulated and documented under RCRA.

Contamination in the Fabrication Area generally resulted from historic use of chemicals in three subareas: the Acid Sump Area, the Arc Melting Building Area; and the Ammonium Sulfate Storage Area. Historic use of solvents represents the primary source of chlorinated volatile organic compounds (CVOCs) in these subareas.

In the Acid Sump Area, caustics and acids are used for cleaning metals in the manufacturing process. Releases from the acid sump area have occurred from historic leaks and spills into soils and groundwater. Groundwater in the acid sump area contained the highest concentrations of chlorinated VOCs measured in the plant during the RI. Important constituents in groundwater included 1,1-dichloroethene (DCE), TCA, TCE and vinyl chloride (VC).

Incidental releases during solvent handling (TCE and TCA) have been the source of contamination in soils and groundwater under and in the vicinity of the Arc-Melting Building Area. In addition, historic road oiling for dust suppression across the Fabrication Area also represents a source of CVOCs.

In 1978, a 400,000-gallon tank containing ammonium sulfate in the Ammonium Sulfate Storage Area failed. This process liquid also contained MIBK, chloride, sulfate, iron, uranium, thiocyanate, and zirconium. In 1991 a spill of pickling acid (hydrofluoric and nitric acid) was the primary source of fluoride and nitrate in the Acid Sump Area.

Fill material along Truax Creek's northern bank placed between 1958 and 1978 was found to be contaminated with radionuclides, PAHs, PCBs, and metals.

Solid Waste Management Units (SWMUs)

The 1997 Teledyne Wah Chang RCRA Facility Assessment (RFA) identified 562 RCRA Solid Waste Management Units (SWMUs) at the Site. The SWMUs were locations or Site features where historical use, handling, storage, etc, may have resulted in a release of hazardous materials to the soil or groundwater at the Site. The SWMUs fell into two general groups: SWMUs that relate to the drainage systems at the Site, and SWMUs that do not. The SWMUs were additionally ranked as Low, Medium, or High Release Potential.

Low Release Potential SWMUs were those that had little or no likelihood of releasing hazardous wastes or constituents to the environment. About 30 percent of the SWMUs fell into this category and required no additional investigation or cleanup.

Over 60 percent of the SWMUs were identified as Medium Release Potential SWMUs, where a release was likely, requiring additional investigation or cleanup. All catch basins and pumped sumps were categorized as Medium or High Release Potential.

The remaining SWMUs were categorized as High Release Potential SWMUs, where a release was documented or was very likely and additional investigation or cleanup was required.

Between 2003 and 2007, DEQ reviewed RCRA Facility Investigation closure reports for all SWMUs, except those drain SWMUs south of Truax Creek. These reports were prepared by Wah Chang and presented the results of evaluation and/or sampling efforts for each SWMU. The results of the SWMU evaluations are summarized below.

All non-drain SWMUs were determined to have a Low Release Potential, requiring no additional investigation or action, with the following three exceptions:

- An underground storage tank (UST) that contained cutting oil and released petroleum into the shallow soils around the tank. This SWMU is unlikely to be a significant source for contamination of groundwater at the Site; however, delineation is incomplete.
- An SWMU that consists of all historical soil stockpile areas at the Site. DEQ has not closed this SWMU because of its poorly defined nature and the lack of overall documentation on what areas it encompasses.
- An SWMU called the former Crucible Cleaning Area (CCA). Wah Chang is currently completing an evaluation of the CCA consisting of installing shallow soil borings and deeper soil and groundwater borings to characterize a release of TCA in the area. Due to historical solvent use in the CCA and the documented low-level solvent impact to shallow soils, the CCA may represent a historical source area for the high levels of chlorinated solvents in the groundwater around well PW-69A.

Of the drain SWMUs, DEQ determined that, with the exception of five, all catch basins and sumps north of Truax Creek were Low Release Priority. Of the exceptions, two are located in the CCA and will be evaluated upon completion of the CCA investigation. The remaining three exceptions are considered Medium Release Potential pending additional evaluation.

In addition to the catch basins and sumps, DEQ determined that the Ammonia Recovery Drain and Fluoride Waste Drain piping systems are Low Release Potential SWMUs. This classification is contingent upon regular inspection and maintenance of these operating lines. The Site-wide Central Wastewater Drain (CWD) piping system is considered a High Release Potential SWMU, as it was originally classified in the 1997 RFA. Most of the CWD piping presents little risk of releasing hazardous constituents to the environment, however, the evaluation of this SWMU cannot be completed until the investigation of the Former Crucible Cleaning Area is complete.

In 2007, Wah Chang submitted a RCRA Facility Investigation report to DEQ for all catch basins, sumps, drains, and piping south of Truax Creek. Upon completion of the review of this report in early 2008, DEQ will have evaluated all RCRA SWMUs on the Site. DEQ has indicated that the review will likely identify:

- A number of SWMUs will be re-ranked as low release potential, requiring no additional evaluation or action, aside from regular maintenance.
- A number of SWMUs will be identified as requiring additional investigation or action, which could include soil sampling, additional research on historical uses, decommissioning, or cleanup if a release is confirmed.

The current status of the SWMUs will be documented in a report prepared by DEQ. This report will provide the framework for requesting additional action by Wah Chang to identified SWMUs.

3.6.3 Solids Area – Lower River Solids Ponds and Schmidt Lake

The Solids Area received lime sludges as a process waste material from facility operations. Waste material primarily contained lime solid precipitate from industrial wastewater, magnesium chloride from non-ferrous metal operations, and carbon from sand chlorination,

From 1957 to 1979 lime solids were placed in the LRSP and Schmidt Lake. In 1977, the unlined sludge ponds attracted the attention of regulatory agencies, EPA, DEQ, and the public because of the presence of radioactive materials, which was first confirmed by the Oregon State Health Division. RI activities conducted between 1989 and 1992 indicated the presence of CVOCs, SVOCs, trace metals, radium, ammonium, nitrate, chloride, fluoride, and magnesium (CH2M Hill 2003a).

Between 1972 and 1978, solid material from the sand chlorination processes was placed in the Chlorinated Residue Pile (CRP) located north of Schmidt Lake (Figure 2). The material stored in the pile contained 80-90 percent carbon, a small amount of zircon sand, and low levels of radionuclide constituents, including uranium, thorium, and their daughter products.

Process modifications in 1978 allowed for the reduction of radioactive compounds in wastewater treatment solids. The process modification directed the radioactive materials into a separate solid waste stream, referred to as chlorinator residue. Implementation of this process modification allowed the remaining solids, referred to as lime solids, to be placed in the Farm Ponds Area.

Solids material produced in the facility's non-ferrous metals operation were placed in the MRRP until May 1983. The primary component of this material was magnesium chloride generated by the zirconium/hafnium reduction process.

3.6.4 Farm Ponds

In October 1979, lime solids were piped as slurry to the south end of the Farm Ponds for additional settling and dewatering. Solids-free return water was decanted from the north end of the ponds and sent to the wastewater treatment plant. Removal and disposal of the solids was regulated under an NPDES permit.

In 1994 the Farm Ponds were closed. Closure was conducted by draining and returning the free water to the wastewater treatment system, excavating and drying the lime solids on an asphalt pad, and transporting the dried solids to a Waste Management, Inc. Subtitle D disposal facility in Arlington, Oregon. The pond area was then re-graded to restore the natural topography. The closure work was performed between 1995 and 2000. Currently, lime solids are managed as solid waste.

Although the material used to construct and dike the ponds was of relatively low permeability, dissolved phase chemicals in the wastewater seeped into the underlying soil and groundwater. The RI investigation indicated the presence of CVOCs and inorganic constituents in both soil and groundwater (CH2M Hill 2003b).

3.7 INITIAL RESPONSE

On February 14, 1991, EPA issued a Unilateral Order to Wah Chang for design and implementation of the selected remedy for the Sludge Pond Operable Unit (OU1). In June 1991, in association with the response action, construction of the off-site monocell at the Finley Buttes Landfill in Boardman, Oregon, was completed. Excavation and removal of the sludges began in July 1991, and were completed in November 1991. Approximately 100,000 cubic yards of solids (including cement) were transported to the monocell at Finley

Buttes. Cover construction and grass seeding of the monocell were completed in April 1992. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds Operable Unit remedial action to Wah Chang.

3.8 BASIS FOR TAKING ACTION

Concern that the unlined sludge ponds were located in the Willamette River floodplain and that hazardous materials from the sludge ponds would migrate to soil, surface water, and groundwater led to EPA formally placing Wah Chang on the National Priorities List (NPL) in October 1983.

In response to releases or a substantial threat of a release of a hazardous substance at or from the Site, Wah Chang commenced an RI/FS for the Site in 1987 under Consent Order (Docket No. 1086-02-19-106). In 1993, Wah Chang completed an RI/FS Report and, in 1995, completed an Addendum 1-Radiological Survey incorporating external gamma and ambient outdoor radon measurements. After publication of the RI/FS and proposed plan, EPA selected the remedy for groundwater, sediments, and soils. The groundwater remedy was modified from the proposed plan in response to public comment, and remediation of surface and subsurface soils were deferred to a separate operable unit. On July 21, 1995, EPA issued a proposed plan for soils remediation, except for the Soil Amendment Area Operable Unit, owned by the City of Millersburg.

The decisions by EPA on remedial actions at Wah Chang are embodied in two final Records of Decision (RODs) on which the State of Oregon gave its concurrence:

- The Groundwater and Sediments Operable Unit (OU2), executed on June 10, 1994 (EPA 1994).
- The Surface and Subsurface Soils Operable Unit (OU3), executed on September 27, 1995 (EPA 1995).

The RODs included EPA's explanation for any significant differences between the final plans and the proposed plans, as well as responsiveness summaries to public comments. It was agreed that institutional controls for the Soil Amendment area operable unit would be enforced under a separate legal vehicle between the U.S., the State of Oregon, and the City of Millersburg. This was completed and entered into the court in 2005.

In 1975 and 1976, Wah Chang had obtained solid waste permits from the DEQ to use, as a one-time application, solids from the primary wastewater treatment plant experimentally as a soil amendment on a 40-acre parcel of property that is now referred to as the Soil Amendment Area Operable Unit. The solids contained low levels of metals, radionuclides and organic compounds. Radium-226 and radium-228 concentrations in surface soil averaged approximately 2.5 and 1.8 picoCuries per gram (pCi/g). The RI/FS performed by Wah Chang subsequently indicated that the radionuclide contamination in the Soil Amendment Area Operable Unit could result in an unacceptable risk from radon inhalation in any future buildings constructed on this area, and that concentrations of organic compounds are above levels that would allow unrestricted use of the property. In 1994, the Soil Amendment Area Operable Unit was transferred to the City of Millersburg through a deed agreement between Wah Chang and the City. The City acquired the Soil Amendment Area and Teledyne Wah Chang acquired property contiguous to its Farm Ponds Area. Presently, institutional controls for the Soil Amendment Area Operable Unit that require radon mitigation in future construction are enforced under a consent decree between the U.S., the State of Oregon, and the City of Millersburg.

3.8.1 Contaminants of Concern

Contaminants of concern (COCs) at Wah Chang were selected based on the following criteria: 1) the concentration of the chemical exceeded naturally occurring levels; 2) there were EPA-derived slope factors or referenced dose available for the respective chemical; or 3) the maximum detected concentration exceeded a conservative health-based screening concentration. Chemicals in groundwater and soil were eliminated from consideration if the maximum detected concentration was less than or equal to $1x10^{-6}$ excess lifetime cancer risk (ELCR) value, or less than or equal to 0.1 hazard index (HI) for non-cancer effects.

OU1 – Sludges

The following COCs were identified in the LRSP and Schmidt Lake sludges:

- Arsenic
- Beryllium
- Bis(2-ethylhexyl)phthalate
- Cadmium
- Chromium VI
- Hexachlorobenzene
- Methylene Chloride
- Nickel
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- 1,1-Dichloroethane (1,1-DCA)

OU2 – Groundwater and Sediment

Groundwater

The following COCs were identified in groundwater:

- Benzene
- 1,2-Dichloroethane (1,2-DCA)
- 1,1-Dichloroethane (1,1-DCE)
- Methyl isobutyl ketone (MIBK)
- 1,1,2,2-Tetrachloroethane (Farm Ponds Area only)
- Tetrachloroethene (PCE)
- 1,1,1-Trichloroethane (1,1,1-TCA)
- 1,1,2-Trichloroethane (1,1,2-TCA)
- Trichloroethene (TCE)
- Vinyl Chloride (VC)
- Hexachlorobenzene

- Bis(2-ethylhexyl)phthalate
- Beryllium
- Copper
- Manganese
- Uranium
- Total polychlorinated biphenyls (PCBs)
- Radium-226
- Radium-228
- Ammonium
- Fluoride

Sediments

The identified COCs in sediment are Total PCBs and radionuclides.

OU3 – Surface and Subsurface Soils

The following COCs were identified in surface and subsurface soils:

- VOCs
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Chrysene
- Dibenz(a,k)anthracene
- Hexochlorobenzene
- Indeno(1,2,3-cd)pyrene
- Total Aroclors
- Total Chromium
- Thorium
- Zirconium
- Radium-226
- Radium-228

3.9 CONCEPTUAL SITE MODEL

This section integrates information on the Site's hydrogeologic setting with knowledge of historical contaminant sources, release mechanisms and exposure pathways to develop an illustrated conceptual site model (CSM) for the Wah Chang facility. As discussed previously, the Wah Chang Site is divided into four geographic sectors to reflect divisions in facility

operations and hydrologic (groundwater and surface water) flow regimes. Therefore, separate CSMs are presented for each of the four sectors: the Farm Ponds, Fabrication, Extraction, and Solids Areas.

3.9.1 Extraction Area

The Extraction Area is approximately 40 acres in size and lies in the southern portion of the Main Plant (Figure 2). It is bounded by Truax Creek to the north, the BNSF railroad tracks to the west and south, and by Old Salem Road to the east. The Extraction Area contains the physical and chemical processes that isolate and extract target metals (zirconium and hafnium) from the zircon sand concentrate.

Hydrogeologic Setting

The hydrostratigraphy in this area is similar to that described for the Farm Ponds and Fabrication Areas, and generally consists of Willamette Silt from 0 to 7 feet, Linn Gravel from 7 to 33 feet, and Blue Clay below 33 feet (Figure 5). The Linn Gravel is the primary water-bearing zone. The depth to groundwater is much deeper in the Extraction Area than in other areas of the Site, generally occurring at a depth of approximately 25 feet bgs in the central portion of the Extraction Area. Groundwater flows to the southwest, towards Second Lake, at an estimated velocity of between 0.1 and 6.0 feet per day.

Natural surface water features adjacent to the Extraction Area include Truax Creek to the north and Second Lake to the west. Second Lake is an oxbow lake formed when the ancestral Willamette River abandoned a former channel. Second Lake was once owned by Simpson Timber and was used for a number of years as a log storage pond. Simpson Timber removed the weir at the outlet of Second Lake in early 1989, lowering water levels by 7 to 10 feet. Second Lake and its west bank are now a city park.

Man-made surface water features within the Extraction Area include the two CWTS ponds located along the northern boundary. The two ponds, Pond 1B and Pond 2, are operated under an NPDES permit. Water from Pond 1B flows under gravity into Pond 2, which in turn enters Truax Creek through the Pond 2 weir.

Contaminant Sources and Releases

There are two primary contaminant sources in the Extraction Area, a CVOC source present in the South Extraction Area, and an inorganic/pH source present in the Feed Makeup Area. A third low-level source, associated with the former V-2 Pond remediated in 1989, is located in the Spills Treatment Area.

South Extraction Area

CVOCs detected in South Extraction Area groundwater are believed to have originated in the vicinity of the maintenance shops where solvents were used until 1982. The mobile, paint, and fiberglass shops historically operated near the south end of Building 7. The release location and mechanism are uncertain, but most likely included placement of small amounts of solvent or solvent bearing wash water on the ground surface over a period of time. Once released to soil, solvent that did not volatilize to the atmosphere, was carried down through the soil column by infiltrating rainwater where a portion of the CVOC mass would have adsorbed to soil organic matter and formed a vapor phase within the air-occupied pore space of the vadose zone.

Solvent transported to the water table would have dissolved in groundwater and been transported to the southwest by natural groundwater flow (advection) with dispersion reducing concentrations. CVOC concentrations are expected to be highest in soil and groundwater in the immediate area of the release. The maximum observed concentrations of CVOCs in groundwater at the time of the 1989 to 1992 RI were 330 µg/L for TCE and 600 µg/L for TCA.

Feed Makeup Area

The primary contaminants observed in Feed Makeup Area groundwater include metals, radionuclides, and general chemistry constituents. Low pH has also been used to characterize Feed Makeup Area groundwater contamination. The presence and distribution of contaminants observed in Feed Makeup Area groundwater is interpreted to be the result of a spill of feed solution that occurred in the mid 1970s in an inaccessible portion of the Feed Makeup Area. Subsurface soil samples were taken from many portions of the Feed Makeup Area to locate spill residuals. While cadmium, copper, manganese, radium, thorium, uranium, and zinc have been detected at concentrations two or more times higher than background levels, the levels observed have not correlated with a concentrated source.

V2 Pond

The site of the former V2 Pond also represents another low-level contaminant source. Historically, elevated levels of MIBK and ammonia were detected in this area. The V2 Pond was operated as part of the wastewater treatment system and was associated with the removal and recovery of ammonia. The pond contained metal precipitate and unreacted lime. The use of the pond ended in 1979, and the V2 solids were removed in 1989. After removal of the solids, the walls and bottom of the pond were scoured with water to remove residues. Before the solids were removed, seepage of contaminants from the pond to the underlying groundwater likely occurred through a release mechanism similar to that described for the Farm Ponds Area.

Contaminant Fate and Transport

Natural occurring CVOC degradation processes have resulted in the appearance of TCE transformation product cis-1,2-dichlorethene (cis 1,2-DCE) in groundwater. TCA transformation products include the abiotic daughter 1,1-dichlorethene (DCE) and the biotic daughter 1,1-dichloroethane (DCA). VC, chloroethane, and ethane have not been detected. Varying redox conditions within the Linn Gavel Aquifer favor different abiotic and biotic processes (biodegradation, co metabolism). Therefore, different daughter products are likely formed in one area of the plume and then transported by groundwater to another area before undergoing the next transformational step.

Potential Receptors and Exposure Pathways

On-site workers could be exposed to CVOCs, metals, radionuclides, and other inorganic parameters present in groundwater. However, groundwater is not used at the facility for any purpose. Drinking water has been obtained from the City of Albany since approximately 1964, and process water from the Willamette River since 1978. Hence, there are no complete human-health exposure pathways.

Groundwater containing CVOCs, and dissolved metals may be entering Second Lake. Exposure to these compounds in surface water by aquatic organisms or by humans eating fish caught from the lake may represent a complete exposure pathway. Evaluation of these exposure pathways in the Baseline Risk Assessment for Human Health and the Environment

(CH2M Hill 1993), using exposure point concentrations that are higher than those currently present, did not identify human health risks exceeding acceptable risk thresholds. CVOCs and inorganic constituents present in groundwater that enters Second Lake do not pose a threat to the fish and benthic organisms residing in the lake (CH2M Hill 1993).

3.9.2 Fabrication Area

The Fabrication Area encompasses approximately 50 acres within the north half of the Main Plant. This area is bounded by Truax Creek to the south, BNSF railroad tracks to the west, Murder Creek to the north, and I-5 to the east (Figure 2). The Fabrication Area contains equipment and processes that consolidate zirconium sponge and recycled material into finished products.

Hydrogeologic Setting

The hydrostratigraphy beneath the Fabrication Area is comprised of four units identified in descending order as: construction fill, Willamette Silt, Linn Gravel, and the Spencer Formation (Figure 6). Localized occurrences of recent alluvium may also occur along the banks of Murder and Truax Creeks.

Construction fill and Willamette Silt represent the uppermost soil horizon. These two units generally extend from the ground surface to depths of up to 15 feet. The Linn Gravel, the uppermost water-bearing zone in the Fabrication Area and the unit where groundwater remediation is being performed, typically occurs at depths between 15 and 30 feet. Beneath the Linn Gravel lies the Spencer Formation, a marine siltstone-sandstone.

Groundwater elevations in the Linn Gravel underlying the Fabrication Area generally range between 190 and 205 feet, varying seasonally with western Oregon's annual climatic cycle. Groundwater occurs in the Linn Gravel under confined conditions. Under natural flow conditions, a majority of the groundwater underflow present beneath the Fabrication Area enters Murder and Truax Creeks, with the remainder flowing west towards the Solids Area. Groundwater velocities under natural flow conditions range from 0.03 to 3.0 feet per day.

Truax and Murder Creeks, which form the southern and northern boundaries of the Fabrication Area, respectively, play an important role in the area's hydrology. The Cooling Water Pond also affects groundwater flow while providing an important source of recharge to the Linn Gravel in the southeastern portion of the Fabrication Area.

Both creeks originate in agricultural lands east of TWCA. Peak flows of 4 cfs for Murder Creek and 15 cfs for Truax Creek generally occur between December and April. Without the Cooling Water Pond overflow and NPDES-permitted discharge from Pond 2, Truax Creek would have no flow during the summer. Groundwater discharge is the primary source of flow to Murder Creek in the summer months, with summer flow rates estimated at 0.5 cfs or less.

Natural groundwater flow entering the Fabrication Area from the east discharges either to Truax or Murder Creek, except for a small portion that passes beneath the BNSF railroad tracks into the Solids Area. Pumping from six groundwater extraction wells, which commenced in June 2001, intercepts baseflow entering the creeks.

Contaminant Sources and Release

The 1989 to 1992 RI determined that CVOCs associated with historic activities conducted in the Acid Sump-Thermite Building, Ammonium Sulfate Storage-Material Recycle, and Arc Melting-Dumpmaster Areas of the Fabrication Area are the primary groundwater contaminant sources. Historic road oiling across the Fabrication Area may also represent a

low-level CVOC source. A wood stave aboveground storage tank failure in 1978 is the primary source of ammonia present in Ammonium Sulfate Storage-Material Recycle Area groundwater, while a spill of pickling acid (hydrofluoric and nitric acid) in 1990 is the primary source of fluoride and nitrate present in Acid Sump-Thermite Building Area groundwater.

Historic use of cleaning solvent in these areas through 1988 is believed to have released TCA, PCE, and TCE to subsurface soil. The highest observed concentrations of these compounds detected in soil samples collected during the RI was 4,300 µg/kg for TCA, 1,300 µg/kg for PCE, and 330 µg/kg for TCE. Field screening of soil generated from several hundred environmental evaluations performed between 1997 and 2005 has not identified any other CVOC occurrences.

Residual PCE, TCE, and TCA present in the above source areas that did not volatilize was carried down through the soil column by infiltrating rainfall and entered the Linn Gravel aquifer. Natural groundwater flow patterns have promoted the spreading and commingling of contaminant plumes that formed downgradient of each source.

Contaminant Fate and Transport Pathways

The presence of other CVOCS in Fabrication Area groundwater such as cis 1,2-dichloroethene (cis 1,2-DCE), 1,1 dichloroethene (DCE), 1,1-dichloroethane (1,1-DCA), VC, and chloroethane is attributed to naturally occurring abiotic and biological transformation processes that convert PCE, TCE, and TCA into less oxidized forms.

Potential Receptors and Exposure Pathways

On-site workers could be exposed to CVOCs present in groundwater; however, groundwater is not used at the facility for any purpose. Drinking water has been obtained from the City of Albany since approximately 1964 and process water from the Willamette River since 1978. Hence, there are no complete human-health exposure pathways.

As documented in the Baseline Risk Assessment for Human Health and the Environment (CH2M Hill 1993), CVOCs present in groundwater that naturally enter Murder and Truax Creeks do not pose a threat to the fish and benthic organisms residing in the creeks.

3.9.3 Solids Area

The Solids Area is an approximately 20-acre parcel located on the west side of the Main Plant. The area is bounded by Truax Creek to the south and west, the Weyerhaeuser Paper Mill wastewater settling ponds to the north, and the BNSF railroad tracks to the east (Figure 2).

The Solids Area was used to store waste material from historic facility operations. This material was placed in four separate areas referred to as the Lower Solids Pond or Lower River Solids Pond (LRSP), Upper Solids Pond or Schmidt Lake, the Magnesium Resource Recovery Pile (MRRP), and the Chlorinator Residue Pile (CRP). The material in these areas was removed between 12 and 24 years ago, under prior EPA- and DEQ-approved actions.

Hydrogeologic Setting

The hydrostratigraphy beneath the Solids Area contains many of the same units observed elsewhere that includes, in descending order, the Recent Alluvium-Willamette Silt, Linn Gravel, and Blue Clay-Spencer Formation (Figure 7). Engineered fill has also been placed locally to reclaim some areas for reuse.

- **Recent Alluvium-Willamette Silt** – This level represents the uppermost unit in the Solids Area, where it occurs at depths between ground surface and 20 feet. Although this unit is composed of two different recognized strata, with differing material properties, they are believed to function as a single water-bearing zone that readily interacts with the underlying Linn Gravel, where present. Groundwater in this unit flows to the west-southwest at velocities between 0.06 and 20 feet per day. The upper end of this range is most likely confined to the regions encompassing the Weyerhaeuser settling ponds, where horizontal gradients are much higher.
- **Linn Gravel** – This level occurs at depths between 20 and 50 feet. As described for the other areas, this unit is a significant water-bearing zone. However, within the Solids Area, the Linn Gravel appears to be less contiguous, which could reduce its importance as a groundwater flow and contaminant transport medium.
- **Blue Clay-Spencer Formation** – This level underlies the Linn Gravel. With a permeability of between 1 x 10-6 to 1 x 10-8 cm/sec these units represent a basal confining layer that restricts downward groundwater movement. Groundwater present within these strata may be naturally brackish due to its origin within a marine depositional environment.

Groundwater elevations in the Recent Alluvium-Willamette Silt generally range between 170 and 194 feet, varying seasonally with rainfall patterns. Seepage from the Weyerhaeuser settling ponds creates a localized mound producing a radial groundwater flow pattern that extends south and west across the Solids Area. The influence of the settling ponds is also evident from the data that show average groundwater temperatures 2 to 4 degrees Centigrade (C) higher in monitoring wells located adjacent to the settling ponds.

Within the bedrock unit, groundwater elevations generally vary from 173 to 187 feet, fluctuating with seasonal rainfall. Because of its low permeability and consolidated nature, groundwater movement within the sandstone and clay is expected to be very slow, with an overall flow direction toward the Willamette River.

The primary natural surface water features in the Solids Area include Truax Creek, Murder Creek, and the Willamette River (Figure 2). Murder Creek forms a topographic and hydrologic boundary along the Wah Chang Main Plant north property line and just north of the Solids Area. The creek, which originates north of Knox Butte, 2 miles east of Wah Chang, flows for approximately 3,500 feet through the Wah Chang property, with a corresponding drop in elevation from 186 feet at the east property line to 172 feet near its confluence with Truax Creek. Discharge in the creek is low most of the year, with flow rates of 0.5 to 4.0 cubic feet per second (cfs) observed during the 1989 to 1992 remedial investigation.

Truax Creek originates southeast of Wah Chang and flows for approximately 4,500 feet through the central portion of the Main Plant and west along the southern boundary of the Solids Area before turning northwest. Following its convergence with Murder Creek, Truax Creek flows northwest for approximately 1.5 miles through Third and Fourth Lakes and Conser Slough before converging with the Willamette River.

Manmade features include the LRSP, Schmidt Lake, and Weyerhaeuser's settling ponds. Water is present in the LRSP throughout the year at an elevation of approximately 195 feet, whereas Schmidt Lake often goes dry between April and November. The water surface elevation in Weyerhaeuser's settling ponds is estimated at 198 feet.

Contaminant Sources and Release

Contaminant sources in the Solids Area included the lime solids formerly stored in the LRSP and Schmidt Lake, and leaching of dissolved-phase constituents from the MRRP and CRP. The solid materials present in these waste management areas were likely sources of CVOCs and metals to groundwater. Although no data are available for the composition of wastewater treated in the settling ponds, seepage from the ponds may contain ammonia, sulfate, TDS, and metals, and may also contain organic material that exerts a significant oxygen demand, creating an anaerobic groundwater environment beneath and immediately downgradient of the ponds.

The solids stored in the LRSP, Schmidt Lake, MRRP, and CRP were removed between 1979 and 1991. Groundwater monitoring performed between 1999 and 2007 for Site-related CVOCs and trace metals has not detected concentrations above ROD standards, indicating that the removal was effective at eliminating these groundwater contaminant sources.

Contaminant Fate and Transport

Although manganese has been observed at concentrations above the ROD standard of 0.05 milligram per liter (mg/L), its occurrence could be attributable to low dissolved oxygen concentrations present in Solids Area groundwater. Anaerobic conditions frequently transform naturally occurring insoluble manganese minerals into a soluble form. Dissolved manganese is expected to revert back to an insoluble mineral when groundwater enters the oxygen-rich environment in the vicinity of the Willamette River.

Receptors and Exposure Pathways

The Solids Area is used for stockpiling of waste material pending characterization and disposal. Stockpile material is consolidated on an approximate 0.5-acre asphalt pad and covered until off-site transport and disposal are coordinated. Wah Chang and contractor personnel are present in this area on a limited basis when material is dropped off or loaded for transport. The area is fenced and access is controlled through a secure gate. Therefore, non-worker personnel (trespasser, farmer or residents) do not have access to the Solids Area.

Workers present in the Solids Area could be exposed to manganese through ingestion, inhalation or dermal contact with groundwater. However, groundwater in this area is not used. Hence, there is no complete human health exposure pathway.

Terrestrial receptors (birds and mammals) may reside or forage in this area. However, due to the depth of groundwater occurrence (3-10 feet bgs), they are unlikely to come in contact with dissolved manganese.

As documented in the Baseline Risk Assessment for Human Health and the Environment (CH2M Hill 1993), inorganic constituents present in groundwater that naturally enter Murder and Truax Creeks do not pose a threat to the fish and benthic organisms residing in the creeks.

3.9.4 Farm Ponds Area

The 115-acre Farm Ponds Area is located approximately 0.75 mile north of the Main Plant (Figure 2) and once contained four 2.5-acre solids storage ponds that were used for industrial wastewater treatment between 1979 and 1993. In accordance with a DEQ-Water Quality approved closure plan (Wah Chang 1994), the ponds were closed by: draining and returning the free water to the Wah Chang's CWTS, excavating and drying the lime solids on an

asphalt pad, and transporting the dried solids to a Waste Management, Inc. Subtitle D disposal facility in Arlington, Oregon. The pond area was then re-graded to restore the natural topography. The closure work was performed between 1995 and 2000.

Hydrogeologic Setting

The hydrostratigraphy underlying the Farm Ponds Area consists of an upper saturated zone and the Linn Gravel aquifer (Figure 8). The upper saturated zone, identified as upper Willamette Silt, extends from the water table to the top of the gray clay which marks the boundary between the upper and lower Willamette Silt. The depth to groundwater varies from near ground surface at the northwest corner of the Site to about 10 feet, depending on location and seasonal conditions. The approximate thickness of the upper saturated zone is 5 to 10 feet. Groundwater flow in the upper saturated zone is to the west-southwest at an estimated rate of 0.01 to 0.8 ft/day. The lower Willamette Silt consists of gray clay with a thickness between 5 and 18 feet. The gray clay is laterally consistent in the Albany-Corvallis area, and therefore, is considered a regionally significant aquitard (CH2M Hill 1993). The hydraulic conductivity of the gray clay is on the order of 10^{-8} cm/sec (10^{-4} ft/day).

Groundwater in the Linn Gravel is confined by the overlying Willamette Silt. The Linn Gravel is approximately 10 to 30 feet thick and comprises a stratified, heterogeneous mixture of silt, sand, and gravel locally cemented with a silt-clay mixture and iron oxide. Groundwater flow in the Linn Gravel is to the west-southwest, toward Third Lake and the Willamette River. Groundwater flow velocities are estimated to be on the order of 0.1 to 1.0 ft/day.

The Blue Clay underlies the Linn Gravel at depths between 30 and to 60 feet below ground surface (bgs). The Blue Clay has a low permeability of between 10^{-8} to 10^{-7} cm/sec, and therefore, represents a barrier to downward groundwater flow.

The surface water hydrology in the Farm Ponds Area consists of two intermittent manmade ditches that drain the agricultural fields north of the Farm Ponds Area and south of the Soil Amendment Area. These ditches merge north of the fence enclosing the Farm Ponds Area. Surface water flows to the west, passing through culverts beneath the Burlington Northern Santa Fe (BNSF) railroad tracks. During the RI, the culverts were sometimes blocked by nutria lodges, causing local and temporary flooding in the winter months. The drainage continues to the west and eventually discharges to Fourth Lake. There is no flow in these ditches during the summer months.

Contaminant Sources and Release

CVOCs were detected in groundwater samples collected from monitoring wells installed in the vicinity of the Farm Ponds Area during the CERCLA OU1 and OU2 RI conducted between 1989 and 1992. The primary CVOCs observed in Farm Pond Area groundwater included PCE, TCA, and their degradation products.

The primary source of contaminants detected in groundwater was the wastewater used to slurry the solids from the CWTS to the Farm Ponds Area. This wastewater contained small amounts of dissolved solvent used in the Main Plant Area. The solids were not considered to be a significant source because of their inorganic composition. TCLP testing confirmed the solids to be a non-hazardous material.

The predominant contaminant release mechanism was wastewater seepage from the ponds to the underlying groundwater. This seepage occurred as a result of the downward vertical hydraulic gradient between the pond water level and the underlying Willamette Silt water table. Pond seepage enabled contaminants to enter the local groundwater flow regime, where

they were then transported to the west-southwest by the natural flow gradient. The extent of CVOCs observed in groundwater at the time of the RI was limited to the area adjacent to the ponds with the highest detected PCE concentration of 170 µg/L. This was observed in 1993 at monitoring well SS located on the south side of Pond 2. The most recent groundwater monitoring results (June 2007) showed a PCE concentration of 41 µg/L at well SS.

Potential Receptors and Exposure Pathways

The Farm Ponds Area is no longer used for wastewater treatment. The primary use of the area is consolidation of non-hazardous material on an approximate 0.5-acre asphalt pad until enough material has been collected for transport to an off-site disposal facility. Wah Chang and contractor personnel are present in this area on a limited basis when material is dropped off or loaded for transport. The area is fenced and access controlled through a locked gate. Therefore, non-worker personnel (trespasser, farmers, or residents) do not have access to the Farm Ponds Area.

Workers present in the Farm Ponds Area could be exposed to CVOCs through ingestion, inhalation or dermal contact with groundwater. However, groundwater in the area where CVOCs occur (near monitoring well SS) is not used. Therefore, there are no complete exposure pathways.

Terrestrial receptors (birds and mammals) may reside or forage in the vicinity of the Farm Ponds Area. However, due to the depth of groundwater occurrence (5–10 feet bgs) where CVOCs occur, terrestrial receptors are unlikely to come in contact with groundwater.

Due to the intermittent nature of surface water in the drainage ditches around the Farm Ponds Area, there are no known aquatic receptors present.

4. REMEDIAL ACTIONS OF OU1 – SLUDGE PONDS

This chapter discusses remedial actions (RAs) of Operable Unit 1 (OU1), and includes a description of the remedy and its implementation.

4.1 REMEDY SELECTION OF OU1 - SLUDGE PONDS

The ROD for OU1 was signed by EPA on December 28, 1989 (EPA 1989). Remedial actions consists of removal, solidification, and off-site disposal of sludge material with the intent to effectively reduce risk to human health and the environment, and to ensure that contaminants are not transported to groundwater, surface water, and/or air.

4.2 REMEDY IMPLEMENTATION OF OU1

On February 14, 1991, EPA issued a Unilateral Order to Wah Chang for design and implementation of the selected remedy for the Sludge Ponds. Based on this order, the following RA took place in accordance with the remedy selected in the ROD for OU1:

- Partial solidification of the sludge using Portland cement.
- Excavation and removal of the sludge from the sludge ponds (Schmidt Lake and the LRSP).
- Construction of a monocell at Finley Buttes Landfill, an off-site, permitted solid waste facility.
- Transportation of the solidified sludge to Finley Buttes Landfill and disposal in the monocell.
- Long-term operation and maintenance (O&M) of the off-site monocell.

In June 1991, construction of the off-site monocell at the Finley Buttes Landfill in Boardman, Oregon, was completed. Excavation and removal of the sludges began in July 1991 and were completed in November 1991. Approximately 110,000 cy of solids (including cement) were transported to the monocell at Finley Buttes. Cover construction and grass seeding of the monocell was completed in April 1992. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds OU RA to Wah Chang (EPA 1993).

4.2.1 Relationship to Groundwater OU2

Lime solids stored in the LRSP and Schmidt Lake leached dissolved organic and inorganic constituents into groundwater. Following the RA, a groundwater monitoring program was implemented in 2000 to confirm the effectiveness of the sludge removal and determine if groundwater quality performance standards could be achieved within the 15-year time frame specified in the Groundwater and Sediments ROD.

Semi-annual groundwater monitoring was performed between March 2000 and September 2002 to assess the effectiveness of the 1991 lime solids removal action with respect to groundwater quality. The monitoring results showed that VOCs, trace metals, and radionuclides were below ROD cleanup standards in 2002.

Groundwater sampling and testing for fluoride, nitrate, and manganese was conducted in November 2003, October 2004, September 2005, and September 2006. Laboratory testing for chloride, a constituent present at elevated concentrations in the lime solids pore water, was

also performed because chloride behaves as a conservative (non-reactive) constituent in the subsurface and provides an independent measure of overall groundwater quality changes.

Because groundwater performance standards had been met, beginning in fall 2003 EPA allowed Wah Chang in 2004 to reduce the level of monitoring in the solids area to annually for the following 2 years and then, once every other year. In 2004, sampling for 1,4 Dioxane resulted in concentrations below levels of concern; therefore, no further testing was required of Wah Chang. Spring 2007 sampling results did not indicate concentrations above ROD cleanup standards for COCs other than fluoride and manganese.

In November 2004, Wah Chang donated 12 acres of the Solids Area, which excluded the LRSP and Schmidt Lake, to the City of Albany. A fence was installed as part of an institutional control to prevent access to the Wah Chang Site. The conservation easement attached to the donation precludes future development of the donated parcel and requires that it be maintained as part of the Willamette Greenway.

4.2.2 Compliance Monitoring of the Finley Buttes Landfill

In order to effectively contain the contaminated sludges removed from the LRSP, a special monocell was constructed at the Finley Buttes Landfill. Two monitoring wells were installed upgradient and downgradient, respectively, of the Wah Chang Finley Buttes' monocell. Groundwater at the landfill has been monitored on a semi-annual basis beginning in July 1991, in accordance with the landfill's Solid Waste Disposal Permit issued by DEQ. Many of the chemical constituents detected in the lime solids are regularly monitored in groundwater, including VOCs and trace metals (antimony, barium, chromium, copper, lead, nickel, selenium, and zinc). 2006 results confirmed that trace metal results were below the health-based standard, and VOCs were not detected in groundwater samples (see Table 4).

4.2.3 Additional Remedial Activity Performed Under Amendment to the RI/FS Consent Order

The following actions were conducted under an amendment to the RI/FS Consent Order.

Supplementary Removal Action at Schmidt Lake

In 1991, EPA received information that drums of radioactive materials had been buried in Schmidt Lake in the 1970s. These drums were located below the sludges that had been the subject of the OU1 RA. Based on this information, EPA requested that Wah Chang conduct additional geophysical investigations in this area. In 1992, pursuant to the additional work provision of the RI/FS Consent Order, Wah Chang conducted an electromagnetic survey in this area. The electromagnetic survey identified additional source materials in and around Schmidt Lake. These source materials included several corroded metal drums containing sands with elevated amounts of thorium and uranium, and an underground storage tank containing liquid petroleum product.

In December 1992, as part of an action referred to as the Schmidt Lake Excavation Project (SLEP), 2,016 cy of materials containing zircon sands with elevated levels of thorium and uranium were removed from Schmidt Lake and transported by Wah Chang to the U.S. Ecology low-level radioactive waste site in Washington for disposal (Wah Chang 1992).

Soil Removal in Fabrication Area

In December 1991, during the installation of a soil boring adjacent to the Emergency Services Building in the Fabrication Area of the Main Plant, a floating non-aqueous oil layer containing 8 percent PCBs was detected. Groundwater in the vicinity of this boring contained

up to 22,500 ppb PCBs floating on the water table at an approximate depth of 13 feet below ground surface (bgs). Additional sampling identified an area of soil, approximately 30 feet by 30 feet, as a probable source of the PCB-contaminated oil. Total PCBs in soil were detected in 18 out of 20 borings. Highest detected concentrations in soil consisted of 440,000 ppb at 12.5 feet bgs, located due east of the Emergency Services Building. These samples were collected at or near the water table and had concentrations that are approximately two orders of magnitude greater than samples from surrounding borings. This suggests a localized contaminant source area in the vicinity of the Emergency Services Building. Field observations indicate groundwater fluctuations may have produced a localized contaminant smear zone at the soil-water interface. The source of the PCB was not identified in the RI; however, the concentrations of total PCBs in shallow soil throughout the Site are attributed to the application of oil for dust suppression.

Remedial activities for the PCB-contaminated soil were conducted by Wah Chang with EPA oversight on November 16–19, 1992 (CH2M Hill 2006). Remedial activities included the removal of contaminated soil from an excavation area approximately 30 feet by 30 feet. Excavation depths ranged from 3 feet bgs to the top of the water table to approximately 13 feet bgs.

Approximately 200 cy of soil were removed (CH2M Hill 2006). Soil was screened for disposal options using field test procedures. Of the 200 cy of soil excavated, approximately 170 cy were disposed of at Waste Managements Arlington Landfill, and 30 cy were placed in the former V2 pond (CH2M Hill 2006).

Ten confirmation soil samples were collected from the sidewalls of the excavation and analyzed for PCBs. Of the 10 soil samples collected, only one exceeded the 5 parts per million (ppm) screening criteria for PCB disposal. The sample result was 250 ppm and was observed to be located in a smear zone. Discolored soil was observed in the upper 2 feet of the excavation and was observed 11 to 13 feet bgs at the bottom of the excavation. Bottom samples of the excavation, where discolored soil was observed (11–13 feet bgs), were not collected (CH2M Hill 2006).

In November 1992 the excavation was backfilled with approximately 280 tons of crushed rock, and then covered with asphalt.

As part of the long-term monitoring for the groundwater remedy on the main plant, Wah Chang is required to submit a Biennial Report of Environmental Evaluations to EPA. This evaluation must document all of the excavations undertaken over the 2-year period and the concentrations of what was left behind following those excavations. The 2003–2005 Wah Chang Biennial Report contained information on one excavation that was conducted in 2005 near the Emergency Services Building for a natural gas pipeline. This excavation was 2 to 3 feet wide, 4 feet deep, and approximately 100 feet long. Soil samples collected from the excavation indicate that PCBs were present at concentrations up to 262 ppm. Dark-stained soil was observed in shallow soil exposed during the investigation, consistent with observations made during the 1992 excavation. Analytical results confirmed PCBs up to 262 ppm in removed, stained soil. PCBs ranged from below detect limits to 12 ppm in samples collected from the base of the excavation.

Farm Ponds Closure and Soil Removal

The Farm Ponds site formerly consisted of four 2.5-acre settling ponds located approximately 0.75 mile north of the Main Plant. Between 1979 and 1993, approximately 2.5 million gallons per day of wastewater, containing 2 to 5 percent lime solids, were pumped from the facility's central wastewater treatment system to the Farm Ponds for settling (solids thickening). The

solids were retained in the ponds and the water pumped back to the central wastewater treatment system. In 1993, the Farm Ponds were replaced by an advanced solids handling system located in the Main Plant.

Although the material used to construct the dikes enclosing the ponds had a relatively low permeability, dissolved-phase chemicals present in the wastewater eventually seeped into the underlying groundwater. From 1989 through 1992, in consultation with the EPA and DEQ, Wah Chang conducted a CERCLA RI/FS that included the Farm Ponds Area and that confirmed the presence and extent of groundwater contamination at the Albany, Oregon facility.

In the vicinity of the Farm Ponds Area, the RI/FS revealed the presence of chlorinated organic compounds in groundwater at concentrations above the National Primary Drinking Water maximum contaminant levels. Several inorganic constituents were also detected at concentrations above background levels or above EPA's secondary drinking water standards. In 1994, based on the findings of the RI, EPA issued a ROD (EPA 1994) specifying the actions Wah Chang must take to mitigate potential risks to human health and the environment posed by soil and groundwater contaminants present at the facility.

In accordance with the ROD and as required by their NPDES permit, Wah Chang submitted a plan to close the Farm Ponds site. The plan proposed excavation and off-site disposal of the wastewater treatment solids remaining in the ponds, leveling and regrading of the dikes, and monitored natural attenuation for areas of groundwater contamination. Between 1995 and 1999, approximately 62,000 tons of solids were removed and disposed of at the Columbia Ridge Landfill in Arlington, Oregon. In 2001, the dikes were leveled and the site re-graded to restore the natural land contours. To monitor the effectiveness of the above actions and to measure natural attenuation rates, groundwater samples were collected from 14 monitoring wells located around the Farm Ponds perimeter between March 2000 and September 2002.

Historical and statistical evaluation of concentration data collected between 2000 and 2002 from the Farm Ponds area monitoring wells revealed the following:

- Tetrachloroethene (PCE), trichloroethene (TCE), and VC were the primary VOCs in groundwater at concentrations above the cleanup standards specified in the ROD.
- Tetrachloroethene was detected at only one of the 14 monitored locations at levels above the 5 microgram per liter (µg/L) cleanup standard. During the 3-year monitoring period, maximum observed concentrations declined steadily from 22.5 µg/L in September 2000, to 8.7 µg/L in September 2002.
- Trichloroethene was detected at two of the 14 monitored locations (wells SS and PE-40) at levels above the 5 µg/L cleanup standard (see Section 9 for monitoring well locations).
    - At well SS, trichloroethene was detected at 6.2 µg/L in September 2000. However, the concentration has remained below the 5 µg/L cleanup standard for the last four sampling events.
    - At well PW-40S, trichloroethene concentrations have declined steadily from 21.5 µg/L in March 2000 to 5.6 µg/L in September.
- Vinyl chloride was detected at one of 14 monitored locations (well PW-40A) at levels above the 2 µg/L cleanup standard. During the 3-year monitoring period, maximum observed concentrations declined steadily from 4 µg/L in June 2000 to 1.1 µg/L in September 2002.

5. REMEDIAL ACTIONS OF OU2 – GROUNDWATER AND SEDIMENTS

This chapter discusses remedial actions of Operable Unit 2 (OU2). It includes a description of the selected remedy, RA objectives, and implementation of RAs.

5.1 REMEDY SELECTION OF OU2

On June 10, 1994, EPA selected the Final Remedial Action for Groundwater and Sediments Operable Unit 2 (OU2), which is described in the ROD (EPA 1994). The ROD is the regulatory instrument EPA used to select RAs in order to address the remedial action objectives (RAOs).

Remedial actions for OU2 identified in the ROD consist of groundwater extraction, pretreatment of discharged extracted groundwater, monitored natural attenuation (MNA), treatment or removal of subsurface source material near the Feed Makeup Building, slope erosion protection along the banks of Truax Creek, sediment removal, and Site-wide actions. The major components of the selected remedy are listed below.

5.1.1 Remedial Action Objectives (RAOs) for OU2

Groundwater RAOs

- Prevent people from drinking groundwater containing contaminant levels above federal and state drinking water standards.
- Prevent contaminated groundwater above federal and state drinking water standards from leaving the TWCA property boundary.
- Reduce the concentrations of TWCA-related organic, inorganic, or radionuclide compounds in groundwater to concentrations below federal or state drinking water standards or other risk-based levels.
- Prevent groundwater containing TWCA-related organic, inorganic, or radionuclide compounds above federal or state standards from discharging into nearby surface waters.

Sediment RAOs

- Prevent TWCA-related contaminants from moving into sediments, and from sediments into surface water.
- Prevent sediments containing TWCA-related contaminants from leaving the Site.
- Prevent aquatic organisms from coming in contact with contaminated sediments.
- Reduced concentrations of TWCA-related compounds in sediment, where necessary, to protect aquatic organisms.

Surface Water RAOs

- Ensure that non-permitted discharge to surface water from the TWCA facility does not exceed federal or state water quality standards.

5.1.2 ROD Amendments or Explanation of Significant Differences (ESD)

During the preparation of the Scope of Work for implementation of the groundwater remedy, the following changes were made to the selected RA and outlined in an Explanation of Significant Differences (ESD) issued October 8, 1996 (EPA 1996).

Change I – Conditional Change to the Western and Northern Perimeter Containment Requirements

EPA dropped the requirement for groundwater extraction at and outside the plant boundaries on the northern and western perimeters. Dropping the perimeter requirements is contingent on conditions described in the ESD (EPA 1996).

For the western and northern perimeters of the Main Plant, requirements to implement groundwater extraction at and/or beyond the facility perimeter were eliminated contingent on:

- Existing groundwater data, and data collected pursuant to the performance of the remedial action, confirming that contaminant levels (and total excess cancer risk and/or HI) are declining at perimeter wells along the property boundary (compliance points) or reached an asymptotic concentration acceptable to EPA and DEQ, and/or other site data or information which indicate that natural attenuation is effectively reducing contaminant levels in off-site areas.
- Existing and new surface water data indicating that discharge of groundwater to surface water bodies is not exceeding ambient water quality criteria (AWQCs).
- Within 1 year of initiation of the remedial design/remedial action (RD/RA) Work Plan (Wah Chang, 1996), EPA/DEQ-approved deed restrictions or other institutional controls acceptable to EPA and DEQ are in place for all off-site properties where groundwater contains contaminants above clean-up levels.

Change II – Clarification in Requirements for the Farm Ponds Area

Additionally as part of the ESD, EPA made the remediation requirements for the Farm Ponds Area consistent with the rest of the Site. Within the Farm Ponds Area, remediation will take place through extraction of hot spots of contaminated soil; however, the plume in the Farm Ponds must be kept from significantly expanding. Compliance with this requirement will be demonstrated by existing groundwater data, and data collected pursuant to the RA indicating that contaminant levels (and total excess cancer risk and/or HI) in wells in the Farm Ponds Area are not increasing, or are declining, and/or other site data or information indicate that natural attenuation is effectively reducing contaminant levels. For consistency with the rest of the Site, EPA changed the point of compliance to the property boundaries in the Farm Ponds Area through this ESD.

Change III – Correction in Identification of Sediment Area Exceeding the Action Level

A review of the RI/FS sediment data indicated that not all areas identified in the ROD exceeded action levels (1 ppm PCBs). These include Conser Slough and Murder Creek.

The areas that do exceed sediment action levels include the confluence of Murder and Truax Creeks, the confluence of Truax Creek and Second Lake overflow, and the reach of Truax Creek that passes along Truax Fill.

5.2 REMEDY IMPLEMENTATION OF OU2

The selected remedy consists of the following RAs to meet groundwater, surface water, and sediment RAOs.

Groundwater RAs

- Remediation of groundwater via groundwater extraction at areas on-site where contaminant concentrations exceed lifetime cancer risk levels of $1x10^{-4}$ and/or substantially exceed the non-cancer HI of 1 for worker exposure (hot spot areas). Extraction shall continue until contaminant concentrations in groundwater throughout the Site are reduced to below Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs), non-zero maximum contaminant level goals (MCLGs), or cancer risk levels of $1x10^{-6}$ and non-cancer risk HI <1 for worker exposure, or until EPA in consultation with DEQ determines that continued groundwater extraction would not be expected to result in additional cost effective reduction in contaminant concentrations at the Site.
- Contaminated groundwater in exceedance of SDWA MCLs, non-zero MCLGs, or cancer risk levels of 10^{-6} and non-cancer risk HI >1 for residential use shall be prevented from migrating off the plant site, or beyond the current boundary of the groundwater contaminant plume at the Farm Ponds Area.
- Discharge of extracted groundwater into Wah Chang's wastewater treatment plant. Pretreatment of groundwater to comply with CWA requirements prior to discharge to the wastewater treatment plant.
- Treatment or removal of subsurface source material near the Feed Makeup Building on the Main Plant.

Sediment RAs

- Slope erosion protection consisting of a geotextile covered by riprap placed along the banks of Truax Creek to prevent contaminated fill material from entering the creek.
- Removal of 3,600 cy of contaminated sediments from surface water bodies adjacent to or flowing through the Site. Additional ecological characterization prior to removal to determine potential impacts of sediment removal to local ecosystems and to provide a mechanism to mitigate those potential impacts.

Site Wide Actions

- Deed restrictions and institutional controls on land and groundwater use for both the Main Plant and the Farm Ponds Area. The objective of this component of the remedy is to ensure that the property and groundwater are used for purposes appropriate to the cleanup levels achieved.
- Environmental evaluations of currently uncharacterized potential contaminated source areas, as needed to ensure achievement of groundwater RAOs. The objective of this component of the remedy is to ensure that contaminated source areas do not adversely impact the remedy.
- Long-term on- and off-site groundwater, surface water, and sediment monitoring which shall include at a minimum the monitoring of on-site wells which are in exceedance of MCLs and non-zero MCLGs, cancer risk levels of 10^{-6}, and non-cancer risk of HI >1 for residential exposure.

- Review of selected remedy at least once every 5 years to ensure protection of human health and the environment.
- Deed restrictions placed on adjacent property on the western perimeter to preclude groundwater use for drinking water.

5.2.2 Groundwater Extraction

Wah Chang implemented a groundwater extraction and treatment system (GETS) in the Extraction and Fabrication Areas as an element of the remedy to achieve groundwater RAOs and cleanup levels. Cleanup levels for groundwater are displayed in Table 2.

Implementation of the remedial design and actions for groundwater were based on the following documents, which present the basis for groundwater extraction, treatment, and conveyance, develop project plans and specifications, and document the remedy's construction:

- Scope of Work for Remedial Design/Remedial Action Groundwater, Sediment, Surface Soil and Subsurface Soil, Teledyne Wah Chang Albany (EPA 1996)
- Extraction Area Groundwater Remedial Design/Remedial Action Work Plan, Wah Chang (CH2M Hill 1999)
- Remedial Action Construction Report for the South Extraction Area (CH2M Hill 2001)
- Feed Makeup Area Construction Report (CH2M Hill 2002)
- Fabrication Area Groundwater Remedial Design Report/Remedial Action Work Plan, Wah Chang (CH2M Hill 2000)
- Fabrication Area Groundwater Remedial Action Construction Report (CH2M Hill 2001)

As part of groundwater extraction, the GETS employ's a system that includes well pumps (pneumatic or submersible), groundwater conveyance pipes, and flow control and monitoring equipment. In general extraction wells were constructed of 6-inch-diameter polyvinyl chloride (PVC) riser casing with 10- to 15-foot long stainless steel well screens.

Extraction Area

The GETS at the Extraction Area consists of two groups of three pumping extraction wells (EWs) each: EW-1, EW-2, and EW-3 in the Feed Makeup Area; and EW-4, EW-5, and EW-6 in the South Extraction Area (SEA). Figure 9 displays the locations of Extraction Area well field. Start-up of GETS operations in the SEA was completed in October 2000. Start-up of GETS operations in the Feed Makeup Area was completed in April 2002.

Fabrication Area

The Fabrication Area well field consists of six extraction wells identified as FW-1, FW-2, FW-3, FW-4, FW-5, and FW-7 (Figure 10). The Fabrication Area well field was designed to hydraulically capture and remove VOC-contaminated groundwater originating from several suspected sources located in the vicinity of the Powder Metallurgy, Dumpmaster/Arrowhead Lake, Material Recycle, Ammonium Sulfate Storage, and Acid Sump/Thermite subareas. Start-up of GETS operations was completed between April and August 2001.

The Remedial Design of the Fabrication Area well field originally called for seven extraction wells. FW-6 was not implemented because testing performed in January 2001 revealed a sustainable yield of less than 0.1 gallons per minute (gpm). This low yield is attributable to the Linn Gravel's nominal saturated thickness, and the potentially lower permeability of Recent Alluvium straddling the creek banks.

5.2.3 Attainment of Groundwater Cleanup Levels

The purpose of groundwater extraction is to expedite the attainment of site-wide groundwater cleanup levels. Wah Chang will continue groundwater extraction until cleanup levels are achieved. The projected time frame for extraction is an estimated 15-year period beginning with the implementation of GETS in 2002. In effort to achieve this timeframe Wah Chang has completed several modifications to GETS including upgrade to a submersible well pump at FW-2, proposed installation of a new extraction well FW-8, and conversion from GAC to CWTS for treating VOCs at select well heads. These efforts are discussed further below.

The ability of GETS to achieve RAOs and cleanup levels cannot be fully determined until the system has been implemented and modified as necessary, and the plume response monitored over time (EPA 1994). If this element of the selected remedy is unable to fully achieve all specified RAOs and cleanup levels, it maybe replaced by contingency measures outlined in Section 10.1.1.2 of the ROD. Progress towards attainment of groundwater cleanup levels was evaluated as part of the Three Year Evaluation of the Groundwater Remedy for the Fabrication Area (CH2M Hill 2005, 2006a) and Extraction Area (CH2M Hill 2007a).

5.2.4 Treatment and Discharge of Extracted Groundwater

Extraction Area

Effluent water from EW-4, EW-5, and EW-6 is treated by individual granular activated carbon (GAC) units to remove VOCs prior to discharge to Wah Chang's Central Wastewater Treatment System (CWTS). Routine O&M includes filter and GAC change-outs. Currently, filter change-outs occur approximately bimonthly and have associated downtime not exceeding 1 hour. GAC change-outs occur annually and have downtime not exceeding 4 hours. No major non-routine maintenance events have occurred with this system.

Effluent water from EW-1, EW-2, and EW-3 is discharged directly to the CWTS through an equalizer tank. The system does not include filters or GAC vessels. Routine O&M includes inspection and repair/replacement of pumps and connectors for corrosion due to the low pH of area groundwater. Associated downtime does not exceed 1 hour. No major non-routine events have occurred with this system.

Fabrication Area

Extracted groundwater from FW-1, FW-2, FW-3, FW-4 and FW-7 was initially treated at the wellhead using GAC to remove CVOCs prior to discharge to the CWTS. In March 2006, EPA approved a shift from the GAC treatment units to Wah Chang's process water cooling towers, which function similar to an air-stripping tower (EPA 2007). Downtime associated with the conversion was approximately 2 weeks. Extracted groundwater from FW-5, which contains ammonia, is treated in Wah Chang's Ammonia Recovery (stream stripping) System.

Currently, routine O&M does not have associated downtime, with the exception of filter change-outs at FW-1. Change-outs occur on an approximately monthly basis, with associated downtimes not exceeding 1 hour. Downtime associated with non-routine O&M is minimized by keeping replacement pumps, flow meters, and other parts on hand. FW-1, FW-5, and

FW-7 have experienced a 2–4 week downtime event due to the fouling of well lines. The fouled well lines were removed and replaced with larger diameter lines to allow on-site maintenance staff to clear any future blockages.

NPDES Permit

Effluent water from the CWTS is discharged to Truax Creek under NPDES permit #100522. The NPDES regulations require that the permit include limits on all pollutants which are or may be discharged at or above state water quality standard (see Table 3).

5.2.5 Groundwater Extraction System Monitoring

Groundwater extraction system monitoring is conducted through periodic sampling and analysis of groundwater samples from extraction wells, selected monitoring wells, and the GAC treatment system to confirm that the system performance objectives are being achieved.

Performance is evaluated with respect to the following:

- Hydraulic response to pumping
- Influent water quality and concentration trends
- GAC treatment efficiency
- Total contaminant mass removed and mass removal rate

Results from these evaluations are presented by Wah Chang in bimonthly and annual progress reports, and fulfill requirements pursuant of Section 10 of Wah Chang's Consent Decree.

5.2.6 Long-Term Monitoring

Long-term monitoring consists of semi-annual sampling and analysis of groundwater from the Extraction Area, Fabrication Area, Solids Area, and Farm Ponds Area, and of surface water from Truax and Murder Creeks. Procedures for groundwater and surface water monitoring are presented in the Field Sampling Plan (CH2M Hill 1997). Long-term monitoring was implemented as part of the RI, and typically occurs in the spring and fall of each year.

Groundwater quality data are compared to cleanup levels displayed in Table 2. Surface water data is compared to ambient water quality criteria (AWQCs) for the protection of human health, drinking water and fish ingestion (see Oregon Administrative Record [OAR] 340-41-445).

5.2.7 Sediment

Implementation of the remedial design and actions for sediment were based on the following documents:

- Truax Creek Sediment Remedial Design Report, Wah Chang, Albany Oregon. Prepared by CH2M Hill, Corvallis, Oregon. June 1997.
- Truax Creek Sediment Remedial Action Work Plan, Wah Chang, Albany, Oregon. Prepared by CH2M Hill, Corvallis, Oregon. July 1997.

Sediment RAs were implemented in 1997 and included:

- Slope erosion protection consisting of a geotextile covered by riprap placed along the banks of Truax Creek to prevent contaminated fill material from entering the creek.
- Removal of approximately 3,600 cy of contaminated sediments from the surface water bodies adjacent to or flowing through the Site. Also, additional ecological characterization prior to removal to determine potential impacts of sediment removal to the local ecosystem and to provide mechanisms to mitigate those impacts.

The construction work for the sediment excavation of Truax Creek was completed in 1997. Contaminated sediments in Truax Creek were excavated and the creek bank was covered with a geotextile and riprap. Sediment samples taken as part of the remediation showed that the depth and extent of sediment contamination was greater than expected along the length of the creek running through the Site. As a result, the portion of the creek between the plant boundaries was remediated.

During the 5 years of post-remediation sediment sampling completed in 2002, only 2 samples out of 52 were above the remedial action cleanup standard of 1 ppm for PCBs (1.2 and 1.5 ppm, respectively). The completion of the Truax Creek sediment remedial action was approved by EPA in December 2002. Wah Chang performed a one-time confirmation sediment sampling event in the winter of 2007 to ensure that the sediment remediation and bank stabilization continue to be protective of human health and the environment (Wah Chang, 2007b). Results from this sampling did not indicate any PCB detections of Truax Creek sediment (CH2M Hill 2007i). .

6. REMEDIAL ACTION FOR OU3 – SURFACE AND SUBSURFACE SOILS

6.1 REMEDY SELECTION

The selected remedy combined source removal with institutional controls to reduce risk to human health and the environment posed by contamination in surface and subsurface soils at the Site. No specific soil RAOs for OU3 were specified in the ROD.

6.1.1 Remedial Actions (RAs) for OU3

Remedial actions consist of:

- Excavation of contaminated soil exceeding the gamma radiation action level of 20 micro-roentgen equivalent man per hour (µrem/hour) above background levels.
- Transportation of the excavated material to an appropriate off-site facility for disposal.
- For areas of the Site where modeling indicates that that radiological contamination remained and radon concentrations in future buildings could exceed 4 picoCuries per liter (pCi/L), institutional controls require that future buildings be constructed using radon-resistant construction methods.
- Requirement that information on areas of subsurface PCB and radionuclide contamination which do not pose a risk if they are not disturbed, be incorporated into the Wah Chang facilities maintenance plan and be made available to future Site purchasers or regulatory agencies.
- Should excavation occur as part of future development of the Main Plant or Soil Amendment Areas, excavated material must be properly handled and disposed of in accordance with federal and state laws.
- Institutional controls requiring that land use remain industrial.

During the preparation of the Scope of Work for implementation of this remedy, the following change was made to the selected remedial action and outlined in an Explanation of Significant Differences issued October 8, 1996 (EPA 1996):

- Actual radon measurement of radon emanating from the soil may be taken during building design and used to determine whether the EPA radon standard is exceeded. If the standards are not exceeded, radon resistant technology would not be required. The requirement for radon sampling following construction still applies. If the building radon concentration exceeded the radon standard in effect at the time, the building would have to be retrofitted with controls to reduce radon levels below the EPA target level or promulgated standard.

6.1.2 ROD Amendments or Explanation of Significant Differences

Following soil cleanup, EPA amended the soil remedy with a September 28, 2001, ESD (EPA 2001), which includes:

- Final Site closure for radionuclides will be conducted pursuant to Wah Chang's Oregon Radioactive Materials License (Broad Scope Naturally Occurring Radioactive Material License) and the Energy Facility Siting Council (EFSC) Administrative Rules, Chapter 345, Division 50.
- On-site surface gamma emissions will be controlled through in-place management of contamination. Prior to Site decommissioning under Oregon Health Service and EFSC, surface gamma emissions must be kept below clean-up levels through in-place management under an EPA- and DEQ-approved management plan, and additional excavation of contamination performed as part of on-going excavation occurring during on-site construction.
- If the Site is not decommissioned under Oregon Health Services and EFSC to EPA's cleanup requirements, radiation management shall be a condition of property transfer to ensure that these controls remain protective. Any partial or complete property transfer shall be conditioned on implementation and maintenance of an appropriate EPA- and DEQ-approved radiation management program.
- Excavation and either creating engineered berms (capped areas of soil with use and maintenance restrictions) or off-site disposal is an acceptable remedy for the Soil Amendment Area if institutional controls cannot be implemented.
- Institutional controls requiring that land use remain consistent with current industrial zoning.

6.2 REMEDY IMPLEMENTATION OF OU3

The decay products of the radionuclides, gamma radiation and radon, are the risk drivers for the soil cleanups at the Site. The cleanup standard for soil was based on reaching a gamma radiation level of 20 µrem/hour over background radiation levels. For areas of the Site where modeling indicated that radon concentrations in future buildings could exceed 4 pCi/L, institutional controls will be implemented which require that future buildings be constructed using radon-resistant construction methods.

6.2.1 Schmidt Lake

On August 26, 1998, Wah Chang excavated between 12 and 15 cy of soil from Schmidt Lake. All areas exceeding the Site action level of 20 µrem/hour above background levels were excavated and transported off-site for disposal. The area was left as it was pending potential re-use of the area.

6.2.2 Sand Unloading Area

The RI/FS identified a relatively small area where surface gamma radiation levels exceeded the cleanup standard of 20 µrem/hour above background. The elevated gamma radiation levels in the area were expected to be emanating from spilled zircon sands (raw materials for the zirconium process) containing a naturally occurring radium-226 component. The underlying assumption for the selection of the excavation remedy was that the RI/FS identified the location and extent of all on-site areas where surface and near-surface gamma emitting material was present. During the excavation of this area, it was determined that although sand was present on the ground surface, it was not the primary source for all of the gamma emissions.

Excavation was stopped when the northwestern edge of the material appeared to extend beneath a concrete slab in front of the mobile maintenance shop, and under the shop itself, and when the northernmost end of excavation would have interfered with on-site traffic with no evidence that the limit of contamination had been reached. In the areas excavated, gamma-emitting material was found within 2 feet of the surface. A confirmation surface gamma survey showed that within the excavated area, levels were below the cleanup standard of 20 µrem/hour above background. The amount excavated was 1,890 cy, twice the ROD estimate.

While some of the gamma emissions in the area resulted from spilled sands on the ground surface, there was a significant quantity of buried material. Four primary types of material were identified in the excavation area: black sand, reddish brown sand, green sand, and gray materials containing rock-like "clinkers" (a waste from the former carbide process emitting significantly elevated levels of gamma radiation). A subsequent review of gamma survey and radionuclide sampling information collected during past excavation projects in the vicinity of the Sand Unloading Area was done by Wah Chang in an attempt to determine the extent of contamination. Radionuclide-contaminated material, which could exceed cleanup levels if uncovered, was found 200 feet to the north, 200 feet to the northeast, and 200 feet to the east of the area. The material found was identified as carbide waste, a process waste with a high radium-226 concentration, which had previously been disposed on the Site. Most of the Sand Unloading Area is now overlain by Wah Chang's new Co-Generation (CoGen) Plant, a natural gas-powered electricity-generating plant. The plant is built on a 14-inch concrete slab, which acts as an effective gamma-blocking barrier..

6.2.3 Front Parking Lot Area

In the RI/FS, black sand, a low-level, radioactive rutile sand (the natural mineral form of titanium dioxide), was identified for removal in the Front Parking Lot Area, and was removed during the soil RA in 1997. Additionally, a 1- to 6-inch layer of black sand was identified 6 to 12 inches below the Front Parking Lot Area's gravel surface. This layer of black sand covered native soil. Samples of the sand indicate that radium-226 levels in the sand could cause radon concentrations in future buildings to exceed the radium-226 action level of 4 pCi/L (the current risk-based level identified in the ROD), and so the area has been added to the Site locations requiring future buildings to be constructed with radon resistant construction methods.

Following soil cleanup, EPA drafted an ESD for the soil remedy that called for the following:

- Final Site closure for radionuclides will be conducted pursuant to Wah Chang's Oregon Radioactive Materials License (Broad Scope Naturally Occurring Radioactive Material License) and the EFSC Administrative Rules (Chapter 345, Division 50).
- On-site surface gamma emissions will occur through in-place management of contamination. Under Oregon Health Services and EFSC, prior to Site decommissioning, surface gamma emissions must be kept below cleanup levels through in-place management under an EPA- and DEQ-approved management plan. Additional excavation of contamination must also be performed as part of ongoing excavation occurring during on-site construction. If the Site is not decommissioned to EPA's cleanup requirements, radiation management shall be a condition of property transfer to ensure that these controls remain protective. Any partial or complete property transfer shall be conditioned on implementation and maintenance of an appropriate EPA- and DEQ-approved radiation management program.

6.2.4 Soil Amendment Area

In 1975 and 1976, Wah Chang had obtained solid waste permits from DEQ to use, as a one-time application, solids from the primary wastewater treatment plant experimentally as a soil amendment on a 40-acre parcel of property (Soil Amendment Area Operable Unit). The solids contained low levels of metals, radionuclides, and organic compounds. Radium-226 and radium-228 concentrations in surface soil averaged approximately 2.5 and 1.8 pCi/g, respectively. The RI/FS subsequently indicated that the radionuclide contamination in the Soil Amendment Area Operable Unit could result in an unacceptable risk from radon inhalation in any future buildings constructed on this area, and that organic compounds are above levels that would allow unrestricted use of the property. Between March 1989 and 1990, the Soil Amendment Area Operable Unit was transferred to the City of Millersburg through a deed agreement between the Teledyne Wah Chang Company and the City. The City acquired the 40-acre Soil Amendment Area, and Teledyne Wah Chang acquired property contiguous to its Farm Ponds Area. Presently, institutional controls for the Soil Amendment Area Operable Unit are enforced under a Consent Decree between the U.S., State of Oregon, and the City of Millersburg.

7. SITE-WIDE ACTIONS

7.1 INSTITUTIONAL CONTROLS

The following institutional controls (ICs) are in place at Wah Chang:

Government Controls

- Zoning restrictions by the City of Millersburg to maintain industrial land use at the Site and adjacent properties (Wah Chang, 1991).
- Development Code restrictions by the City of Albany (Public Improvements 12.410) that require that all new developments connect to municipal water lines if service is available within 150 feet. This restriction prevents the use of groundwater for potable purposes. Note that the development code does allow new single-family homes to use wells for water supply, when service is not available, if approved by the City (Wah Chang 1997).

Proprietary Controls

- Deed restriction or restrictive covenant that requires Wah Chang and adjacent properties to restrict groundwater use as a drinking water supply. This includes land owned by Linn County in the vicinity of Old Salem Road, and on the Burlington Northern Railroad right-of-way (Wah Chang 2001; Oremet-Wah Chang 1999a; Oremet-Wah Chang 1999b; Oremet Wah Chang 1999c; Stoel Rives 1999).
- Controls on the Main Plant and Farm Ponds Area to restrict access through the use of fencing, signage (postings), and daily security patrols and manned guard stations. Farm Ponds has a fence only (Wah Chang 1997).
- Conservation easement to prevent land development, and to conserve and protect property and natural resources in the Solids Area.

Enforcement Controls

- ICs on the Main Plant and Farm Ponds in the form of deed restrictions and access restrictions are to be implemented as long as Wah Chang remains an active facility and/or until cleanup levels are achieved, as stipulated in the ESD for OU3 (EPA 2001).
- Provisions regarding transfer of property ownership (notice of obligations to successor in title) as stipulated in Consent Decree (U.S. 1997).
- ICs and deed restrictions on land and groundwater use for the Main Plant and Farm Ponds Area to ensure that the property and groundwater use are appropriate to cleanup levels achieved, as stipulated in the Consent Decree (U.S. 1997; Wah Chang 1997).
- Provide access to the Site at all reasonable times to EPA and its Contractors, as stipulated in the Consent Decree (U.S. 1997).
- Controls to ensure long-term protectiveness from materials contaminated with radionuclides are to be incorporated in the Broad Scope Radioactive Materials License (#ORE-90001) for the facility. License conditions require that operations be conducted in accordance with the State of Oregon “Standards for Protection Against

Radiation – OAR Division 333 Section 120 and Division 111" for the operating facility. Decommissioning requirements under this license establish protectiveness controls for any radioactive materials remaining in areas by requiring decontamination to release the Site for unrestricted use upon permanently discontinuing manufacturing activities.

- Long-term maintenance in areas known or suspected to contain gamma-emitting materials (GEM) of pavement, capped material or structures, as stipulated in the ESD for OU3 (EPA 2001).
- Areas of the Site where modeling indicates that radon concentrations in building exceed 4 pCi/Liter, require that building be constructed using radon resistant construction methods, as stipulated in the ESD for OU3 (EPA 2001).
- ICs for the Soil Amendment Area have been completed and are enforceable under the Consent Decree (U.S. 2006).

Informational Devices

- Information to occupational worker regarding risks from contamination.
- Information on PCBs and radionuclide contamination, which do not pose a risk if they are not disturbed, be incorporated into Wah Chang's maintenance plan, and be made available to future Site owners or regulatory agencies.

The following ICs have not been implemented:

- ICs required by the ESD for OU3 are incorporated into the SOW for long-term protectiveness. These ICs are discussed above.

7.2 ENVIRONMENTAL EVALUATIONS OF UNINVESTIGATED AREAS

Environmental evaluations of uninvestigated areas are conducted to ensure that the RAOs for groundwater are being achieved. Environmental evaluations of previously uninvestigated areas occur whenever Wah Chang discontinues use, paves, or otherwise disturbs any pond, area, or building on the Site (CH2M Hill 2006). Environmental Evaluation Reports (EERs) were prepared for the period of September 1999 to September 2001 (CH2M Hill 2001b), September 2001 to September 2003 (CH2M Hill 2003c), and September 2003 to December 2005 (CH2M Hill 2006a).

Between September 1, 1997, and December 31, 2005, a total of 544 excavations were performed at locations distributed throughout the site, with over 16,000 cubic yards of soil removed and disposed. Soil from 94 percent of these excavations tested non-hazardous and required no special disposal. Soil from only 6 percent of the excavations (33 excavations) generated soil or debris that required special disposal. Of these 33 excavations, testing results found PCBs (15 excavations), MIBK (11 excavations), radionuclides (5 excavations) or other constituents such as HCB (2 excavations) at levels requiring special disposal.

The Toxic Substances Control Act (TSCA) is an applicable relevant and appropriate requirement (ARAR) for both the Surface and Sub-surface Soils ROD and the Groundwater and Sediments ROD and therefore applies to CERCLA remedial actions when special disposal of contaminated soil is necessary.

8. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This section cites the progress met since the last (second) five-year review for the Wah Chang NPL Site, conducted in 2003. This section includes protectiveness statements for the three OUs (OU1 through OU3) cited in the second five-year review, and discusses the status of recommendations and follow-up actions since the second five-year review was completed.

8.1 OU1 – SLUDGE PONDS

Protectiveness Statement from the Last Review

The remedy is protective.

Status of Recommendations and Follow-up Actions Since the Last Review

No recommendations were made in the last five-year review.

Status of Any Other Prior Issues

None identified.

8.2 OU2 – GROUNDWATER AND SEDIMENT

Protectiveness Statement from the Last Review

Groundwater

The remedy is considered protective because the cleanup levels are still within EPA's risk range, and there is no current or potential exposure pathway.

Sediment

The remedy is protective.

Status of Recommendations and Follow-up Actions Since the Last Review

Groundwater

Recommendation: Monitor TCE toxicity developments, and any other contaminants of concern as they come under review (Chemical Specific ARARs).

Status: Ongoing.

Toxicity factors or slope factors (SF) have changed since the preparation of the Year 2000 Remedial Design Risk Assessment to Year 2005, based on a review of risk-based concentrations (RBCs) for the IRIS and California Environmental Protection Agency databases. These databases are available at: www.epa.gov/reg3hwmd/risk/human/index.htm and http://www.oehha.ca.gov/risk/ChemicalDB/index.asp, respectively.

- 1,1-DCE oral SF changed from 0.6 to 0 milligrams per kilograms per day (mg/kg/day) (non-carcinogen)
- TCE oral SF changed from 0.11 to 0.4 mg/kg/day (0.013 mg/kg/day for California Environmental Protection Agency)
- PCE oral SF changed from 0.51 to 0.54 mg/kg/day

- VC oral slope factor changed from 1.8 to 0.75 mg/kg/day.

Recommendation: Incorporate revised toxicity values into the groundwater remedy for 1,1-DCE into groundwater remedy as appropriate.

Status: Ongoing.

Revised toxicity values for 1,1-DCE and TCE have been incorporated into the remedy to evaluate 10^{-4} cancer risk. These revisions suggest a reduction in ELCR at hot spot wells. This is due to EPA's decision to change DCE's status from a suspected carcinogen to a non-carcinogen.

Recommendation: Wah Chang to perform three-year evaluation on groundwater system and implement any necessary changes.

Status: Ongoing.

Three-year performance evaluations for the groundwater remedy at the Extraction Area, Fabrication Area, Solids Area, and Farm Ponds Area have been performed. EPA has provided comments and direction on the Fabrication Area (EPA 2006a, 2007b), Solids Area (EPA 2007c), and Farm Ponds Area (EPA 2007d). Extraction Area (EPA 2007e) is under review.

Since the last five-year review, in January 2003, GETS was implemented in the Main Plant. GETS performance is currently being evaluated; however, the following modifications were made to help the system progress towards fulfilling groundwater RAOs:

- The method of treatment of extracted groundwater has changed in four extraction wells in the Fabrication Area, from GAC to air stripping using the facilities cooling towers (CTs). This change is to help limit downtime associated with GAC maintenance and increase well yields associated with flow restrictions from GAC (EPA 2007). On March 17, 2006, EWs FW-2 and FW-3 were diverted to cooling tower CT-06, and FW-4 and FW-7 were diverted to cooling tower CT-02 (Figure 5-2).
- An electric submersible pump has replaced pneumatic pump in FW-2, in an effort to increase the well's ability for hydraulic capture and to accelerate concentration reductions of VOCs (Wah Chang 2006).

Monitored natural attenuation (MNA) in groundwater is ongoing in the Main Plant and the Solids and Farm Ponds Areas. VOCs appear to be degrading and/or are being retarded in these areas; however, the rate and the effectiveness at which natural attenuation is occurring is being evaluated.

Environmental evaluations in the Main Plant Area are ongoing, and data reviews are submitted periodically to EPA. Since the RI/FS was not intended to interfere with ongoing operations at the Wah Chang facility, unknown environmental conditions exist in many areas beneath active ponds, buildings, and structures. In order to assess the impact of these unevaluated areas on previous CERCLA actions, Wah Chang submits environmental evaluations and data reviews on a biennial basis to EPA to ensure that any data gaps identified can be addressed so that Superfund RAs will continue to be effective. Since the last five-year review and based on EPA comments, Wah Chang has amended the Environmental Evaluation Protocol to incorporate a new field protocol for testing soil PCBs. In 2004, Wah Chang began using a test kit to screen for PCB levels in the field during excavation. The CHLOR-N-SOIL™ test kit was used to determine if the PCB concentration of a soil sample was less than or greater than 50 ppm. Under the 2005 protocol, where concentrations are greater than 50 ppm, additional excavation to a maximum depth of 4 feet is required. PCB

contaminated soils > 1 ppm are subject to TSCA PCB disposal regulations, 40 CFR. 761.60 and the Oregon Hazardous Waste Management Rules for PCBs, OAR 340-110. PCB contaminated soils > 50 ppm require disposal as hazardous waste in an appropriate landfill.

In addition, Wah Chang proposed the following actions, which will be evaluated by EPA subsequent to this five-year review:

- Installing extraction well FW-8 to replace FW-6, which was never functional. The well will be placed within the groundwater hot spot near monitoring well PW-13. Installation and testing of this proposed well will be performed in a manner consistent with the Groundwater Test Well Work Plan (CH2M Hill 2007b).
- During drilling of the extraction well FW-8's borehole in October 2007, a hard, potentially metallic object was encountered at a depth of 11 feet bgs. Drill cuttings removed from a depth of 10 to 11 feet bgs displayed an oily sheen with a solvent-like odor. Laboratory analysis of a grab sample collected from a drum containing investigation derived waste (IDW) from this approximate depth indicated a TCA concentration of 1,420,000 μg/L, TCE concentration of 2,810 μg/L, and 1,1-DCE concentration of 23,600 μg/L (CH2M Hill 2007c). These TCA concentrations are believed to be greater than its solubility limit, and may be present as a non-aqueous phase liquid (NAPL). Due to the potential presence of NAPL and/or high concentrations of dissolved phase VOCs in groundwater, modification to the groundwater remedy in the Fabrication Area maybe necessary to achieve RAOs within the estimated 15-year time frame for cleanup. Wah Chang is conducting further investigation into the nature and extent of the contamination under an EPA-approved Revised Work Plan (CH2M Hill 2007c). Following this investigation, any remedial action in this area will be addressed by Wah Chang and EPA.
- A one-time sampling event in October 2007 of surface water from Murder and Truax Creeks and groundwater from wells that are adjacent to the creeks. This effort is being conducted to further evaluate the extent to which VOC contamination in groundwater is affecting surface water quality. The Work Plan for this effort is currently being prepared by Wah Chang.
- Wah Chang is further investigating the CCA SWMU in order to further define the nature and extent of historical TCA contamination in soils and groundwater in the Fabrication Area. Existing soil sample results collected between 1991 and 2005 suggest that there is a deep source of VOCs in soil. TCA was historically used to clean ingots and melting equipment, the level of which was further exacerbated by wash water. Fieldwork for this investigation was conducted in August 2007 in a manner consistent with the Work Plan for RFI No. 6, Former Crucible Cleaning Area (CONFO45BA02) (CH2M Hill 2007d,e). Results from this investigation will be reported by Wah Chang in the spring of 2008.
- Wah Chang, in cooperation with DEQ and the City of Albany, is evaluating if the outfall to Truax Creek can be eliminated and a new conveyance system and outfall to the Willamette can be constructed. A renewed NPDES permit for discharge of process water is currently being prepared by DEQ.

Sediment

PCB-contaminated soil in Truax Creek between BNRR and SPRR was remediated by removing sediment and replacing it with clean river run gravel in an effort to stabilize the creek bank. Confirmation sampling was requested by EPA to determine if newly deposited sediment in Truax Creek streambed resulting from winter flows will meet the performance standard for PCBs of 1 ppm. Wah Chang has performed confirmation sampling of PCBs in sediment from Truax Creek in winter 2007. Sampling was conducted in a manner consistent with the Truax Creek Sediment Remediation Operation and Maintenance Plan (CH2M Hill 1997c) and Sampling and Analysis Plan (SAP) (Wah Chang 2007b). Analytical results indicated that PCBs were not detected in sediment in Truax Creek.

Status of Any Other Prior Issues

None were identified.

8.3 OU3 – SURFACE AND SUBSURFACE SOIL

Protectiveness Statement from the Last Review

The remedy is protective in the short term, because contaminated soils have been removed from the Site and surface gamma exposure has been eliminated. However, in order for the remedy to remain protective in the long term, the SOW must be modified to implement the conditions of the ESD (decommissioning requirements implemented by Oregon Department of Health, property transfer requirements and requirements for in place management of contamination).

Status of Recommendations and Follow-up Actions Since the Last Review

Recommendation: Amend the SOW to incorporate requirements in the ESD for OU3. EPA and DEQ should conduct negotiations and Wah Chang to implement requirements.

Status: Incomplete. Action does not affect current level of protectiveness.

Status of Any Other Prior Issues

Institutional Controls for the Soil Amendment Area Operable Unit have been implemented, pursuant to a consent decree which was lodged in federal court in 2006, and are currently being implemented by the City of Millersburg. It is expected that additional soil remediation on the Main Plant will take place during Site decommissioning pursuant to Wah Chang's Oregon Radioactive Materials License and the EFSC Administrative Rules.

9. FIVE-YEAR REVIEW PROCESS

9.1 ADMINISTRATIVE COMPONENTS

The approach used to conduct this five-year review followed EPA's Comprehensive Five-Year Guidance (EPA 2001). The Five-Year Review effort was led by EPA Region 10 Remedial Project Manager, Mr. Ravi Sanga. Mr. Sanga was assisted by Ms Debra Sherbina, the EPA Community Involvement Coordinator (CIC); Ms Sheila Eckman, EPA Unit 3 Site Cleanup Manager; Ms Joan Shirley, EPA Assistant Regional Counsel; Mr. Timothy Brincefield, EPA Policy Advisor; Mr. Curt Black, EPA Risk Evaluation Unit Hydrogeologist; Mr. Geoff Brown, DEQ Project Manager; and Mr. Eric Roth, Parametrix Project Manager and Project Hydrogeologist. The Five-Year Review was conducted from May 1, 2007, to December 30, 2007.

9.2 COMMUNITY INVOLVEMENT DURING THE FIVE-YEAR REVIEW

During many years of Site study and response activities, EPA and Oregon DEQ have engaged in numerous attempts to reach out to community interests and solicit community involvement. However, there has been minimal community interest for this Site. For example, because it had never been used, the Albany library has returned the administrative record to the EPA; therefore, there were no community interviews conducted for this five-year review. However, a newspaper notice was placed in the Albany Herald on May 3, 2007, to announce the start of the five-year review (Appendix A). No public comments were received. Another newspaper notice will be placed in the Albany Herald upon completion and availability of this review.

9.3 STANDARDS REVIEW

The remedies selected in the OU1, OU2, and OU3 RODs are intended to be protective of human health and the environment and to comply with ARARs. The ARARs have been reviewed to identify any new or updated state or federal regulatory standards that might affect the protectiveness of the remedy. Applicable new or updated ARARs identified in the course of this five-year review are located in Section 8.2.

9.4 DOCUMENT AND DATA REVIEW

A list of relevant documents reviewed is given in Appendix B.

9.5 DATA REVIEW FOR OU1

On June 30, 1993, EPA issued a Certification of Completion for the Sludge Pond Operable Unit (OU1) Remedial Action to Wah Chang (EPA 1993). The remedial action for OU1 is considered complete (see Section 4 for details on the OU1 remedial action). As part of OU1, operation and maintenance (O&M) activities continue at the Finley Buttes Landfill monocell in Boardman, Oregon.

In accordance with the landfill's Solid Waste Disposal Permit, groundwater was monitored on a semi-annual basis for VOCs and metals between July 1991 and February 2006. Tables 4 and 5 present a summary of VOCs and total metals concentrations in groundwater from monitoring wells MW-4 and MW-5, respectively (Shaw 2006). Well MW-4 is hydraulically upgradient, and well MW-5 is hydraulically downgradient, of the monocell. Review of the

February 2006 results confirms that concentrations of trace metal results were below the health-based standards and that VOCs were not detected in groundwater samples (Tables 4 and 5).

9.6 DATA REVIEW FOR OU2

This section presents a summary of findings for the Groundwater and Sediment Operable Unit (OU2). Because the groundwater remedy was not fully in place during the previous five-year review cycle, a comprehensive review of the remedy for each of Wah Chang's remedial sectors is provided in this Five-Year Review Report. Remedial sectors include the Main Plant and Extraction, Fabrication, Solids, and Farm Ponds Areas. These remedial sectors are discussed separately, because of the nature and extent of contamination (linked to manufacturing process and waste management) and site hydrology (drainage features, groundwater flow divides, and direction of flow). Additional information regarding OU2 activities is provided in Section 5 of this report.

9.6.1 Main Plant: Groundwater Extraction and Treatment System (GETS)

This section provides a review of data and information summarized in the March 2005 to January 2007 bi-monthly progress reports of the Extraction and Fabrication Areas Groundwater Remedy Three-Year Evaluation (CH2M Hill 2006a, 2007a), and in documents listed in Appendix B.

Operation

- Bi-monthly reports completed by Wah Chang contained relevant and applicable information necessary to evaluate system operation, including evaluations of system downtime, operation, and maintenance activities (Appendix A). Status reports were provided to the EPA in a timely manner, typically by the first week of the second month after completion of activities.
- Wah Chang and the O&M Contractor provided trained personnel to satisfy operation requirements.

Maintenance

- Monthly operating logs completed by Wah Chang contained relevant and applicable information necessary to evaluate system maintenance.
- Wah Chang performed scheduled routine maintenance activities.
- Wah Chang responded to unscheduled, non-routine maintenance activities in a timely manner. The O&M Contractor reasonably communicated these activities to the EPA within reasonable time frames.

GCW Treatment System Performance Evaluation

Granular Activated Carbon (GAC)

Table 6 provides a summary of extraction well flow rates, influent/effluent water total VOC concentrations, and approximate GAC treatment system efficiencies. A review of this information is provided below.

- GAC is currently used to pre-treat extracted groundwater from:

  - Extraction Area wells EW-41 through EW-6
  - Fabrication Area well FW-5
- Extracted water is being effectively treated by carbon adsorption. In general, analytical results indicated that VOCs in effluent water are below ROD cleanup levels. In addition, extracted water is further treated by the second carbon unit and the plants central wastewater treatment system (CWTS).

Cooling Tower Air Stripping

- Cooling tower air-stripping is currently used to treat extracted water from:
  - FW-1; Diverted to cooling tower (CT) CT-04 on October 21, 2005.
  - FW-2 and FW-3; Diverted to CT-6 on March 17, 2006.
  - FW-4 and FW-7; Diverted to CT-2 on March 17, 2006.
- Conversion of selected wells to treatment using CT air-stripping has:
  - Provided beneficial reuse of groundwater in lieu of surface water as the make up of process water for the equipment cooling systems.
  - Increased groundwater extraction rates.
  - Increased the system's run time by eliminating temporary shutdowns associated with routine cartridge filter changes, GAC exchange, and maintenance of chlorination and sequestering equipment.
- Extracted water is likely being effectively treated by air stripping; however, its effectiveness cannot be confirmed by monitoring. This is due to the effluent and process water streams being combined in the CT during stripping. As such, extracted water (effluent) is diluted by the much larger volume of process water during the stripping process, and extracted water/process water is further treated in combined flow at the plant's CWTS. A theoretical review of treatability of CVOCs by the CT was conducted by Wah Chang prior to conversion (CH2M Hill 2006b). This review indicated that the CT would effectively volatize CVOCs.

Ammonia Recovery System (ARS)

For FW-5, groundwater is conveyed to the Ammonium Recovery System (ARS) to remove ammonia/ammonium prior to discharge to the CWTS. The efficiency at which groundwater is treated by the ARS, and the resulting ammonia concentrations, have not been determined because sampling of the system has not been required.

Central Wastewater Treatment System (CWTS)

CWTS is currently used for final treatment of water extracted from EW-1 through EW-6 and FW-1 through FW-7. Treated water is discharged to Truax Creek under the Site's federal NPDES permit OR000112 and Oregon NPDES permit 100522. Discharged water under the state and federal permits must meet ROD cleanup levels displayed in Table 3. Review of the discharge monitoring reports and discussion with DEQ personnel indicate that approximately 14 violations occurred by Wah Chang in the last 10 years (personal communications from Mr. Tim McFetridge, DEQ to Mr. Eric Roth, Parametrix). These were for Class II Notice of Noncompliance (NON) violations for fluoride, nickel, cyanide, radium, MIBK, and total suspended solids (TSS). These resulted in four civil penalties for

NON violations, one civil penalty for cyanide violation, and one civil penalty for fish kill. No violations for VOCs were indicated.

DEQ is currently in the process of renewing NPDES OR000112. The permit will likely go out for public comment in 2007.

9.6.2 Main Plant: Extraction Area

Extraction well and monitoring well locations for the Extraction Area are displayed on Figure 11. The figure also displays the South Extraction Area (SEA), the Feed Makeup Area, and other relevant Site features. Groundwater contamination in the Feed Makeup Area is characterized by the presence of metals, radionuclides, and low (acidic) pH levels. The Feed Makeup Area GETS is composed of extraction wells EW-1 through EW-3. The objective of the Feed Makeup Area GETS is to reduce the concentration of facility-related contaminants in groundwater through groundwater extraction and treatment.

Groundwater contamination in the SEA is characterized by the presence of chlorinated solvents, which include TCE and DCE. The SEA GETS is composed of extraction wells EW-4 through EW-6. The objectives of the SEA GETS are to prevent the off-site migration of VOCs above drinking water standards and to remove VOC mass.

Mass Removal

As of February 28, 2007, 7.9 pounds of Total VOCs, 107,002 pounds of total dissolved solids (TDS), and 157 pounds of fluoride have been removed by GETS in the Extraction Area 3 (Wah Chang 2007a).

Figure 12 displays a time series plot for total VOC mass removed at extraction wells EW-4 through EW-6 from April 2002 to January 2007. The figure indicates that extraction well EW-4 is removing approximately 0.1 pounds of Total VOCs per month, while extraction wells EW-5 and EW-6 are removing less than 0.04 pounds per month. The figures indicate that a majority of the VOC mass being removed is by EW-4.

GETS Hydraulic Containment and Capture

Figure 11 shows the October 2006 water level contour map for the Extraction Area (CH2M Hill 2007a). The map displays estimated direction of groundwater flow and hydraulic gradient. Water level contours were constructed by estimating lines of equal elevation (equipotentials) at 2-foot contour intervals, with the direction of groundwater flow normal to the contour lines.

Figure 11 indicates that groundwater flows west southwest across the Extraction Area to Second Lake or Truax Creek. Ponds 1B and 2 provide local recharge to groundwater and to surface water in Truax Creek. The figure suggests that extraction wells EW-1 through EW-3 provide localized hydraulic capture in the Feed Makeup Area, and that extraction wells EW-4 through EW-6 provide localized capture in the SEA. The extent to which these extraction wells effectively control groundwater movement is uncertain due to the limited number of observation wells within the extraction area zone of influence.

Groundwater Monitoring

The groundwater monitoring network in the Extraction Area is composed of 15 monitoring wells (see Figure 11).

Feed Makeup Area

Of the 15 wells in the Extraction Area, nine are in the Feed Makeup Area. Of these nine wells:

- Five wells were installed in areas where groundwater concentrations exceeded the $1x10^{-4}$ risk and are considered hot spot wells: PW-28A and B, PW-51A, PW-52A, and PW-53A.
- One well, PW-27A, was installed in an area where groundwater concentrations were below the $1x10^{-4}$ risk, and is considered a non-hot spot well.
- Three wells were installed adjacent to Second Lake and are considered perimeter wells: PW-22A, PW-23A, and PW-24A.

Table 7 displays a summary of ammonia, fluoride, total metals, total dissolved solids (TDS), and radium-226 and 228 concentrations in groundwater from hotspot, non-hot spot, and perimeter monitoring wells. The table indicates that:

During the year 2000 baseline conditions (prior to GETS start):

- One or more of the perimeter wells exceeded ROD cleanup levels for ammonia, arsenic, fluoride, manganese, and radium.
- Three or more of the hot spot wells exceeded ROD cleanup levels for ammonia, arsenic, fluoride, manganese, nickel, and radium.
- Groundwater pH ranged from 0.9 to 6.9 pH units and, in general, is not in the range of natural waters (pH 5 to 9).

During the fall 2006 event (approximately 3 years after GETS start-up):

- Two of the perimeter wells exceeded ROD cleanup levels for fluoride, and three of the perimeter wells exceeded ROD cleanup levels for manganese. Perimeter wells did not exceed their respective ROD cleanup levels for any other COCs.
- Four of the hot spot wells exceeded ROD cleanup levels for fluoride, and manganese. Hot spot wells did not exceed their respective ROD cleanup levels for any other COCs.
- Groundwater pH ranged from 1.4 to 7 pH units, and in general is not in the range of natural water (pH 5 to 9).

Review of the groundwater quality data for the Feed Makeup Area suggests that GETS has not been effective at reducing water pH and concentrations of inorganic constituents. Wah Chang is evaluating the use of groundwater flushing with a weak basic solution (lime) as a remedial alternative in the Feed Makeup Area.

South Extraction Area (SEA)

Of the 15 wells in the Extraction Area, six wells are in the SEA. Of these six wells:

- Two wells were installed in the area where groundwater concentrations were below the 1x10-4 risk and are considered non-hot spot wells: PW-47A and PW-48A.
- Four wells were installed adjacent to Second Lake and are considered perimeter wells: PW-25A, PW-26A, PW-49A, and PW-57A.

Table 8 provides a summary of DCA, 1,1-DCE, cis-1,2-DCE, TCA, TCE, and PCE in groundwater from non-hotspot and perimeter monitoring wells. The table indicates that during the year 2000 baseline conditions (prior to GETS start):

- Only non-hot spot well PW-47A exceed ROD cleanup levels for DCE, TCE, and PCE.
- All perimeter wells exceed the ROD cleanup level for TCE. One perimeter well, PW-57A, also exceeds the ROD cleanup level for DCE.
- TCA, DCA, and cis-1,2-DCE concentrations are below their respective ROD cleanup levels in all non-hot spot and perimeter wells.

During the fall 2006 event (approximately 3 years after GETS start-up):

- Only non-hot spot well PW-47A exceeded ROD cleanup levels for DCE and TCE. Non-hot spot wells did not exceed their respective ROD cleanup levels for any other COCs.
- All perimeter wells except PW-57A had VOC concentrations below their respective ROD cleanup levels.

Review of groundwater quality data suggest that DCE and TCE are the only VOCs that are persistent in groundwater in the SEA. Figures 13 and 14 display DCE and TCE concentration trends over time, respectively, for non-hot spot and perimeter wells. The figures indicate that DCE and TCE concentrations in groundwater are generally decreasing since the implementation of GETS, except for non-hot spot well PW-47A. Water quality data in this well suggests that GETS has not been effective in reducing DCE and PCE concentrations. As such, Wah Chang is evaluating the use of enhanced bioremediation as a remedial alternative in the SEA.

9.6.3 Main Plant: Fabrication Area

Extraction and monitoring well locations are displayed on Figure 15. Groundwater contamination in the Fabrication Area is characterized by the presence of chlorinated solvents, which primarily include DCE, TCA, TCE, PCE, and VC. In the Fabrication Area, GETS is composed of extraction wells FW-1 through FW-5 and FW-7. The main objectives of GETS in the Fabrication Area are to remove VOC mass, and reduce VOCs concentrations to below ROD cleanup levels.

Mass Removal

Figure 16 displays a time series plot for total VOC mass removed at extraction wells FW-1 through FW-5 and FW-7, from April 2001 to January 2007. The figure indicates that VOC mass recovery rates have varied widely, ranging from 2.5 to 12 pounds per month. Approximately 40 percent of the total mass removed is from FW-1, with only 2 pounds yielded from extraction well FW-7 (CH2M Hill 2005). Mass recovery rates in wells FW-2, FW-3 and FW-4 have generally declined.

As of February 28, 2007, 439 pounds of total VOCs, and 20,014 pounds of ammonia have been removed by GETS in the Fabrications Area (Wah Chang 2007a).

GETS Hydraulic Containment and Capture

Figure 15 shows the October 2006 water level contour map for the Fabrication Area (CH2M Hill 2007f). The map displays the estimated direction of groundwater flow and gradient.

Water level contours were constructed by estimating lines of equal elevation (equipotentials) at 1.5-foot contour intervals, with the inferred direction of groundwater flow normal to the equipotential lines.

Figure 15 indicates that groundwater flow in the southern portion of the Fabrication Area is to the west-southwest towards Truax Creek; and in the northern portion of the Fabrication Area to the north-northwest towards Murder Creek. This difference in the direction of groundwater flow is a result of a groundwater flow divide between these two drainages. In the southern portion of the Fabrication Area, the Cooling Water Pond provides a localized source of recharge to groundwater and the resulting radial direction of groundwater flow. Recharge from the Cooling Water Ponds creates a groundwater flow divide between extraction wells FW-1, FW-4 and FW-7 in the Arc Melting subarea, and extraction wells FW-2, FW-3 and FW-5 in the Acid Sump and Ammonia Sulfate Storage subareas.

Extraction wells FW-1, FW-4 and FW-7 appear to locally affect the direction of groundwater flow. However, extraction wells FW-2, FW-3 and FW-5 appear to be limited in the extent to which they are altering the direction of groundwater flow. This is most notable in extraction well FW-2, which does not display any deflection of groundwater equipotential lines, suggesting limited hydraulic capture. The extent to which extraction wells are controlling groundwater flow and movement is also limited by the number of observation wells in the extraction well's zone of influence.

Figure 15 indicates that no or limited hydraulic controls of groundwater flow or movement are in place in the northern portion of the Fabrication Area (north of the apparent groundwater flow divide).

Groundwater Monitoring

The groundwater monitoring network in the Fabrication Area is composed of 44 monitoring wells (see Figure 15).

Hot Spot Well Area Wells

Of the 44 wells, 19 wells are installed in an area where groundwater concentrations were above the $1x10^{-4}$ risk and are considered hot spot wells (CH2M Hill 2007f). These include the following monitoring wells:

- PW-11, PW-12, and PW-13 are located in the vicinity of Acid Sump and Fabrication Buildings.
- PW-01A, PW-03A, PW-42, PW-71A, PW-83A, PW-85A, PW-86A, and MW-03A are located in the vicinity of the Ammonium Sulfate Storage Building.
- PW-30A, PW-45A, PW-68A, PW-69A, PW-73A, MW-01A, MW-02A, and MW-4A are located in the vicinity of the Arc Melting and Power Metallurgy Buildings.

Table 9 displays a summary of VOC concentrations in groundwater from hot spot wells. The table indicates that DCE, TCA, TCE, PCE and VC exceeded their respective ROD cleanup levels in two or more hot spot wells during the fall Year 2000 baseline event.

Figures 17–30 display DCE, TCA, TCE, PCE and VC concentrations in groundwater, respectively, over time for notable hot spot wells in the Fabrication Area. In general, the figures indicate that contaminant concentrations have decreased in a majority of hot spot wells since the implementation of GETS. However, DCE, TCE and VC concentrations above their respective ROD cleanup levels persist in a number of hot spot wells. Most noteworthy are the following hot spot wells:

- PW-12 and PW-13, in the vicinity of the Acid Sump Building Area (see Figures 17 through 18, and 20);
- PW-01, PW-42A, PW-86A, in the vicinity of the Ammonium Sulfate Storage Building Area (see Figures 22, 24, and 26); and
- PW-45A and PW-73A, in the vicinity of the Arc Melting Building Area (see Figures 27, 29, and 30).

Time trend projections presented by Wah Chang in the 3-Year Review of Fabrication Area Groundwater Remedy (CH2M Hill 2005, 2006a, 2007f) suggest that a number of hot spot wells will meet ROD cleanup levels within the 15-year time frame outlined in the ROD (EPA 1994) (see Section 5.2.3). However, EPA does not concur with these projections because it is premature at this time for Wah Chang to evaluate the effects of sorbed contaminants (COCs adsorbed to particulate matter) on cleanup time or potential concentration rebound from pump and treat (EPA 2007). Because of persistent concentrations of VOCs in noteworthy hot spot wells, Wah Chang is evaluating the use of enhanced bioremediation in the Fabrication Area.

Groundwater samples for 1,4-Dioxane analysis were collected in the Fabrication Area of the Main Plant from extraction wells FW-1, FW-3, and FW-4 and monitoring well PW-69A during the spring 2006 semiannual monitoring event (CH2M Hill 2006a). Laboratory analyses of the 1,4-Dioxane samples revealed concentrations between 5.3 and 23.9 μg/L, calculated for the Site-specific industrial worker exposure pathway. A preliminary remediation goal (PRG) of 26 μg/L was calculated using EPA Region 9 PRGs, which are appropriate for an industrial-based scenario (CH2M Hill 2006a). Provided that groundwater remains unavailable for potable use through ICs, the concentrations of 1,4-Dioxane found in groundwater do not pose a risk for human health. The EPA has not yet established a federal drinking water standard or MCL for 1,4-Dioxane.

Table 10 displays a summary of ammonia, fluoride and nitrate in hot spot wells. The table indicates that hot spot wells PW-01, PW-03A, PW-11A, and PW-13A exceeded the ROD cleanup levels for these constituents. The table also suggests that there is no apparent trend in constituent concentrations over time.

Non-Hot Spot Area Wells

Of the 44 wells, 15 wells are installed in areas where groundwater concentrations were below the $1x10^{-4}$ risk and are considered non-hot spot wells:

- PW-10, PW-14, PW-19A, PW-70A, PW-80A, PW-81A, PW-82A, located in the vicinity of the Acid Sump and Fabrications Buildings.
- PW-84A, PW-87A, PW-92A, located in the vicinity of the Ammonia Sulfate Storage Building.
- PW-46A, PW-72A, PW-74B, PW-91A, located in the Arc Melting and Power Metallurgy Buildings.
- PW-31A, located northeast corner of the Site (hydraulically upgradient).

Table 9 displays a summary of VOC concentrations in non-hot spot wells. The table indicates that DCE, TCA, and TCE exceeded their respective ROD cleanup levels in one or more non-hot spot wells during the fall Year 2000 baseline event. Most notable are non-hot spot wells PW-10, and PW-46A.

Figures 31 through 33 display DCE, TCA, and TCE concentrations over time for notable non-hot spot wells in the Fabrication Area. In general, the figures indicate that contaminant concentrations have decreased in non-hot spot wells since the implementation of GETS. However, concentrations of DCE and TCE still persist above their respective ROD cleanup levels in wells PW-10A and PW-46A.

Table 10 displays a summary of ammonia, fluoride and nitrate in non-hot spot wells. The table indicates that exceedances of the ROD cleanup levels for these constituents have been observed in non-hot spot wells PW-10, PW-03A, PW-11A, and PW-13A. The table also suggests that there is no apparent trend in concentrations of these constituents over time.

Perimeter Wells

Northern Perimeter Wells - Murder Creek

Of the 44 wells in the Fabrication Area, six wells are installed in the area adjacent to Murder Creek:

- PW-77A (considered a hot spot well)
- PW-15AR, PW-16A, PW-76A, PW-78A, and PW-79 (considered non-hot spot wells)

Table 9 displays a summary of VOC concentrations in northern perimeter wells. The table indicates that DCE exceeded its respective ROD cleanup levels in three of the six northern perimeter wells during the fall Year 2000 baseline event. No other VOCs were detected above ROD cleanup levels in northern perimeter wells, except TCE and VC in well PW-77A. The table indicates that well PW-77A has VC concentrations that are increasing over time and TCE concentrations that are just below its respective cleanup level.

Figure 34 displays DCE concentrations over time for notable northern perimeter wells. In general, the figure indicates that DCE concentrations have increased or remained consistent in northern perimeter wells since the implementation of GETS.

Table 10 displays a summary of ammonia, fluoride and nitrate in perimeter wells. The table indicates that no northern perimeter wells exceeded ROD cleanup levels during the Year 2000 baseline event. However, the table indicates that well PW-79A exceeded fluoride and nitrate ROD cleanup levels after the implementation of GETS.

Western Perimeter Wells – Truax Creek

Of the 44 wells in the Fabrication Area, four wells are installed in an area adjacent to Truax Creeks:

- PW-20A, PW-75A, PW-88A, and PW-89A. These wells are considered non-hot spot wells.

Table 9 displays a summary of VOC concentrations in western perimeter wells. The table indicates that DCE, TCA and TCE exceeded their respective ROD cleanup levels in one or more of the western perimeter wells during the fall Year 2000 baseline event. No other VOCs were detected above ROD cleanup levels in western perimeter wells.

Figure 35 displays DCE concentrations over time for relevant western perimeter wells. In general, the figure indicates that DCE concentrations have decreased in western perimeter wells since the implementation of GETS.

Table 10 displays a summary of ammonia, fluoride and nitrate in perimeter wells. The table indicates that no western perimeter wells exceeded ROD cleanup levels during the Year 2000 baseline event. However the table indicates that well PW-79A exceeded fluoride and nitrate ROD cleanup levels after the implementation of GETS.

Surface Water

Table 11 displays a summary of COCs in surface water samples collected adjacent to perimeter wells along Murder Creek (MC) and Truax Creek (TC) during the fall 2006 sampling event. For purposes of comparison, surface water samples were collected from the creeks during the same sampling event in which groundwater was collected from perimeter wells (CH2M Hill 2007f). In addition, the table displays ROD cleanup criteria based on ambient water quality criteria (AWQCs) for human health, water and fish consumption (EPA 1994; CH2M Hill 2007f).

Murder Creek

Surface water samples MC-1 through MC-4 were collected in Murder Creek from locations adjacent to northern perimeter wells PW-79A, PW-78A, PW-77A, and PW-76A, respectively. Table 11 indicates that:

- DCE and TCE were detected in surface water sample MC-1, which was collected in the vicinity of well PW-79A. DCE concentrations were above the AWQC. DCE, TCA, and TCE were also detected in groundwater from perimeter wells PW-16A and PW-79A (see Table 9).
- DCE was detected in surface water sample MC-3, which was collected in the vicinity of PW-77A. The DCE concentration was above its AWQC. DCE was also detected in groundwater from PW-77A.
- Detected concentrations of fluoride and nitrates in surface water were below their respective AWQCs.

Truax Creek

Surface water samples TC-1 through TC-4 were collected in Truax Creek from locations adjacent to western perimeter wells PW-90A (abandoned), PW-89A, PW-88A, and PW-75A. Table 8 indicates that:

- TCE, VC, cis-1,2-DCE, DCA, and ammonia were detected in Truax Creek surface water samples TC-2 and TC-3, (opposite of PW-89A and PW-88A) during the fall Year 2006 event. VC concentrations were above its AWQC.

Fabrication Area Isoconcentration Maps

Isoconcentration maps were used to further evaluate the distribution of DCE, TCA, and TCE prior to the implementation of GETS (Year 2000) and after 3.5 years of GETS operation (Year 2006). Isoconcentration maps display COCs concentrations in groundwater from extraction, hot spot, non-hot spot, and perimeter wells, and surface water quality data from Murder and Truax Creeks. The maps were prepared by contouring lines of equal concentrations at 1x, 10x, and 100x the ROD cleanup levels for DCE, TCA, and TCE. In addition, the maps display water level elevation contours and inferred direction of flow for the fall of Year 2000.

Figure 36 shows DCE concentrations in groundwater with isoconcentration contour lines of 7, 70, and 700 µg/L. The extent of the DCE groundwater plume is displayed by green contour lines for Year 2000 and by red contour lines for Year 2006. The figure indicates that an appreciable reduction in the size of the DCE plume has occurred since the implementation of GETS. The figure also indicates that in general DCE concentrations have decreased. Most notable are hot spot wells PW-12 and PW-13, which display Year 2006 DCE concentrations below the 700 µg/L contour line. However, appreciable concentrations of DCE remain in northern perimeter wells PW-77 through PW-79, with detected concentration of DCE observed in surface water from Murder Creek. Detected concentrations of DCE are also observed in surface water samples from Truax Creek.

Figure 37 shows TCA concentrations in groundwater with isoconcentration contour lines of 200 and 2,000 µg/L. The extent of the TCA groundwater plume is displayed by green contour lines for Year 2000 and by red contour lines for Year 2006. The figure indicates that an appreciable reduction in the size of the TCA plume has occurred since the implementation of GETS. The figure also indicates that in general TCA concentrations have decreased. Most notable are hot spot wells PW-12, and PW-69A, which display Year 2006 TCA concentrations below the 2,000 µg/L contour line.

Figure 38 shows TCE concentrations in groundwater with isoconcentration contour lines of 5 and 50 µg/L. The extent of the TCE groundwater plume is displayed by green contour lines for Year 2000 and by red contour lines for Year 2006. The figure indicates that an appreciable reduction in the size of the TCE plume has occurred since the implementation of GETS. The figure also indicates that in general TCE concentrations have decreased. Most notable are hot spot wells PW-12 and PW-42A, which display Year 2006 DCE concentrations below the 50 µg/L contour line. However, as with DCE appreciable concentrations of TCE are also observed in surface water samples from Truax Creek.

Review of isoconcentration maps suggest that the magnitude and extent of VOC contamination in the Fabrication Area has been reduced since the implementation of GETS. However, GETS appears to be limited in its effectiveness to capture VOCs in the vicinity of FW-2, in areas northwest of FW-3, and in areas south of FW-4.

9.6.4 Main Plant: Monitored Natural Attenuation

As part of the remedy, groundwater will be reduced to the ROD cleanup levels at and outside the compliance points (plant boundary) through groundwater remediation and natural attenuation (EPA 1996). Review of water quality data presented in the Fabrication Area Three-Year Review of the Groundwater Remedy (CH2M Hill 2005, 2006a) and Extraction Area Three-Year Review of Groundwater Remedy (CH2M Hill 2007a) suggests that the conditions that drive the reductive dechlorination transformation pathway may be present; but EPA believes that these conditions are variable throughout the Site. As such, the degree to which transformation may occur is variable and compound-specific. Most noted are the conditions necessary to reductively dechlorinate TCE.

At the northern perimeter of the Fabrication Area, geochemical data indicates that anoxic-to-anaerobic conditions may be favorable for abiotic biodegradation of TCA. This is observed through increasing concentrations of DCA, which correlate with decreasing concentrations of TCA. The presence of DCE, cis 1,2-DCE, and VC along flowpaths downgradient from source areas indicates that biodegradation of TCA and/or PCE and TCE is occurring. However, complete biodegradation of DCE, TCE, and their byproducts may be limited due to unfavorable redox conditions necessary to support full reductive dechlorination. Furthermore,

EPA recognizes that reduction of DCE, TCE and VC to non-chlorinated products may be limited. This may be most relevant in the Fabrication Area, where elevated concentrations of DCE, TCE and VC persist above the ROD cleanup levels.

EPA expects that MNA will likely continue to be evaluated as a long-term remedial action to meet RAOs. Additional data will be collected and evaluated as a follow-up to this five-year review in order to continue to track the ability of MNA to meet RAOs.

9.6.5 Main Plant: Comparison of Risk-Based Remedial Action Target Areas

To help evaluate the ability of the groundwater remedy to meet RAOs, a comparison was made between the Year 2000 (baseline) and Year 2006 (3.5 years after the implementation of GETS) $1x10^{-4}$ ELCRs. Both Year 2000 and 2006 ELCRs were determined using methodologies outlined in the Baseline Risk Assessment (CH2M Hill 1993) and in the Fabrication Area Addendum to Three-Year Groundwater Remedy Evaluation (CH2M Hill 2006a). The range of risk was calculated using reasonable maximum exposure assumptions. Groundwater contaminants detected most frequently that account for the majority of potential carcinogenic risk include DCE, TCA, TCE, PCE, and VC. The Year 2006 ELCR incorporates the most recent analytical data and changes in toxicity slope factors for these constituents (Section 8.2). The most noted change was the change in status for DCE from a suspected carcinogen to a non-carcinogen.

Figure 39 displays 2000 and 2006 $1x10^{-4}$ ELCRs for the Extraction Area. The figure indicates a sharp reduction in the area that defines the $1x10^{-4}$ ELCR from Year 2000 to Year 2006.

Figure 40 displays Year 2000 and Year 2006 $1x10^{-4}$ ELCRs for the Fabrication Area. The figure indicates a sharp reduction in the area that defines the 1x10-4 ELCR from Year 2000 to Year 2006.

Reduction in size of the area that defines the $1x10^{-4}$ ELCR in both the Extraction and Fabrication Areas is due to the change in DCE status and to the reduction in CVOC concentrations in hot spot areas. The comparison suggests that groundwater remedy is progressing towards meeting applicable groundwater RAOs.

9.6.6 Solids Area

The groundwater monitoring network in the Solids Area is composed of 17 monitoring wells (see Figure 41). Of these 17 wells:

- Eight wells are screened in Willamette Silt (WS): PW-07A, PW-09A, PWA-1, PWB-1, PWC-1, PWF-1, PW-17B, and PW-18B.
- Four wells are screened in the Linn Gravels (LS): PWA-2, PWB-2, PWD-2, and PWE-1.
- Five wells are screened in the Blue Clay (BC): PWB-3, PWC-2, PWD-2, PWE-2, and PWF-2.

Groundwater Flow

Figure 41 displays a water level elevation contour map for September 2002. The figure indicates that groundwater flows in an east-southeast direction across the Solids Area to Truax Creek and, ultimately, to the Willamette River. The figure indicates that a relatively steep hydraulic gradient exists around the former LRSP and Schmidt Lake, but it becomes broader and more uniform in the western portion of the Solids Area.

Groundwater Quality

Groundwater sampling and analysis completed between 1989 and 1991, in conjunction with the RI/FS activities, indicated the presence of contaminated groundwater underlying the Solids Area. To determine if these constituents posed a potential hazard to human health and the environment, a baseline risk assessment and environmental evaluations were completed in 1993 (CH2M Hill 1993). Potential human hazards, quantified as excess lifetime cancer risk (ELCR) assuming ingestion of groundwater by an industrial worker, ranged from 7.0×10^{-8} to 2.0×10^{-4}, with arsenic and 1,1-dichloroethene accounting for a majority of the risk. Potential human health hazards quantified as non-cancer risks varied from 1.1 to 16.0 (unit less) with manganese accounting for a majority of the non-cancer risk.

Other constituents detected in groundwater at concentrations above the National Primary Drinking Water maximum contaminant levels (MCLs) include nitrate, fluoride, barium, beryllium, cadmium, chromium, selenium, trichloroethene, and radium-226. In addition, chloride, sulfate, and total dissolved solids (TDS) were observed at concentrations above Secondary Drinking Water Standards.

The primary groundwater contaminant source in the Solids Area was lime solids stored in the LRSP and Schmidt Lake. A three-year groundwater monitoring program was implemented in March 2000 (CH2M Hill 1999) to confirm the effectiveness of the removal and to determine if groundwater quality performance standards could be achieved within the 15-year time frame specified in the Groundwater and Sediments ROD.

Manganese concentrations above the 0.5 mg/L ROD standard were detected at all 17 monitoring well locations during each of the four annual monitoring events. Fluoride and nitrate concentrations above ROD standards were also observed, but less frequently, with 6 of 17 wells exhibiting fluoride concentrations above the 2 mg/L ROD standard, and 3 of 17 wells showing nitrate concentrations above the 10 mg/L ROD standard.

Table 12 displays a summary of COC concentrations in groundwater from monitoring wells in the Solids Area (CH2M Hill 2007g). Manganese concentrations detected between the November 2003 and September 2006 monitoring period ranged from 0.12 to 24.6 mg/L, with the highest levels observed at MW-17B. Although manganese levels remain elevated above the 0.05 mg/L ROD standard, concentrations have continued to decline at a majority of the monitoring well locations.

Two wells exceeded the ROD standard for fluoride, and three wells exceeded the ROD standard for nitrate.

9.6.7 Farm Ponds

The groundwater monitoring network in the Farm Ponds Area is composed of four monitoring wells (see Figure 42). Of these four wells:

- Three wells are screened in Willamette Silt: PW-40S, SS, and WS.
- One well is screened in the Linn Gravels: PW-40A.

Groundwater Flow

Figure 42 displays a water level elevation contour map for September 2002. The figure indicates that groundwater flow direction is across the Farm Ponds Area, from east to west, under a uniform hydraulic gradient estimated at 0.02 feet per foot.

Groundwater Quality

Table 13 displays a summary of VOC concentrations in groundwater from monitoring wells in the Farm Ponds Area (CH2M Hill 2007h). Groundwater monitoring performed through September 2002, supplemented by monitoring conducted between September 2003 and September 2006, indicates that removal of lime solids from the Farm Ponds site has reduced groundwater VOC concentrations in the Farm Ponds area. However, rising PCE concentrations, accompanied by increasing concentrations of TCE and cis 1,2-DCE, are a concern to EPA as potential indicators that source material may still be present in the vicinity of the Farm Ponds area and that reductive dechlorination is limited.

9.6.8 Environmental Evaluations of Uninvestigated Areas

Uninvestigated areas require ongoing evaluation in order to assess the risk to human health as well as effects on the groundwater remedy. The 2003 to 2005 Biennial Environmental Evaluation Report (CH2M Hill 2006c) indicates that 98 excavations were conducted in previously uninvestigated areas during this reporting period. Soil from these excavations was field-screened for potential contamination, with positive detection samples being analyzed for toxicity characteristic leaching potential (TCLP) metals, VOCs, and SVOCs. Review of the test results suggests that:

- COC concentrations were below soil threshold values; or
- Contaminated soil was not in contact with the water table; or
- COCs observed in soil were not observed in groundwater from downgradient monitoring wells.

EPA does not believe, at the time of this review, that VOC contaminated soil in uninvestigated areas would call in to question the protectiveness of the groundwater remedy.

PCBs

Total PCB concentrations in excess of the TSCA limit of 50 milligrams per kilogram (mg/kg) disposal requirement and EPA Region IX soil PRG for dermal contact of 44 mg/kg have been identified in surface and subsurface soils at the Site. The most significant identified PCB impacts are in the vicinity of the Emergency Services Building (see Figure 10). As part of the Phase 2 Remedial Investigation activities conducted in 1991, contaminated soil was observed in borings located due east of this (CH2M Hill 1993). The investigation identified residue oil containing 5.7 percent PCBs (Arochlor 1248) floating on the water table at an approximate depth of 13 feet bgs. Based on this result, additional fieldwork was conducted to determine the nature and extent of contamination (CH2M Hill 1993). These activities consisted of sampling and analyzing soil and groundwater from 19 boreholes and groundwater from three monitoring wells (PW-45A, PW-46A, and PW-30A). This field effort indicated that PCB impacts to shallow soil and groundwater were limited.

Ten confirmation soil samples were collected from the sidewalls of the excavation and analyzed for PCBs. Of the 10 soil samples collected, only one exceeded the 5 ppm screening criteria for PCB disposal. The sample result was 250 ppm and was observed to be located in a smear zone. Discolored soil was observed in the upper 2 feet of the excavation and was observed 11 to 13 feet bgs at the bottom of the excavation. Bottom samples of the excavation, where discolored soil was observed (11-13 feet), were not collected (CH2M Hill 2006).

Remedial activities were conducted by Wah Chang, with EPA oversight, in November 1992 (CH2M Hill 2006). Remedial activities included the removal of contaminated soil from an approximately 30 foot-by 30-foot excavation area. Excavation depths ranged from 3 feet bgs

to the top of the water table at approximately 13 feet bgs. Approximately 200 cy of soil were removed (CH2M Hill 2006). All soils removed with PCB concentrations of 50 parts mg/kg or greater were managed as TSCA waste. The excavation was backfilled in November 1992 with approximately 280 tons of crushed rock and covered with asphalt.

The 2003-2005 Biennial Evaluation Report indicated that PCB concentrations in soil from a trench excavation in the vicinity of the Emergency Services Building Area exceeded 150 mg/kg. Observation along the trench sidewall indicated a continuous layer of dark stained soil approximately 2 feet bgs. These observations are consistent with 1992 observations. Analytical results from the base of the trench indicated that PCB concentrations were below the TSCA limit of 50 mg/kg.

In general, available information does not show that PCB contamination poses a concern to human health and the environment because direct exposure to contaminated soil is thought to be limited by a protective cap (concrete or asphalt). Based on data from Wah Chang's ongoing environmental evaluations of uninvestigated areas, the groundwater remedy is not likely to be adversely affected by PCB contamination because: PCB concentrations greater than 50 mg/kg have not been found to be in contact with groundwater; PCBs are relatively immobile and not readily leached; and the underlying silt and fill material has low permeability. However concentrations of PCBs left behind during environmental excavations of uninvestigated areas under CERCLA require ongoing evaluation in order to assess risk to human health as well as effect to the groundwater remedy (Section 7.2). All soils removed that are >50 ppm should be managed as TSCA waste. Soils contaminated with PCBs >1 ppm < 50 ppm should be sent to an appropriate landfill for low level PCB waste, per TSCA PCB Disposal Regulations, 40 CFR 761.60.

9.7 OU3

The RD/RA Status report (Wah Chang 1999) noted that unexcavated contaminated material remained on Site and identified a "Sand Unloading Area Management Boundary". A recently erected Wah Chang building, the CoGen building, in the vicinity of this area was built on top of the existing asphalt without excavation of the contamination underneath the asphalt and with no digging or sampling prior to construction. Gamma surveys were performed to meet the ROD gamma radiation cleanup criteria; however, the ROD also required demonstration that construction over residual contamination will not result in radon concentrations in air above 4 pCi/L indoors. This demonstration did not occur for the CoGen Building and therefore an assessment for radon is needed in this building (Section 9.7).

9.8 SITE INSPECTION

Site inspections were conducted by EPA on April 3, 2007 and September 18, 2007. The purpose of the inspections was to review the implementation and assess the protectiveness of the remedy, including the presence of fencing to restrict access and to prevent unauthorized access to treatment systems. A Site Inspection Checklist is provided in Appendix C. Wah Chang implements numerous on-site access and use restrictions as part of Site operations. The Site is fenced and access is controlled. The groundwater treatment systems are all installed in sheds for protection. The shed floors are lined to prevent loss of contaminated water in case of system breach. Wells are flush mounted or protected by bollards. No issues were identified.

The Soil Amendment Area is still a grassy field, with no evidence of planned construction, although institutional controls are in place that would require radon-resistant construction if buildings are constructed in this area.

9.9 INSTITUTIONAL CONTROL REVIEW

Institutional controls for Wah Chang consist of deed restrictions and restrictive covenants for the main facility and adjacent properties and are further described in Section 5.2.8. All original deed restrictions, easements and restrictive covenants were reviewed by EPA for all site and non-site ICs. With the exception of the Co-Gen building (Section 9.7), the ICs appear to be functioning as intended in the ROD. A Title Search to certify that all ICs are in place as intended has been started but has not been completed. A title search is being conducted by EPA in order to determine whether deed restrictions are still in place. As part of the interviews with Wah Chang's environmental manager, status of the institutional controls were assessed. The site inspection verified that the fence surrounding the Farm Ponds area still acted as an appropriate engineering control and that the Soil Amendment Area is still undeveloped.

9.10 INTERVIEWS

As part of this five-year review, interviews were conducted with Mr. Lee Weber, Wah Chang's Environmental Manager.

10. TECHNICAL ASSESSMENT

The RAs as described in the three RODs for the Site have been implemented and are functioning as designed. The Site achieved construction completion status in September 2002.

10.1 TECHNICAL ASSESSMENT OF OU1

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

The remedy is functioning as intended by the decision documents. The RA as described in the ROD for the Site has been implemented and is functioning as designed. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds Operable Unit RA to Wah Chang for the cleanup of contaminated material in the LRSP and Schmidt Lake. Groundwater continues to be monitored on a semiannual basis in the Solids Area, which includes the LRSP and Schmidt Lake.

Since the last five-year review, Wah Chang donated 12 acres of the Solids Area to the City of Albany as a conservation easement to preclude future development. Inspection of the area indicated that a wetland has been created on this parcel and that this area is not used for industrial purposes.

10.1.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

The only change in OU1 is that 12 acres of the Solids Area has been turned into a wetland. This change does not significantly affect the exposure assumptions for OU1, since the area has been remediated. There have been no changes in the physical conditions at the Site that would affect the protectiveness of the remedy. There are no changes in the exposure assumptions or RAOs used in making the remedy decisions in OU1.

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

No other information calling into question the protectiveness of the remedy was identified during the five-year review.

10.1.4 Technical Assessment Summary

The remedy for OU1 is protective of human health and the environment. Institutional Controls in the form of a conservation easement preclude further development on 12 acres of the Solids Area that is part of the LRSP.

10.2 TECHNICAL ASSESSMENT OF OU2

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

Groundwater

The groundwater remedy has been implemented and is currently being evaluated for its effectiveness. The GETS system has been evaluated for the Fabrication Area, and is currently

being evaluated for the Extraction Area. EPA expects to complete the evaluation for the Extraction Area in 2008. Institutional controls are in place to prevent on- and off-site use of contaminated groundwater, and to ensure that Site use remains industrial. Data indicates that estimated excess lifetime carcinogenic and non-carcinogenic risks to human health in groundwater have been reduced in the Main Plant Area since the initiation of the GETS system (see Figures 39 and 40). However, opportunities for optimizing GETS are being conducted and/or discussed between EPA and Wah Chang.

ICs have been implemented on the site in the form of restrictions on land use, groundwater use for drinking water, access, and construction. and Easement and Equitable Servitude Agreements on adjacent properties preventing use of groundwater for drinking water. Additional control is provided by the City of Albany requirements that require all new developments connect to municipal water lines if service is available within 150 feet.

Sediment

The bank stabilization was implemented by Wah Chang in 2000 and is currently function as intended. No additional RA by EPA is planned for sediments. Wah Chang conducted an additional round of sediment sampling and analysis in Truax Creek to assess the protectiveness of the remedy. Appreciable concentrations of PCBs were not found in Truax Creek sediments.

10.2.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Since the last five-year review, changes to the slope factor and exposure point concentration have occurred for selected contaminants (DCE and TCE) that were used to define areas of the Site that exceeded a $1x10^{-4}$ ELCR (Section 8.2). Active groundwater extraction was implemented in those "hotspot" areas that exceeded a $1x10^{-4}$ ELCR. However, given that hotspot areas were defined based on pre-remediation concentrations, these slope factor changes do not affect the status of the groundwater remedy.

Chemical-specific ARARs for Oregon's AWQCs protection of human health water and fish ingestion have been updated from OAR 340-41-0445 to 340-41-0033 (Adopted by the Environmental Quality Commission on May 20, 2004 to become effective February 15, 2005). Updated AWQCs have not been recognized by EPA; however appear to be consistent with 2006 Clean Water Act AWQCs human health consumption of water and organisms. EPA will assess whether the updated criteria affect the protectiveness of the remedy with regard to surface water protection.

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

In order to improve hydraulic control of the hot spot in the northern portion of the Fabrication Area (in the vicinity of PW-11), EPA requested Wah Chang to install an additional extraction well FW-8 (CH2M Hill 2007c). During drilling of the extraction well's borehole in October 2007, a hard, potentially metallic object was encountered at a depth of 11 feet bgs. Drill cuttings removed from a depth of 10 to 11 feet bgs displayed an oily sheen with a solvent-like odor. Analysis of a reconnaissance grab sample collected from a drum containing IDW from this depth indicated a TCA concentration of 1,420,000 μg/L, TCE concentration of 2,810 μg/L, 1,1-DCE concentration of 23,600 μg/L (CH2M Hill, 2007f). TCA concentrations are believed to be greater than its solubility limit, and TCA may be present as a non-aqueous phase liquid (NAPL). Due to the potential presence of NAPLs and/or the high concentrations

of dissolved phase chlorinated organics in groundwater, modification to the groundwater remedy in the Fabrication Area maybe necessary to achieve RAOs and the estimated 15-year time frame for cleanup. Wah Chang is currently conducting further investigation into the nature and extent of the contamination under an EPA-approved Revised Work Plan (CH2M Hill 2007c). Following this investigation, any remedial action in this area will be addressed by Wah Chang and EPA.

In the Feed Makeup Area of the Extraction Area of the Main Plant, low ground water pH still remains. Modifications to the remedy in the Feed Makeup Area may be necessary to achieve RAOs and the estimated 15-year time frame for cleanup. Wah Chang and EPA are evaluating the feasibility of groundwater infiltration using a basic solution to neutralize acidic groundwater and precipitate metals.

In order to expedite cleanup to ROD cleanup levels within the time frame specified, Wah Chang and EPA are currently evaluating proposals for bioaugmentation in wells in the South Extraction Area. If successful, this technology may be used at hot spot areas in the Fabrication Area.

High concentrations of PCBs left behind during environmental excavations of uninvestigated areas under CERCLA require ongoing evaluation in order to assess risk to human health as well as the effect to the groundwater remedy. All soils removed with greater than 50 mg/kg concentrations of PCBs should be managed as TSCA waste.

In 2007, EPA examined the groundwater-to-indoor air pathway for three on-site buildings: two office space buildings, and the building nearest the highest potential risk to indoor air. Based on examination of multiple lines of evidence that included groundwater concentrations nearest the buildings, building ventilation, and the presence of extraction wells in the vicinity of groundwater with elevated solvent concentrations, EPA will continue monitoring groundwater in the vicinity of this area. Should current groundwater concentrations increase near these buildings, EPA will require additional lines of evidence that could include indoor air samples.

10.2.4 Technical Assessment Summary

EPA is evaluating the effectiveness of GETS and its ability to achieve cleanup goals in a reasonable time frame. Ongoing and follow-up actions have been identified in this review. The change of several wells in the fabrication area from GAC to the facilities' cooling towers has resulted in more water being pumped through the system and could expedite the attainment of ROD cleanup levels within the specified time frame. Areas of the Main Plant where groundwater concentrations are still above cleanup levels require further evaluation by EPA and Wah Chang regarding the feasibility of potential groundwater remedy enhancement or modification. Further delineation of the recent TCA impacts in the Fabrication Area and an expedited decision on the remedial action in this area will be necessary to help meet RAOs within the ROD's specified time frame. ICs have been properly implanted and are effective at preventing exposure.

10.3 TECHNICAL ASSESSMENT OF OU3 AND THE SOIL AMENDMENT AREA

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

The remedy is functioning as intended by the decision documents. Final Site closure for radionuclides will be conducted pursuant to Wah Chang's Oregon Radioactive Materials

License and the Energy Facility Siting Council Administrative Rules. This work will be conducted under the oversight of the Oregon Health Services Division and in consultation with DEQ and EPA. Currently, Site safety is in place through Wah Chang's radiation management programs.

The site wide controls required in the September 2001 Soil ESD need to be incorporated into the Scope of Work for long-term protectiveness. Short-term protectiveness is in place through the Broad Scope Materials Radioactive License and is being implemented as part of the Wah Chang ongoing safety program.

Site wide Institutional Controls that apply to OU3 require radon controls in future buildings in areas of the Wah Chang plant where soil radiation levels are thought to pose a risk to building occupants, should future buildings be constructed on this area.

No additional work by EPA is currently planned for the Soil Amendment Area. The institutional controls are in place. The Soil Amendment Area is currently being used for agriculture. Re-use opportunities for this area are currently being explored by DEQ in coordination with EPA.

10.3.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

There have been no changes to the exposure assumptions, toxicity data, cleanup levels, and RAOs that would affect the remedy for the soils OU.

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

The remedy for OU3 and the Soil Amendment Area is protective. Compliance with ROD requirements for future plant operations will continue to be monitored and enforced. Since the last five-year review, Wah Chang has constructed the CoGen facility on an area of the Site where residual radioactive contamination is still in place. Although the CoGen facility is not operating and has limited occupational use,, construction has not met the radon controls envisioned for new facilities in the ROD, in accordance with the site-wide institutional controls. An evaluation will be conducted to understand the risk to human health and if these construction controls apply.

As cited in the Soil ROD, areas of the Site, or contamination at the Site not previously addressed, are subject to investigation and corrective action under RCRA. For conditions or contamination at the Site previously unknown that are later discovered, such conditions or contamination may be addressed under either RCRA or CERCLA.

10.3.4 Technical Assessment Summary

According to the data reviewed, the remedy is functioning as intended by the ROD and as modified by the ESD. While the soil remediation has been completed, additional soils cleanup will be required under the Wah Chang NORM License decommissioning at plant closure. Future buildings erected on the Main Plant property will have to comply with criteria set forth in the ROD and ESD. As such, radon mitigation may be warranted.

Institutional controls for the Soil Amendment Area are in place. Since Radon ICs for the Co-Gen building were not implemented, indoor air radon sampling is required for this building.

11. ISSUES, FOLLOW-UP ACTIONS, AND RECOMMENDATIONS

This section discusses required and/or suggested improvements to current Site operations, remedies, or conditions.

11.1 OU1 – SLUDGE PONDS

None

11.2 OU2 – GROUNDWATER AND SEDIMENT

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
GROUNDWATER			
Extraction Area			
Groundwater Extraction and Treatment System (GETS) will not likely reduce chemicals of concern (COCs) concentrations to below ROD cleanup levels within the 15-year time frame in the Feed Makeup Area. COCs include fluoride, manganese, and radium, which are likely mobilized by acidic conditions. Acidic conditions are not effectively addressed by GETS. (Section 9.6.2).	Evaluate the use of groundwater flushing as a new remedial action. Groundwater flushing would use a weak basic solution (lime) to raise groundwater pH and decrease the mobility of inorganic constituents. Evaluation would include bench scale testing and a pilot test under an approved Work Plan. Any use of groundwater pH neutralization will be contingent on EPA's determination that it does not adversely affect the protectiveness of the groundwater remedy. If this technology is determined feasible, a modification to the Record of Decision (ROD) would be expected to occur before the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
GETS will not likely reduce VOCs concentrations to below ROD cleanup levels within the 15-year time frame in the South Extraction Area (SEA) and within the Fabrication Area (Section 9.6.2).	Evaluate the use of enhanced bioremediation as a new remedial action in the SEA. Enhanced bioremediation would likely use a series of temporary borings to deliver a lactate (or equivalent) solution to the subsurface to create anaerobic conditions to facilitate bio-dechlorination of trichloroethene (TCE) and tetrachloroethene (PCE). Evaluation would include a pilot test under an approved Work Plan. The use of enhanced bioremediation is contingent on EPA's determination that it does not adversely affect the protectiveness of the groundwater remedy If this technology is determined feasible; a modification to the ROD would be expected to occur before the end of the fiscal year 2009.	No/Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Fabrication Area			
Apparent limited hydraulic control of the hot spot area in the vicinity of FW-3 (Section 9.6.3); extraction well FW-6 is not functioning as intended (Section 5.2.2); and increasing and/or persistent concentrations of VOCs exist in northern perimeter wells (Section 9.6.3).	Enhance GETS by installing new extraction well FW-8 (Section 8.2). Optimize GETS by increasing groundwater pumping rates at FW-3 due to change in VOC treatment from granular activated carbon (GAC) to cooling tower (Section 5.2.4). Continue semi-annual groundwater sampling and analysis. Evaluation of this issue is anticipated to be completed by the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
Apparent limited hydraulic control of the hot spot area in the vicinity of FW-2 and FW-5 (Section 9.6.3).	Optimize GETS by increasing discharge at FW-2 by replacing existing pneumatic pump with a new electric submersible pump (Section 8.2); change VOC treatment from GAC to cooling tower (Section 5.2.4); and conduct maintenance and development on extraction well's well screens. Evaluation of this issue is anticipated to be completed by the end of fiscal year 2009.	No/Yes	Wah Chang with EPA oversight
GETS may be limited in its ability to achieve RAOs and ROD cleanup levels in the projected 15-year time frame as indicated by persistent concentrations of DCE and TCE above ROD cleanup levels in groundwater from noted hot spot wells (Section 9.6.3).	Continued groundwater monitoring on a semi-annual basis through 2010.	No/Yes	Wah Chang with EPA oversight
Conditions for natural attenuation in the Fabrication Area may not be conducive for the full dechlorination of TCE and DCE, as observed by increasing concentration of VC and cis 1,2-DCE in groundwater from perimeter and non-hotspot wells, and in surface water. The data set used to evaluate monitored natural attenuation (MNA) is limited (Section 9.6.3).	Continue groundwater monitoring semi-annually. Sample and analyze for applicable and relevant water quality indicators to evaluate MNA through 2010.	No/Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Chemical-specific applicable or relevant and appropriate requirements (ARARs) for Oregon's AWQCs for protection of human health water and fish ingestion have been updated from Oregon Administrative Rules (OAR) 340-41-0445 to 340-41-0033 (adopted by the Environmental Quality Commission on May 20, 2004 to become effective February 15, 2005) (Section 10.2). Updated AWQCs have not been recognized by EPA; however, appear to be consistent with 2006 Clean Water Act AWQCs for human health, consumption of water, and organisms.	Compare criteria between OAR 340-41-0445 and 340-41-0033. Use criteria which is most stringent to evaluate COCs in groundwater and surface water.	No/Yes	Wah Chang and EPA
Wah Chang is further investigating the Crucible Cleaning Area (CCA) Solid Waste Management Unit (SWMU) in order to further define the nature and extent of historical trichloroethane (TCA) contamination in soils and groundwater in the Fabrication Area (Section 10.2). Existing soil sample results collected between 1991 and 2005 suggest that there is a deep source of VOCs in soil.	Work with DEQ RCRA Program to ensure that SWMUs closures are consistent with the groundwater remedy.	No/Yes	DEQ/EPA and Wah Chang with EPA oversight
Discovery of non-aqueous phase liquid (NAPL) and/or high concentration of VOCs in groundwater in the Fabrication area during drilling of proposed extraction well FW-8. Contamination may stem from a release from an unidentified source and may affect the groundwater remedy.	Determine the nature and extent of VOCs in soil and groundwater using reconnaissance borings. Assess source of contamination and release mechanism. Prepare a feasibility study evaluating appropriate remedial options. Expedite a decision on implementing a remedial action if determined that a release has occurred. Revise installation location for FW-8. Should additional response action be needed regarding this issue, a decision document will be completed before end of fiscal year 2009.	No/ Yes	Wah Chang with EPA oversight
Ensure that contaminated groundwater does not pose a risk to building occupants through vapor intrusion (Section 10.2.3).	Continue to evaluate groundwater VOCs concentrations in areas where potential exposures could occur. Should groundwater VOCs concentrations increase in these areas, vapor intrusion pathway will be assessed. Advise building occupants of the results. Take necessary actions to address unacceptable exposure impacts.	No/ Yes	Wah Chang with EPA oversight

Issue	Follow-Up Action/ Recommendation	Affects Protectiveness Current/Future	Responsible Party
Solids Area			
Natural attenuation processes maybe limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of manganese and fluoride above the ROD cleanup levels in groundwater from noted monitoring (Section 9.6.6).	Continued groundwater monitoring on a semi-annual basis through 2010.	No/Yes	Wah Chang with EPA oversight
Farm Ponds Area			
Natural attenuation processes maybe limited in their ability to achieve RAOs and ROD cleanup levels as indicated by persistent concentrations of PCE, TCE and VC above the ROD cleanup levels in groundwater from noted monitoring (Section 9.6.7).	Continued groundwater monitoring on a annual basis through 2010. EPA will require that Wah Chang analyze groundwater for chloride and specific conductance from identified wells (WS, PW-43S/43A, PW-44S/44A) in future sampling events. EPA believes these results may help better understand advective movement of groundwater and the role of natural attenuation for VOCs.	No/Yes	Wah Chang with EPA oversight
SURFACE WATER			
Surface water in Truax Creek has exceeded ROD cleanup levels for TCE and vinyl chloride (VC) (Section 9.6.3).	Conduct supplemental surface water sampling at Truax Creek and groundwater sampling from applicable western perimeter wells in March 2008 (Section 7.2). Evaluate risks of exposure to human health and the environment via the surface water pathway.	No/Yes	Wah Chang with EPA oversight
Potential threat to human health and the environment from consumption of fish or organisms in Second Lake (Section 3.9.1).	Evaluate if exposure pathway is complete by end of calendar year 2008.	No/Yes	Wah Chang with EPA oversight
SEDIMENT			
Determine if the remedial action for sediment is functioning as intended (Section 5.2.7).	Conduct sediment sampling and analysis in a manner consistent with approved Work Plan. Results of sampling demonstrate that sediment remedy is protective.	No/Yes	Wah Chang with EPA oversight
Historic impacts to soil from polychlorinated biphenyl (PCBs) in the vicinity of the Emergency Services Building may affect the protectiveness to the groundwater remedy (Section 9.6.8).	Work with Wah Chang to further assess potential PCBs impacts to groundwater. Sample and analyze groundwater from monitoring wells PW-30A and PW-46A for Total PCBs by the applicable EPA method. Should PCBs be detected in groundwater from these wells, Wah Chang may have to take further remedial actions or conduct modifications to GETS to meet remedial action objectives (RAOs) and ensure the protectiveness of the groundwater remedy.	No/Yes	Wah Chang and EPA

11.3 OU3 – SURFACE AND SUBSURFACE SOIL

Issue	Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party
The Scope of Work (SOW) and Consent Decree do not incorporate requirements of the 2001 Soil ESD regarding overall cleanup during decommissioning and other factors (Section 10.3.1).	Amend the SOW to incorporate applicable requirements of the Soil ESD by calendar year 2009.	No/Yes	Wah Chang and U.S. and State of Oregon
Construction of the CoGen Building may not comply with institutional controls that require that future buildings be constructed using radon-resistant construction methods (Section 10.3.3).	Radon testing will be conducted in the CoGen Building by end of calendar year 2008. All other buildings constructed on areas of the main plant where residual radiological contamination would lead to an increased risk of radon exposure will require testing. Radon testing will be conducted to evaluate risk to human health and if mitigation is necessary.	No/Yes	Wah Chang and EPA

11.4 SITE WIDE

Issue	Recommendation/Follow-Up Action	Affects Protectiveness Current/Future	Responsible Party
Verify that all institutional controls (ICs) are in place	Complete Title Search for all parcels for entire site by end of calendar year 2008.	No/Yes	EPA

12. PROTECTIVENESS STATEMENT

This section presents protectiveness statement for OU1 through OU3.

12.1 OU1 – SLUDGE PONDS

The remedy for OU1 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

12.2 OU2 – GROUNDWATER AND SEDIMENT

Progress to meet the groundwater RAOs is being made through an operating groundwater extraction and treatment system (GETS); and institutional controls (ICs) are in place to restrict on-site and off-site beneficial use of groundwater. A protectiveness determination for the remedy at OU2 cannot be made at this made at this time until further information is obtained. Further information will be obtained by taking the actions as described below. It is expected that these actions will be completed in the end of fiscal year 2010 upon which a determination of protectiveness of the groundwater operable unit can be made.

- Implement further response actions to treat source area groundwater contamination in the Feed Makeup Area stemming from fluoride and manganese and acidic pH conditions that are above ROD cleanup levels. Groundwater quality conditions in the Feed Makeup Area are unlikely to achieve RAOs within the estimated 15-year time frame. The response action was not considered in the ROD. Implementation of the remedy would require a modification to the groundwater ROD.
- Implement response actions in the SEA, where groundwater CVOC concentrations are not declining at a rate likely to achieve RAOs within the estimated 15-year time frame. Response actions that are considered include bioaugmentation that were not considered at the time of the ROD
- Implement additional response actions in the fabrication area in order to deal with increased groundwater TCA concentrations in the area of the Crucible Cleaning Area (CCA) Solid Waste Management Unit (SWMU), and in the vicinity of extraction well FW-8 (Acid Sump Area). Response actions considered in the CCA SWMU include bioaugmentation that was not considered at the time of the ROD. Response actions in the vicinity of FW-8 are unknown at this time and will be better understood when data is submitted by Wah Chang to EPA regarding the recent sampling to characterize the nature and extent of contamination in this area.
- Continue to evaluate effectiveness of existing remedy and take necessary further response action to meet RAOs with the estimated 15-year time frame. Response actions could include optimization of GETS; modification of the groundwater remedy; and/or reevaluation of estimated time frame.
- Further evaluate detections of COCs in surface water from Truax and Murder Creeks. Take necessary actions to address unacceptable exposure impacts.
- Evaluate potential risk to human health and the environment from the consumption of fish and/or organisms at Second Lake.
- Evaluate the potential exposure to current onsite workers from indoor air vapor intrusion associated with contaminated groundwater. Advise building occupants of the results. Take necessary actions to address unacceptable exposure impacts.

- Incorporate relevant revised toxicity factors for COCs into the groundwater remedy.
- Conduct ongoing evaluations of residual PCB concentrations left behind during environmental excavations of uninvestigated areas in order to assess risk to human health as well as effects on the groundwater remedy.
- Ensure that the remedy for sediments is protective through sampling and analysis and long-term maintenance.

12.3 OU3 – SURFACE AND SUBSURFACE SOIL AND THE SOIL AMENDMENT AREA

The remedy for OU3 is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

12.4 SITE WIDE PROTECTIVENESS

A site wide protectiveness determination for the implementation of the overall remedies at Teledyne Wah Chang cannot be made at this time until further information is obtained from proposed remedy enhancements to the groundwater operable unit (OU2). It is anticipated by 2010 that information will be obtained regarding these remedy enhancements and an overall site wide protectiveness determination can be made.

13. NEXT REVIEW

The next statutory review will be in 2012, five years after signature date of this review. Since hazardous substances above levels that allow for unlimited use and unrestricted exposure remain at the Site, five-year reviews will continue.

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TABLES

Table Notes

Acronyms
ARARs = Appropriate or Relevant, and Appropriate Requirements (EPA, 1994)
BC = Blue Clay
cis-1,2-DCE = cis-1,2-Dichloroethene
CWA = Clean Water Act
DCA = 1,1-Dichloroethane
DCE = 1,1-Dichloroethene
HS =Hot Spot Well
LG = Linn Gravel
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
NHS = Non-Hot Spot Well
OAR = Oregon Administrative Rules
OAR RL = Oregon DEQ Reference Level
P = Perimeter Wells
PCBs = Polychlorinated Biphenyls
PCE = Tetrachloroethene
RL = Reporting Limit
ROD = Record of Decision
SMCL = Secondary MCL
SVOCs = Semi Volatile Organic Compounds
TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
WS = Willamette Silt
VC = Vinyl Chloride
VOCs = Volatile Organic Compound

Units
C = Celsius
ft = feet
ft/day = feet per day
ft2/day = square feet per day
gpm = gallons per minute
mg/L = milligrams per liter
mV = mill volts
pCi/L = picoCuries per Liter
S.U. = standard units
µg/L = micrograms per liter
uS/cm = microsiemes per centimeter

Qualifiers
Bold = Non-detect, laboratory reporting limit exceeds ROD cleanup level
J = the result for this analysis is
NS = Not sampled
U = Compound is not detected at or above the method reporting limit
= measured at shown value
-- = no value

References
1 = Remedial Investigation / Feasibility Study, CH2M Hill, 1993
2 = Record of Decision for OU2. Table 10-1. EPA, 1994
3 = Record of Decision for OU2. Table 10-3. EPA, 1994
4 = 2006 Semiannual Environmental Monitoring Report, Shaw Environmental, Inc. Table C-6
5 = 2006 Semiannual Environmental Monitoring Report, Shaw Environmental, Inc. Table C-5

6 = 1,1-DCA cleanup level is calculated for HI = 1 for industrial exposure

7 = 1,1-DCA cleanup level is calculated by risk-based value on industrial worker tap water ingestion pathway

8 =OAR. 1991. Oregon Administrative Rules 340-41-445 (section 2)(p) Willamette Basin, Toxic Substances. July 1991.

9 = OAR. 2004. Oregon Administrative Rules 340-41-0033. May 2004.

10 = The Environmental Quality Commission adopted the following criteria on May 20, 2004 to become effective February 15, 2005.

11 = Standard for ammonia was calculated by Wah Chang (Wah Chang, 2006: Table 5b) critical chronic concentration for fresh water; fish early life not present using a pH value of 8.32 and temperature of 20 degrees Celsius at Truax Creek.

Notes

* Finely Buttes Landfill Monitoring Well MW-4 is located upgradient from the Wah Chang monocell.

** Finely Buttes Landfill Monitoring Well MW-5 is located downgradient from the monocell.

Table 1
Hydrogeologic Properties of the Linn Gravels

Area [1]	Average Saturated Thickness of Linn Gravels	Hydraulic Conductivity Geometric Mean	Transmissivity
Fabrication	14 ft	2.1 ft/day	15 to 1,000 ft^2/day
Extraction	15 ft	3.4 ft/day	9 to 390 ft^2/day
Solids	19 ft	28 ft/day	27 to 3,300 ft^2/day

Table 2
Summary of COCs in Groundwater and Cleanup Levels

COCs [2]	Chemical Classification	Cleanup Level in µg/L	Basis
Benzene	VOC	5	MCL
1,2-Dichloroethane (1,2-DCA)	VOC	5	MCL
1,1-Dichloroethane (DCE)	VOC	7	MCL
Methylisobutyketone (MIBK)	VOC	5,000	HI=1
1,1,2,2-Tetrachloroethane	VOC	0.175	1.00E-06
Tetrachloroethene (PCE)	VOC	5	MCL
1,1,1-Trichloroethane (TCA)	VOC	200	MCL
1,1,2-Trichloroethane (1,1,2-TCA)	VOC	3	Non-zero MCLG
Trichloroethene (TCE)	VOC	5	MCL
Vinyl Chloride	VOC	2	MCL
Hexachlorobenzene	VOC	1	MCL
Bis(2ethylhexyl)phthalate	SVOCs	0.2	MCL
Beryllium	Inorganic Element	4	MCL
Copper	Inorganic Element	1,000	SMCL
Manganese	Inorganic Element	50	SMCL
Uranium	Inorganic Element	30	MCL
Total PCBs	SVOCs	0.5	MCL
Radium 226	Radionuclide	5	MCL
Radium 228	Radionuclide	5	MCL
Ammonium	Inorganic Compound	250,000	OAR 333-61-030
Fluoride	Inorganic Element	2,000	OAR 333-61-030
Nitrate	Inorganic Element	10,000	MCL

Table 3
Cleanup Levels for Treated Effluent Water

COCs [3]	Concentration	Basis
DCE	0.033 µg/L	OAR 340-41-445
1,1,2-TCA	0.6 µg/L	OAR 340-41-445
VC	2 µg/L	OAR 340-41-445
Total PCBs	0.079 nanograms per liter	OAR 340-41-445
Fluoride	4,000 µg/L	OAR 340-41-445
Nitrate	10,000 µg/L	OAR 340-41-445

Table 4
Summary of February 2006 Volatile Organic Compounds in Groundwater
Finley Buttes Regional Landfill

Compound [4]	Concentration (µg/L)	
	MW-4	MW-5
1,1,1,2-TETRACHLOROETHANE	1 U	1 U
1,1,1-TRICHLOROETHANE	1 U	1 U
1,1,2,2-TETRACHLOROETHANE	1 U	1 U
1,1,2-TRICHLOROETHANE	1 U	1 U
1,1-DICHLOROETHANE	1 U	1 U
1,1-DICHLOROETHENE	1 U	1 U
1,1-DICHLOROPROPENE	1 U	1 U
1,2,3-TRICHLOROBENZENE	1 U	1 U
1,2,3-TRICHLOROPROPANE	1 U	1 U
1,2,4-TRICHLOROBENZENE	1 U	1 U
1,2,4-TRIMETHYLBENZENE	1 U	1 U
1,2-DIBROMO-3-DICHLOROPROPANE	2 U	2 U
1,2-DICHLOROBENZENE	1 U	1 U
1,2-DICHLOROETHANE	1 U	1 U
1,2-DICHLOROETHANE	1 U	1 U
1,2-DICHLOROPROPANE	1 U	1 U
1,3,5-TRIMETHYLBENZENE	1 U	1 U
1,3-DICHLOROBENZENE	1 U	1 U
1,3-DICHLOROPROPANE	1 U	1 U
1,4-DICHLOROBENZENE	1 U	1 U
2,2-DICHLOROPROPANE	5 U	5 U
2-BUTANONE (MEK)	5 U	5 U
2-CHLOROTOLUENE	1 U	1 U
2-HEXANONE	5 U	5 U
4-CHLOROTOLUENE	1 U	1 U
ACETONE	10 U	10 U
BENZENE	1 U	1 U
BROMOBENZENE	1 U	1 U
BROMOCHLOROMETHANE	1 U	1 U
BROMODICHLOROMETHANE	1 U	1 U
BROMOFORM	1 U	1 U
BROMOMETHANE	2 U	2 U
CARBON TETRACHLORIDE	1 U	1 U
CHLOROBENZENE	1 U	1 U
CHLOROETHANE	2 U	2 U
CHLOROFORM	1 U	1 U
CHLOROMETHANE	2 U	2 U
CIS-1,2-DICHLOROETHENE	1 U	1 U
CIS-1,3-DICHLOROPROPENE	1 U	1 U
DIBROMOCHLOROMETHANE	1 U	1 U
DIBROMOETHANE	1 U	1 U
DIBROMOMETHANE	1 U	1 U
DICHLORODIFLOUROMETHANE	2 U	2 U
ETHYLBENZENE	1 U	1 U
HEXACHLOROBUTADIENE	2 U	2 U
ISOPROPYLBENZENE	1 U	1 U

Compound [4]	Concentration (µg/L)	
	MW-4	MW-5
METHYL tert-BUTYL ETHER	5 U	5 U
METHYLENE CHLORIDE	5 U	5 U
NAPHTHALENE	1 U	1 U
n-BUTYLBENZENE	1 U	1 U
n-PROPYLBENZENE	1 U	1 U
p-ISOPROPYL TOLUENE (MIK)	5 U	5 U
sec-BUTYLBENZENE	1 U	1 U
STYRENE	1 U	1 U
tert-BUTYLBENZENE	1 U	1 U
TETRACHLOROETHENE	1 U	1 U
TOLUENE	1 U	1 U
TRANS-1,2-DICHLOROETHENE	1 U	1 U
TRANS-1,3-DICHLOROPROPENE	1 U	1 U
TRICHLOROETHENE	1 U	1 U
TRICHLOROFLUOROMETHANE	2 U	2 U
VINYL CHLORIDE	1 U	1 U
XYLENES, TOTAL	2 U	2 U

Table 5
Summary of February 2006 Total Trace Metal in Groundwater
Finley Buttes Regional Landfill

Metal [5]	Concentration (µg/L)		Comparison Levels (µg/L)	
	MW-4	MW-5	MCL/SMCL	OAR RL
ANTIMONY [Sb]	0.001 U	0.001 U	0.006	--
ARSENIC [As]	0.0032	0.001 U	0.05	0.05
BARIUM [Ba]	0.041	0.056	2	1
BERYLLIUM [Be]	0.0004 U	0.0004 U	0.004	--
CADMIUM [Cd]	0.0005 U	0.0005 U	0.005	0.01
CHROMIUM [Cr]	0.0057	0.005 U	0.1	0.05
COBALT [Co]	0.002 U	0.002 U	--	--
COPPER [Cu]	0.0025	0.002 U	1.3	1
LEAD [Pb]	0.001 U	0.001 U	0.015	0.05
NICKEL [Ni]	0.002 U	0.002 U	0.1	nv
SELENIUM [Se]	0.0014	0.001 U	0.05	0.01
SILVER [Ag]	0.005 U	0.005 U	0.05	0.05
THALLIUM [Tl]	0.001 U	0.001 U	0.002	--
VANADIUM [Va]	0.042	0.005 U	--	--
ZINC [Zn]	0.0084	0.0081	5	5

Table 6
Summary of Treatment System Performance Metrics

		Extraction Area						Fabrication Area														
		EW-4	EW-5	EW-6	South Extraction Area			FW-1			FW-2			FW-3			FW-4			FW-7		
Month	Cumulative Volume (in Gallons)	Average Flow Rate (gpm)			Influent Total VOCs Concentration (µg/L)	Mid-Point Train 1 Total VOCs Concentration (µg/L)	Mid-point Train 2 Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)
Oct-00	36,830																					
Nov-00	73,690																					
Dec-00	110,581																					
Jan-01	147,503																					
Feb-01	184,453																					
Mar-01	221,434																					
Apr-01	258,445																0.40			2.94		
May-01	295,487													24.56			7.02			5.41		
Jun-01	332,559							7.88			4.99			13.40			6.63					
Jul-01	369,662							7.57			8.88			1.74			5.69					
Aug-01	406,796							7.14			7.13			1.23			5.20			5.65		
Sep-01	443,960	0.65	0.13	0.18				6.60			6.94			0.95			4.88			5.76		
Oct-01	481,155	0.62	0.08	0.14	134.2			6.33	97.00		7.12	625.6		0.81	3844.2		4.64	926.3		5.76	77.4	
Nov-01	518,380	1.82	0.10	0.17				6.27			7.38			0.95			6.07			4.26		
Dec-01	555,636	5.32	0.20	0.23				2.81			7.78			0.94			5.41			2.01		
Jan-02	592,923	5.55	0.19	0.23	248.3			4.45	996.90		7.65	256.6		0.75	1492		5.59	702.6		1.47	38.7	
Feb-02	630,238	1.24	0.19	0.21				7.36			7.57			0.65			5.31			4.39		
Mar-02	667,584	0.85	0.15	0.24				9.96			7.41			0.91			5.16			5.48		
Apr-02	704,960	0.00	0.00	0.00	79.2			2.01	946.40		7.02	676.4		1.60	3073.7		3.64	1144.7		5.09	23.5	
May-02	742,367	2.95	0.09	0.17				1.93			6.90			1.78			4.66			4.42		
Jun-02	779,804	2.42	0.08	0.15				1.97			6.76			1.77			4.05			4.01		
Jul-02	817,272	2.42	0.08	0.15	62			2.73	1,493.00		7.25	638		1.72	2578		4.05	1033		3.96	40	
Aug-02	854,771	1.99	0.08	0.14				3.15			7.06			1.86			4.33			2.74		
Sep-02	892,300	1.78	0.08	0.15				1.39			7.15			1.85			2.29			2.30		
Oct-02	929,860	1.79	0.07	0.13	99.4			4.01	3245.7		6.74	482.4		1.97	3148.1		1.24	1359		3.40	44.5	
Nov-02	967,450	1.61	0.05	0.12				4.29			7.95			1.74			3.86			3.65		
Dec-02	1,005,071	14.20	0.13	0.25				5.02			8.80			2.64			5.53			2.74		
Jan-03	1,042,723	5.70	0.17	0.19	35.8			5.07	112.9		9.15	176.2		1.85	2392.5		4.68	455.1		2.74	14.1	
Feb-03	1,080,403	5.80	0.19	0.22				5.30			8.65			2.16			2.39			3.52		
Mar-03	1,118,114	5.09	0.18	0.21				6.02			8.18			2.14			3.74			2.83		
Apr-03	1,155,855	5.99	0.24	0.23	45.6			5.12	2992.4		8.09	203.2		2.22	1828.2		4.66	476.2		3.30	31.6	
May-03	1,193,627	3.73	0.17	0.20				4.47			7.86			2.05			4.65			3.60		
Jun-03	1,231,429	2.09	0.12	0.17				8.52			7.81			1.88			4.70			3.25		
Jul-03	1,269,262	1.64	0.10	0.15	168.6			8.23	2992		5.26	498		1.91	1573.6		4.16	877		2.86	195.2	
Aug-03	1,307,126	1.29	0.09	0.15				4.01			3.99			2.07			2.47			4.65		
Sep-03	1,345,020	1.15	0.08	0.14				4.03			3.72			2.00			3.99			4.60		
Oct-03	1,382,945	1.34	0.09	0.14	182			4.32	4107		3.44	374		2.11	2127		3.77	730		4.82	72.8	
Nov-03	1,420,900	1.61	0.09	0.15				4.09			3.07			2.10			3.99			5.00		
Dec-03	1,458,886	5.98	0.25	0.19				4.18			5.78			2.51			3.83			5.00		
Jan-04	1,496,903	6.15	0.34	0.18				5.34			5.87			2.50			1.24			5.10		
Feb-04	1,534,949	4.94	0.31	0.18	45			5.03	1017.3		4.40	231.1		2.29	2127.4		1.70	395.4		5.13	22.7	
Mar-04	1,573,026	3.16	0.22	0.15				3.25			4.23			2.06			1.05			2.64		
Apr-04	1,611,133	1.69	0.16	0.14	149.8			2.07	1967.2		3.84	384.6		1.93	1916.4		1.36	1084		3.33	24.4	
May-04	1,649,271	1.50	0.15	0.13				5.26			2.39			1.63			1.33			3.09		
Jun-04	1,687,439	1.26	0.12	0.14				8.37			2.18			1.91			1.50			2.36		
Jul-04	1,725,638	1.16	0.10	0.14	151.2	38.3	27.5	6.11	3,015.00	1,916.00	2.17	1,018.00	24.00	1.97	2,168.0	198.00	3.81	896.00	458.00	2.80	58.00	8.30
Aug-04	1,763,868	1.07	0.09	0.14				5.18			1.10			2.19			4.41			2.81		
Sep-04	1,802,128	0.58	0.11	0.12				4.62			5.16			2.35			4.05			3.48		
Oct-04	1,840,419	0.94	0.13	0.11	197.5	54.6	29.9	5.36	4468.1	221	6.11	310.00	29.00	2.27	1,526.0	1.30	4.40	531.00	91.00	4.05	32.00	4.50
Nov-04	1,878,740	1.31	0.15	0.10				6.62			6.09			2.39			4.54			2.94		
Dec-04	1,917,092	1.75	0.16	0.10				5.69			5.30			2.53			4.85			5.26		
Jan-05	1,955,475	1.65	0.13	0.08				7.47			5.80			2.26			4.22			4.09		
Feb-05	1,993,886	2.52	0.19	0.13				6.63			5.60			2.08			3.92			3.78		
Mar-05	2,032,328	2.19	0.13	0.10	53.4	56.9	37.4	8.60	626.1	3223	4.77	381.00	36.00	1.98	1,503.0	343.00	3.83	458.00	245.00	3.80	25.00	<0.5
Apr-05	2,070,800	3.02	0.17	0.12				3.42			5.81			2.25			3.70			2.98		
May-05	2,109,303	2.57	0.17	0.13				1.98			5.70			2.36			4.98			2.52		
Jun-05	2,147,836	2.03	0.15	0.13	84.1	67.2	48.5	10.15	365.6	124	5.12	267.00	65.00	2.17	1,949.0	2.00	4.83	842.00	379.00	4.14	38.00	NS
Jul-05	2,186,400	1.52	0.11	0.14				5.86			6.52			2.03			4.31			4.49		
Aug-05	2,224,995	1.76	0.10	0.14				2.43			6.04			2.16			4.13			4.65		
Sep-05	2,263,620	1.54	0.11	0.11				3.79			5.67			2.50			4.08			4.16		
Oct-05	2,302,276	1.87	0.01	0.12	47	56.7	49.3	4.63	268.8	880	5.53	281.00	79.00	2.26	330.0	6.00	4.40	939.00	66.00	3.03	27.00	0.50
Nov-05	2,340,962	3.71	0.84	0.17				2.08			3.62			0.92			4.96			3.04		
Dec-05	2,379,679	4.34	0.97	0.13	73.7	57.4	187.1	1.41	1034/747	--	4.13	354.00	117.00	0.97	2,250.0	10.40	5.06	610.00	187.00	3.79	22.00	0.50
Jan-06	2,418,427	12.02	1.99	0.18				5.32			1.33			1.49			5.95			3.61		
Feb-06	2,457,203	5.57	1.52	0.15				6.32			4.99			1.33			4.76			3.81		
Mar-06	2,496,010	3.89	1.13	0.13				10.86			6.45			2.38			4.31			5.59		

Table 6
Summary of Treatment System Performance Metrics

		Extraction Area						Fabrication Area														
		EW-4	EW-5	EW-6	South Extraction Area			FW-1			FW-2			FW-3			FW-4			FW-7		
Month	Cumulative Volume (in Gallons)	Average Flow Rate (gpm)			Influent Total VOCs Concentration (µg/L)	Mid-Point Train 1 Total VOCs Concentration (µg/L)	Mid-point Train 2 Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)	Average Flow Rate (gpm)	Influent Total VOCs Concentration (µg/L)	Midpoint Total VOCs Concentration (µg/L)
EPA approval to transition from GAC units to Air Cooling Towers March 06																						
Apr-06	2,534,847	3.40	1.13	0.13				4.77			6.19			2.36			4.21			4.94		
May-06	2,573,715	1.96	0.86	0.12	57.9	58.7	52.5	4.12	9114/9121	--	5.52	175.00	--	2.16	1,338.0	--	4.33	693.00	--	4.95	20.00	--
Jun-06	2,612,613	2.38	0.85	0.13				3.46			5.49			2.25			4.57			5.50		
Jul-06	2,651,542	1.63	0.58	0.14				3.56			5.28			2.01			4.06			3.30		
Aug-06	2,690,502	2.22	0.74	0.14	112.6	0	0	3.89	3795/3802	--	6.93	342.00	--	2.13	1,626.0	--	3.83	1,013.00	--	4.37	31.00	--
Sep-06	2,729,492	2.78	0.73	0.13				4.26			6.11			2.18			3.80			3.23		
Oct-06	2,768,513	1.45	0.67	0.12				4.57			5.96			2.11			3.91			3.28		
Nov-06	2,807,564	5.52	1.10	0.16	39.2	7.9	1	5.10	2280.15	--	6.80	64.00	--	2.91	1,563.0	--	5.20	438.00	--	3.79	21.00	--
Dec-06	2,846,646	5.92	1.43	0.16				5.67			7.26			2.75			4.90			3.80		
Jan-07	2,885,759	5.67	1.56	0.15				6.10			7.17			2.60			4.32			3.23		
Feb-07	2,924,900	4.00	1.22	0.14	53.4	23.7	3.4	6.16	1,753.00	--	6.87	98.00	--	2.43	1,126.0	--	4.27	511.00	--	2.65	10.00	--
Mar-07	2,964,072	4.44	1.21	0.15				7.32			7.06			2.36			4.48			2.87		
Apr-07	3,003,274	2.87	0.92	0.15				9.42			12.03			2.16			4.28			3.29		
May-07	3,042,507	2.15	0.84	0.15	51.2	33.5	24.9	4.09	NS	--	12.11	259.00	--	2.11	1,079.0	--	4.05	619.00	--	3.60	10.00	--
Jun-07	3,081,770	1.55	0.66	0.14				8.70			12.13			1.93			4.04			2.12		
Jul-07	3,121,064	1.23	0.55	0.17				11.65			14.69			2.08			3.42			2.98		
Aug-07	3,160,389	1.17	0.44	0.17				12.42			20.15			1.96			3.69			2.73		
Sep-07	3,199,744																					
Oct-07	3,239,130																					
Nov-07	3,278,546																					
Dec-07	3,317,993																					

Table 7
Summary of Ammonia, Fluoride, Total Metals, and Radium in Groundwater, Extraction Area - Feed Makeup Area

Well Type Hot Spot (HS), Non-Hot Spot (NHS), Perimeter (P)	Well	Parameter	Unit	ROD Standard	Baseline July 2000	ReBaseline February 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	PW-28A	AMMONIA [NH_3] / AMMONIUM[NH_4]	mg/L	250	**450**	146	23	**294**	**322.34**		**350**	226	230		250	106
HS	PW-28B				**298**	130										
HS	PW-50A				161	104	92.6	100	114.5	70	100	25.9	40	20	20	17.7
HS	PW-51A				195	56	92.6	90.1	69.65	72	83	55	43	50	45	49.1
HS	PW-52A				**367**	247	**316**	254	239.81	220	220	215	160	150	93	179
NHS	PW-27A					25.8	21.3	21.4	27.03	24	7	40.3	24	30	26	26.8
P	PW-22A				252	199	196	200.7	91.06	240	200	156	180	170	180	
P	PW-23A				81.5	87.5	104	92.7	89.23	120	87	86.4	70	60	58	34.7
P	PW-24A				**265**	87.9	171	72	172.3	140	89	146	160	100	160	45.5
HS	PW-28A	ARSENIC [AS]	mg/L	0.05	**0.239**	0.002 U	0.05 U	**1.05** U	**10** U	**0.06**	0.02 U	**1.5** U	0.02 U		0.02 U	**2.5** U
HS	PW-28B					**0.071**										
HS	PW-50A				**0.107**	**0.0572**	0.05 U	0.0322	0.0162	0.02 U	0.02 U	**0.075** U	0.02 U	0.02 U	0.02 U	0.05 U
HS	PW-51A				0.044	0.002 U	0.005 U	0.014	0.02 U	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U
HS	PW-52A				**0.099**	0.002 U	0.005 U	**0.105** U	**0.067**	0.03	0.02 U	0.037	0.02 U	0.02 U	0.02 U	0.05 U
NHS	PW-27A					0.002 U	0.005 U	0.01 U	0.005 U	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U
P	PW-22A				0.0105	0.0061	0.005 U	0.0148	0.0087	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	
P	PW-23A				**0.124**	0.0042	0.0107	0.01 U	0.0112	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U
P	PW-24A					0.002 U	0.005 U	0.01 U	0.005 U	0.02 U	0.02 U	0.015 U	0.02 U	0.02 U	0.02 U	0.025 U
HS	PW-28A	CADMIUM [CD]	mg/L	0.005	**0.0361**	0.0005 U	**0.01** U	**0.526** U	**5** U	**0.04**	**0.05**	**0.5** U	**0.04**		**0.05**	**0.5** U
HS	PW-28B					0.0005 U										
HS	PW-50A				**0.025**	0.0008	**0.01** U	**0.0219**	**0.0121**	**0.01**	**0.01**	**0.025** U	**0.01** U	**0.01** U	**0.01** U	**0.01** U
HS	PW-51A				**0.0127**	0.0021	0.003	**0.0076**	**0.0119**	**0.01** U	**0.01** U	**0.0052**	**0.01** U	**0.01** U	**0.01** U	0.005 U
HS	PW-52A				**0.0171**	0.001	0.0024	**0.0524** U	**0.0177**	**0.03**	**0.02**	**0.0066**	**0.02** U	**0.02**	**0.02**	**0.01** U
NHS	PW-27A					0.0005 U	0.001 U	0.005 U	0.001 U	**0.01** U	**0.01** U	0.005 U	**0.01** U	**0.01** U	**0.01** U	0.005 U
P	PW-22A				0.00025 U	0.0005 U	0.001 U	0.005 U	0.001 U	**0.01** U	**0.01** U	0.005 U	**0.01** U	**0.01** U	**0.01** U	
P	PW-23A				0.00025 U	0.0005 U	0.001 U	0.005 U	0.001 U	**0.01** U	**0.01** U	0.005 U	**0.01** U	**0.01** U	**0.01** U	0.005 U
P	PW-24A					0.0005 U	0.001 U	0.005 U	0.001 U	**0.01** U	**0.01** U	0.005 U	**0.01** U	**0.01** U	**0.01** U	0.005 U
HS	PW-28A	CHLORIDE [CL]	mg/L	none	9,920	12,800	13,300	8,590	10,300	7,200	7,700	6,140	7,000		7,000	7,380
HS	PW-28B				10,767	11,000										
HS	PW-50A				8,362	8,930	6,460	4,640	3,840	4,800	3,100	4,610	4,000	3,400	3,300	2,490
HS	PW-51A				5,030	4,620	4,600	3,220	3,960	2,600	2,800	2,270		1,900	1,900	1,510
HS	PW-52A				9,310	9,040	8,390	7,130	6,410	5,700	5,000	4,670	4,600	3,900	3,700	4,850
NHS	PW-27A					907	1,180	806	852	880	1,100	848	1,000	1,000	1,100	2,160
P	PW-22A				19,034	377	555	449	363	420	500	323	530	360	400	
P	PW-23A				194	412	338	285	258	300	350	284	380	200	260	156
P	PW-24A				162	61	132	47.8	104	79	95	130	150	68	120	97.8
HS	PW-28A	FLUORIDE [F]	mg/L	2	**12.9**	0.1 U	**6.19**	**25** U	**4.984**	**8**	**9**	1 U	**8**		**9**	0.1 U
HS	PW-28B				**6.9** J	0.1 U										
HS	PW-50A				**12.4**	0.1	**5.62**	**35.8**	**25.865**	**8**	**26**	0.5 U	**8**	**6**	**5**	1.9
HS	PW-51A				**148**	0.5	**4.77**	**13**	**10.089**	**11**	**9**	**6.56**	**6**	**6**	**5**	**2.7**
HS	PW-52A				**30.2**	0.3	**5.7**	**35.2**	**22.992**	**34**	**25**	1.86	**25**	**22**	**17**	0.28
NHS	PW-27A					0.2	1.87	2 U	0.1 U	1 U	1 U	0.5 U	1 U	1 U	1 U	0.1 U
P	PW-22A				**10** U	**3.66**	0.39	**2.41**	1.75	**3**	**3**	**2.78**	**3**	**4**	**5**	
P	PW-23A				**13.6**	**14.6**	**12.8**	**14.6**	**12.1**	**15**	**12**	**10.4**	**10**	**14**	**15**	**17.8**
P	PW-24A				**4.6**	1	0.32	0.29	0.35	1 U	1 U	0.1 U	1 U	1	1	0.68
HS	PW-28A	IRON (FE)	mg/L	none	1,450	642	883	727	768	390	510		440		310	
HS	PW-28B				1,480	667										
HS	PW-50A				599	647	179	146	124	22	90	20.2	29	19	14	
HS	PW-51A				55.1	51.7	18.5	40.1	24.3	18	18	9.24	6.9	8.9	4.8	
HS	PW-52A				471	292	21.4	278	251	170	140	153	130	160	99	
NHS	PW-27A					1.05 U	0.284	0.158	1.5	1.2	0.63	0.211	3.2	1.3	0.39	
P	PW-22A				20.2	25.4	29.5	21.9	22.5	13	27	13	31	13	14	
P	PW-23A				19.9	1.96	3.59	2.02	3.39	4.2	2.1	2.08	2.8	1.7	1.5	
P	PW-24A				1 U	1.05 U	0.1 U	0.1 U	0.01 U	0.05 U	0.05 U	0.1 U	0.05 U	0.05 U	0.05 U	
HS	PW-28A	MANGANESE [MN]	mg/L	0.05	**18.2**	**10.2**	**15.3**	**15**	**24.1**	**9.3**	**17**		**14**		**16**	**11.2**

Table 7
Summary of Ammonia, Fluoride, Total Metals, and Radium in Groundwater, Extraction Area - Feed Makeup Area

Well Type Hot Spot (HS), Non-Hot Spot (NHS), Perimeter (P)	Well	Parameter	Unit	ROD Standard	Baseline July 2000	ReBaseline February 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	PW-28B				16.5	9.16										
HS	PW-50A				107	11.8	58.3	68.2	75.3	41	51	50.7	43	33	28	28.7
HS	PW-51A				58.4	50.1	13.5	43	55.1	26	40	35.6	26	30	19	19.1
HS	PW-52A				48	17.1	4.27	75.8	78.8	44	67	54.3	38	47	26	30.2
NHS	PW-27A					2.42	1.35	2.63	2.02	2.1	1.6	2.7	2.7	2.5	1.8	2.05
P	PW-22A				3.53	3.38	4.18	2.66	2.75	2.5	3.7	2.01	4.4	2.6	2.7	
P	PW-23A				4.65	15.6	12.3	10.1	11.1	10	14	11.9	13	11	9.2	8.02
P	PW-24A				9.11	2.81	8.25	2.33	7.88	4.3	6.1	5.49	7.7	3.4	6.2	5.51
HS	PW-28A	NICKEL [NI]	mg/L	2	6.25	4.75	6.13	3.79	20 U	2.7	4.1	2.46	3		2.6	2 U
HS	PW-28B				6.47	4.57										
HS	PW-50A				3	4.04	1.75	1.87	1.74	0.55	1	0.536	0.56	0.38	0.33	0.326
HS	PW-51A				2 U	0.989	0.472	1.08	1.07	0.69	0.65	0.523	0.45	0.41	0.36	0.297
HS	PW-52A				3.54	2.43	0.38	3.46	3.42	2.3	1.9	2.23	1.8	1.7	1.4	2.25
NHS	PW-27A					0.21 U	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02	0.02 U
P	PW-22A				0.2 U	0.211 U	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	
P	PW-23A				0.2 U	0.21 U	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02	0.02 U
P	PW-24A				0.2 U	0.21 U	0.01 U	0.02 U	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02	0.02 U
HS	PW-28A	TOTAL DISSOLVED SOLIDS [TDS]	mg/L	none	16,300	22,400	28,400	21,600	18,800	10,600	14,000	11,800	13,000		1,200	15,200
HS	PW-28B				15,900	17,700										
HS	PW-50A				12,900	19,700	9,070	6,970	8,200	7,800	4,800	7,710	6,900	5,400	4,900	5,070
HS	PW-51A				8,230	10,300	8,760	6,680	7,100	4,800	5,300	5,200	4,600	3,400	3,300	3,980
HS	PW-52A				11,800	14,800	12,200	10,300	11,300	7,900	7,200	6,570	6,900	5,300	4,700	6,370
NHS	PW-27A					2,760	2,960	2,790	3,340	2,800	3,200	3,110	3,400	3,100	3,000	3,600
P	PW-22A				898	779	866	856	678	670	730	654	930	1,100	670	
P	PW-23A				1,000	1,450	1,220	1,030	1,180	1,100	1,300	1,200	1,500	860	1,000	821
P	PW-24A				1,590	562	1,570	616	1,460	990	1,100	1,270	1,500	2,900	1,500	1,190
HS	PW-28A	RADIUM 226 [RA 226]	pCi/L	5	69	107	168	91.3	138	11	10 U	51.4	10 U		10 U	10.4
HS	PW-28B				46	104										
HS	PW-28B				130	90										
HS	PW-50A					65.4	28.3	21	15.4	10 U	10 U	5.7	10 U	10 U	10 U	2.6
HS	PW-51A				0.5	0.6	0.7	1	0.5 U	10 U	10 U	0.2 U	10 U	10 U	10 U	0.2 U
HS	PW-52A				12	45.6	6.1	8.7	6.3	10 U	10 U	2	10 U	10 U	10 U	3.9
NHS	PW-27A					0.6	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2	10 U	10 U	10 U	0.2 U
P	PW-22A				0.2	0.4	0.4	0.2 U	0.4	10 U	10 U	0.2 U	10 U	10 U	10 U	
P	PW-23A				13	0.2 U	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2 U	10 U	10 U	10 U	0.2 U
P	PW-24A					0.2 U	0.2 U	0.2 U	0.2 U	10 U	10 U	0.2 U	10 U	10 U	10 U	0.2 U
HS	PW-28A	RADIUM 228 [RA 228]	pCi/L	5	140	110	352	25.1	56	25	10 U	38.7	10 U		10 U	5.4
HS	PW-50A					52	44.7	25.6	19	10 U	10 U	10.8	10 U	10 U	10 U	6.1
HS	PW-51A				1.7	1 U	2.8	1 U	1 U	10 U	10 U	1 U	10 U	10 U	10 U	1 U
HS	PW-52A				9.3	25	7.3	3.7	1 U	10 U	10 U	1.8	10 U	10 U	10 U	2.7
NHS	PW-27A					1 U	1 U	1 U	1 U	10 U	10 U	1 U	10 U		10 U	1 U
P	PW-22A				1.4	1 U	3.6	5.1	1 U	10 U	10 U	1 U	10 U		10 U	
P	PW-23A				2.6	1 U	1 U	1 U	1 U	10 U	10 U	1 U	10 U		10 U	1 U
P	PW-24A					1 U	1 U	1 U	4	10 U	10 U	1 U	10 U		10 U	1 U
HS	PW-28A	pH	unit	5 to 9	1.25	3.12		1.4	1.89	2.3	2.15	1.91	1.92	2.3	1.68	
HS	PW-50A				1.89			2.4	2.89	3.62	3.53	3.08	1.97	3.45	3	
HS	PW-51A				3.64	5.75		3.37	4	4.03	4.36	4.3	3.16	4.17	3.85	
HS	PW-52A				2.1			3.02	3.39	3.54	3.68	3.64	2.33	3.64	3.2	
NHS	PW-27A							5.61	6.08	6.01	6.28	6.05	5.68	5.97	5.73	
P	PW-22A				6.64			6.73	6.76	6.81	6.65	6.51	6.3	6.63	6.18	
P	PW-23A				6.83			6.99	6.97	7.03	6.85	6.67	6.6	6.77	6.46	
P	PW-24A				6.38			6.33	6.6	6.49	6.44	6.31	6.14	6.3	6.17	

Table 8

Summary of VOCs Concentration in Groundwater, Extraction Area - South Extraction Area

All Concentrations in micrograms per liter (µg/L)

Well Type Non-Hot Spot (NHS), Perimeter (P)	Well	Parameter	ROD Standard	Baseline July 2000	Jan-01	Apr-01	Jul-01	Apr-02	Oct-02	Apr-03	Oct-03	Apr-04	Sep-04	May-05	Sep-05	May-06	Aug-06	May-07
NHS	PW-47A	cis-1,2-DCE	70	6	4.4	3.3	5.7	4.8	3.5	5.17	4.68	9.04	8.16	7.3	4	12.1	13.7	13.5
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U	--	--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			1	1 U	1 U	1.4	1 U	1.9	1 U	1.05	0.94	0.78	0.5 U	2.3	0.73	0.95	0.51
P	PW-26A			1.6	2.2	1.6	2.7	1.9	2.4	1 U	1.96	0.5 U	0.73	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J
P	PW-49A			0.7 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-57A			4.5	1 U	3.5	7.7	2.6	6	3.56	5.52	4.62	5.96	5.2	6.1	5.3	5.9	5.2
NHS	PW-47A	1,1-DCA	1280 (6)	41.2	34.2	28.4	27.3	30.7	24.3	26.57	28.9	45.5	41	26.8	18.7	34.7	46.4	44.9
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U	--	--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			6.5	2.2	1.09	4.2	1.5	6	1 U	2.86	3.92	3.03	1.4	5.2	3.7	6	2.7
P	PW-26A			1.4	2.5	1.9	1.8	1 U	1.8	1 U	2.07	0.5 U	0.98	0.5 U	0.5 U	0.5 U	0.11 J	0.18 J
P	PW-49A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-57A			22.8	22.8	21.6	26.7	18.8	40	28.06	30.45	26.58	32.35	25.6	29.8	22.2	22.6	20.8
NHS	PW-47A	DCE	7	**11.7**	**7.4**	4.9	**11**	6.1	2.6	6	2.78	**7.73**	5.42	6.4	2.9	**7.4**	**10.8**	**11.3**
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U	--	--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			2.6	1.3	1 U	2.5	1 U	1.5	1 U	1 U	1.22	0.82	0.5 U	1.3	1.1	1.8	0.71
P	PW-26A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-49A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-57A			**8.1**	**11.2**	6.5	**13.5**	**7.1**	**10.1**	5.52	**8.3**	6.32	**7.9**	7	**8.1**	6.1	5.8	5.6
NHS	PW-47A	PCE	5	**5.5**	2.4	4.6	**5.9**	3	3.2	3.4	3.13	4.81	3.71	2.8	1.6	3.1	3.8	4.1
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U		--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			3	1.2	1 U	2.9	1 U	2.8	1 U	1.47	1.38	1.19	0.59	2.3	1.1	1.5	0.85
P	PW-26A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J	0.13 J
P	PW-49A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-57A			3.9	**5.8**	4.1	**7.1**	4.3	4.3	4.15	3.96	3.93	3.6	2.9	3.3	3	2.7	2.4
NHS	PW-47A	TCA	200	68	55	82.3	66.7	97.6	54.9	95.77	75.68	134 D	117.81 D	86.5	49.9	99.3	130	116 D
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U	--	--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			4.1	1.5	1 U	2.9	1 U	2.9	1 U	1.17	1.79	1	0.59	1.9	1.3	2	1.2
P	PW-26A			2.1	4.6	2.5	2.8	1.8	1.9	1 U	2.54	0.64	1.45	0.5 U	0.5 U	0.5 U	0.34	0.62
P	PW-49A			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-57A			42.1	48	44.2	78	44	76.6	60.69	60.16	48.65	58.65	52.1	59.6	41.1	45	42.6
NHS	PW-47A	TCE	5	**38.4**	**27**	**47.7**	**34.7**	**43.5**	**34.6**	**50.55**	**48.18**	**72.77**	**68.47**	**52.3**	**34.5**	**69.6**	**78.9**	**63.3**
NHS	PW-48A			1 U	1 U	1 U	--	1 U	--	--	1 U	--	--	0.5 U	--	0.5 U	--	0.5 U
P	PW-25A			**6.5**	2.5	1.08	**5.1**	1.8	**5.6**	1 U	3.13	3.5	2.53	1.3	4.7	2.4	3.8	1.8
P	PW-26A			**8.1**	**13.4**	**8.7**	**7.1**	**12.4**	**12.3**	**9.1**	**6.46**	2.39	3.7	1.9	1.1	1.5	1.3	1.7
P	PW-49A			**8.4**	2.5	1 U	**6.1**	3.5	**6.1**	1.12	1.21	**5.18**	0.5 U	1.4	4.2	2.5	1.1	2.2
P	PW-57A			**32.8**	**41.5**	**28.7**	**44.3**	**28.4**	**46.7**	**40.93**	**41.97**	**34.56**	**42.2**	**35.1**	**41.1**	**39.9**	**41.6**	**30.7**

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	1,1-DCA	3700 (7)	58.2	16.8	1.3	2.8	1.66	5.45	2.4	2.73	0.57	0.5 U	0.12 J	0.5 U	0.15 J
HS	MW-02A			154	157	206	197	131.42	124	102	75.06	28.3	10.6	6.5	6.4	4.6
HS	MW-03A			2.81	36.8	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-04A			75	81	21.9	68.6	23.52	38.42	9.98	31.06	9.4	11	5.2	11.9	3.8
HS	PW-01A			24.3	29.5	58.9	64.5	47.03	47.87	58.4	58.84	64.8	54.4	52.6	56.1	50.8
HS	PW-03A			49.9	154	21.5	18.3	5.62	6.66	5.33	6.44	4.8	2.5	1.8	1.6	0.77
HS	PW-11			54.3	158	93.7	29.9	12.38	27.99	32.28	51.52	6.9	47.3	5.6	18.5	1.6
HS	PW-12			901	120	149	162	99.17	71.51	82.26	114.25	139	242	83.3	55	123
HS	PW-13			1,660	1,390	1,890	1,730	1,260	865	1,370	842	1,430	1,440	1,210	545	285 D
HS	PW-30A			34.4	32	26.1	39.3	12.9	39.57	32.96	25.25	25.6	18.8	24.8	32.5	17
HS	PW-42A			21.8	72.3	14.3	7.2	10.14	6.04	6.91	5.25	3.1	4.2	2.6	5.8	8.4
HS	PW-45A			128 L	65.3	53.4	47.7	71.51	56.7	72.79	91.96	42.5	54.7	27.7	1.6	21.1
HS	PW-68A			53.1	4.6	1 U	76.2	0.5 U	2	7.68	1.09	0.5 U	2.5	0.65	0.32 J	0.78
HS	PW-69A			648	1,280	1,520	2,110	1,440	1,390	949	736	677	525	748	274	205
HS	PW-71A			51.4	51.1	14.2	8.7	9.88	8.62	10.21	4.78	8.5	10.9	1.9	1.5	0.5 U
HS	PW-73B			41.6	50.6	41.6	43.9	30.14	31.15	23.75	21.99	19	16.9	12.1	10.8	11.8
HS	PW-83A			11.4	5.3	6.1	4.1	2.87	3.23	3.12	3.12	2.5	2.7	1.6	1.9	1.2
HS	PW-85A			17.4	15.3	38	7.1	13.4	12.53	6.28	5.87	9.3	7.9	5.2	6.7	6.2
HS	PW-86A			243	233	359	198	143.65	35.8	73.91	80.89	48.2	39.2	22.8	18.2	2.3
NHS	PW-10	1,1-DCA	3700 (7)	327	323	264	328.85	161.25	193	111	129.35	69.5	171	81.2	114	131 D
NHS	PW-14			2.2												
NHS	PW-16A			1 U			1.8	1.1	1.34	1.05	1.51	1.4	1.3	1.5	2.3	1
NHS	PW-19A			1.7										0.5 U	0.5 U	0.5 U
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			9.5	29.8	21.9	15	9.33	8.73	15.63	4.38	6.8	2.2	5.7	0.27 J	5.4
NHS	PW-70A			1 U												
NHS	PW-72A			3.1	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U				
NHS	PW-74B			3.2	9.3	9.1	10.8	5.7	7.35	5.76	5.96	6.7	8.7	10.5	8.2	7.2
NHS	PW-75A			54.6	20.4	13.3	24	14.3	22.64	30.14	23.54	17.3	10.8	12	10.2	5.5
NHS	PW-80A			15.6	15.1	12.1	11.6	9.02	6.97	8.84	4.08	1.8	1.2	1.9	1.3	1.8
NHS	PW-81A			1 U												
NHS	PW-82A			1.8	2.3	1.6	1.6	0.94	0.84	0.61	0.68	0.5 U	0.5 U	0.32 J	0.5 U	0.27 J
NHS	PW-84A			6.5	1.9	1.5	1.4	0.94		0.75	0.59	0.62	0.74	0.7	0.86	1.2
NHS	PW-87A			1.5	1.3	1.5	1 U	0.84	1 U	0.77	0.5 U	0.8	0.5 U	0.77	0.5 U	0.62
NHS	PW-88A			1 U	1 U	1 U	1 U	0.5 U	1 U	2.67	6.96	5.9	2.9	4.3	0.28 J	0.57
NHS	PW-89A			5.7	2.9	5.5	3.4	0.5 U	1 U	2.86	2.99	2.4	1.9	1.6	0.67	1.4
NHS	PW-91A			63.2	34.5	23.3	29	11.77	16.72	19.21	6.23	13.1	5.3	10.6	0.23 J	0.5 U
NHS	PW-92A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	1,1-DCA	3700 (7)	5 U												
P	PW-76A			2.3	36.5	1.6	1.71	3.01	1.96	2.5	4.83	5.4	0.65	0.5 U	0.5 U	0.28 J
P	PW-77A			189	225	167	163.05	118.8	127.44	341	449	478	483	526	477	515 D
P	PW-78A			118	211	195	95.2	143.52	123.09	143	99.08	130	124	144	99.4	123 D
P	PW-79A			12.3	14.8	30.2	18.6	27.93	52.72	30.91	20.49	22.5	34.1	26.8	36.4	26.9

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	DCE	7	**131**	**24.7**	4.4	3.3	2.45	**8.83**	4.1	3.89	1.4	0.66	0.25 J	0.5 U	0.5
HS	MW-02A			**455**	**377**	**414**	**375**	**237.22**	**253.93**	**219**	**188.7**	**177**	**185**	**151**	**108**	**96.7**
HS	MW-03A			**9.6**	**76**	1	1.9	1	1	0.5	0.74	0.5	0.5	0.1 J	0.19 J	0.5 U
HS	MW-04A			**224**	**164**	**67.1**	**166**	**59.37**	**101**	**32.4**	**98.41**	**34.9**	**48**	**27.4**	**58.4**	**23.3**
HS	PW-68A			**222**	3.2	3	**154**	1 U	3.26	6.08	1.38	0.5 U	3.2	0.84	0.37 J	0.88
HS	PW-69A			**247**	**217**	**232**	**212**	**153**	**160.51**	**127**	**90.14**	**152**	**79.8**	**102**	**24.9**	**48.4**
HS	PW-73B			**56.8**	**56**	**48**	**55.4**	**33.25**	**36.42**	**30.78**	**28.39**	**25.6**	**25.5**	**18.8**	**18.5**	**20.3**
NHS	PW-10	DCE	7	**18.6**	**29.6**	**15.2**	**18.59**	**9.89**	**14.04**	**8.8**	**9.67**	6.6	**10.9**	**7.7**	**7.1**	**9.5**
NHS	PW-14			1 U												
NHS	PW-16A			1.7			3.5	1.16	2.33	1.95	3.95	3.5	4	3.7	**7.3**	2.8
NHS	PW-19A			1 U										0.5 U	0.5 U	0.5 U
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			**9.2**	**16.3**	**18.6**	**14.3**	**9.48**	**9.4**	**18.15**	5.24	**8.8**	0.71	**9.7**	0.18 J	**9.6**
NHS	PW-70A			1 U												
NHS	PW-72A			2.2	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U				
NHS	PW-74B			5.1	**9.4**	**10.7**	**9.4**	3.86	4.99	4.48	4.33	5	6.7	**8.1**	6.4	5.9
NHS	PW-75A			**51.4**	1 U	**14.8**	**27.9**	**10.92**	**18.13**	**21.81**	**15.34**	**14.6**	**10.8**	**8.2**	**13.7**	5.7
NHS	PW-80A			**93.6**	**71.1**	**81.3**	**57.4**	**37.71**	**30.6**	**38.02**	**14.73**	6	3.5	5.8	2.9	5.6
NHS	PW-81A			1 U												
NHS	PW-82A			**9.3**	**9.6**	**11.3**	5.3	1 U	2.88	2.53	2.11	1.3	0.5 U	1	1.9	1
NHS	PW-84A			**22.9**	2.9	2.1	1 U	1 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2	1.9
NHS	PW-87A			1.4	1.4	2.9	1.2	1 U	1 U	0.94	0.5 U	1	0.5 U	0.94	0.5 U	0.7
NHS	PW-88A			1 U	1 U	1 U	1 U	1 U	1 U	1.28	3.01	2.7	1.3	2	0.14 J	0.32 J
NHS	PW-89A			3.5	1.3	2.2	1 U	3.14	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.21 J
NHS	PW-91A			**70.6**	**29.7**	**18.7**	**29.3**	**10.43**	**11.48**	**10.76**	5.62	**9**	**7.7**	**9.3**	0.23 J	0.1 J
NHS	PW-92A			1 U	1.1	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	DCE	7	5 U												
P	PW-76A			6.9	1.4	1.5	0.7	1 U	**29.38**	**29.27**	0.61	0.86	4	0.5 U	0.5 U	0.79
P	PW-77A			**90.7**	**96.3**	**39.8**	**16.45**	**22.89**	**40.54**	**45.09**	**62.12**	**68.3**	**85**	**31.1**	**51.7**	**27.5**
P	PW-78A			**67**	**95.1**	**116**	**84.2**	**72.25**	**66.72**	**65.59**	**51.04**	**64.1**	**62.4**	**69.6**	**60.2**	**58.1**
P	PW-79A			**16.6**	**10.5**	**37.5**	**12.8**	**25.13**	**41.25**	**18.29**	**11.25**	**18.9**	**29.4**	**30.7**	**24.3**	**20.8**

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	TCA	200	2.4	1.2	1 U	2.2	1 U	79.84	0.5 U	9.99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-02A			37	21.3	18.4	22	10.56	11.14	6.24	4.84	0.51	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-03A			3.7	68.1	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-04A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-68A			**652**	7.5	5.7	**202**	0.62	4.17	8.36	1.77	0.87	3.4	0.88	0.54	0.95
HS	PW-69A			**3,790**	**4,240**	**5,840**	**5,810**	**3,400**	**2,620**	**2,570**	**1,390**	**2,100**	**1,780**	**885**	**384**	**482**
HS	PW-73B			1.9	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-10	TCA	200	125	188	121	136.6	82.55	104	70.83	73.58	55.9	62.6	58.9	69.2	78.7
NHS	PW-14			1 U												
NHS	PW-16A			2.6			5.4	1.71	3.98	3.23	5.75	5.1	7	4.1	10.7	4.3
NHS	PW-19A			1 U										0.5 U	0.5 U	0.5 U
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			1 U	2.7	4.3	1.5	0.85 J	1 U	0.95	0.5 U	0.57	0.5 U	0.32 J	0.5 U	0.56
NHS	PW-70A			1 U												
NHS	PW-72A			2.4	2	1.9	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U				
NHS	PW-74B			1.1	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J
NHS	PW-75A			**311**	29	125	38.6	134	37.92	**313**	88.85	85.5	14.1	46.9	14.3	44.2
NHS	PW-80A			108	95.5	133	71.9	48.85	45.57	55.44	16.4	6.9	3.2	6.3	3.8	7.2
NHS	PW-81A			1 U												
NHS	PW-82A			9.4	9.6	6.7	4.8	0.5 U	1.9	1.21	1.06	0.63	0.5 U	0.29 J	0.5 U	0.22 J
NHS	PW-84A			18.2	1.8	1 U	1 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 J
NHS	PW-87A			1.018	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-88A			2.6	1.5	1.4	2.6	0.68	1.48	1.31	0.96	1.1	0.73	0.72	0.5	0.49 J
NHS	PW-89A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-91A			**391**	43.9	**278**	160	143.28	63.55	97.9	6.63	52.5	8.7	43.9	0.16 J	0.5 U
NHS	PW-92A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	TCA	200	39												
P	PW-76A			14.8	1.6	2	2.18	0.5 U	75.57	80.55	1.57	1.8	7.3	0.5 U	0.5 U	2.1
P	PW-77A			50 U	2.1	3.1	2.22	1.28	0.56	5.51	16.35	28.9	26.8	17.7	13.1	14.6
P	PW-78A			22.8	17.8	14.4	13.9	10.63	13.35	13.9	7.86	7.5	8.8	8.4	12.1	16.7
P	PW-79A			28.9	15.9	84.4	28	81.02	151.95	69.12	26.48	48.4	72.6	71.4	67	70.5

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	TCE	5	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-02A			2.4	1.8	2 U	2.1	1.55	1.29	1.41	1.11	1	0.87	0.89	0.83	0.66
HS	MW-03A			1 U	1 U	1	1 U	1 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J
HS	MW-04A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-01A			**5.5**	5	**10.3**	**10.1**	**8.91**	**8.51**	**10.79**	**9.77**	**13.3**	**9.6**	**10.9**	**10**	**10.4**
HS	PW-03A			**6.4**	**46.5**	2.1	2.2	0.87	0.92	0.84	1.13	0.97	0.56	0.5 U	0.5 U	0.21 J
HS	PW-11			**13.9**	**45.8**	**89.6**	**13.4**	**6.3**	**31.35**	**43.99**	**70.72**	4	**65**	**5.5**	**27.6**	1.9
HS	PW-12			**186**	**17.5**	**24.3**	**20.9**	**10.58**	**7.99**	**8.55**	**10.75**	**14.3**	**24.8**	**9.7** J	**7.7**	**15.2**
HS	PW-13			**14.1**	**8.5**	**11.7**	**15.1**	**10.13**	**7.9**	**10.48**	**7.7**	**11.0**	**11.0**	**10.4**	**5.6**	3.7
HS	PW-30A			5	2.7	**5.5**	4.6	1.14	3.73	3.55	2.6	3	1.9	3.1	3.9	2.4
HS	PW-42A			**112**	**110**	**106**	**84**	**54.49**	**105.24**	**66.36**	**92.99**	**82**	**1,100**	**20.4**	**39.4**	**77.3**
HS	PW-45A			3.5	2.4	2.4	2.5	2.14	2.04	2.04	1.82	1.7	1.6	1.4	0.12 J	1.8
HS	PW-68A			1 U	1	1 U	1 U	0.5 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-69A			**11.2**	**6.6**	**25.1**	**8.4**	**8.51**	**10** U	**8.65**	5 **U**	**8.8**	**6**	**5.9**	2.5 J	3.2 J
HS	PW-71A			**13.6**	4.2	**88.2**	**159**	**221.1**	**249.1**	**88.71**	**330**	**244**	**21.5**	2	0.55	0.5 U
HS	PW-73B			**31**	**23.1**	**22.4**	**24**	**19.14**	**18.51**	**14.58**	**14.46**	**14.5**	**13.1**	**9.7**	**8.1**	**10.8**
HS	PW-83A			1.8	1 U	1 U	0.8	0.5 U	0.58	0.51	0.50001	0.5 U	0.5 U	0.5 U	0.5 U	0.24 J
HS	PW-85A			4.3	1.3	3	1 U	1.37	1.05	0.62	0.57	0.77	0.76	0.55	1.1	4.3
HS	PW-86A			**373**	**244**	**239**	**289**	**215.4**	**359.61**	**281**	**272**	**275**	**258**	**205**	**137**	**11.2**
NHS	PW-10	TCE	5	**6**	**5.6**	**5.2**	**9.15**	3.73	4.65	3.63	3.67	2.9	3.7	2.5	3.4	3.4
NHS	PW-14			1 U												
NHS	PW-16A			1 U			1.3	0.51 J	1 U	0.68	1.38	1.2	1.4	1.4	3	1.4
NHS	PW-19A			1 U										0.5 U	0.5 U	0.5 U
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			**5.2**	**6.8**	**8.7**	**7.4**	**6.25**	**5.61**	**11.41**	3.24	**5.8**	0.5 U	**5.7**	0.5 U	**5.4**
NHS	PW-70A			1 U												
NHS	PW-72A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 **U**	0.5 U				
NHS	PW-74B			3.7	4.6	4.8	4.9	2.91	3.19	2.67	2.27	2.7	3.7	3.8	2.8	3
NHS	PW-75A			**6.3**	1 U	1 U	3.5	1 U	2.24	0.91	0.65	0.9	0.5 U	0.5 U	4	0.58
NHS	PW-80A			**19.7**	**12.7**	**16.4**	**11.1**	**11.88**	**8.64**	**11.25**	4.69	2	1	2	1.3	2.3
NHS	PW-81A			1 U												
NHS	PW-82A			1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-84A			1.2	1 U	1 U	1 U	0.5 U		0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	1.9	**14.5**
NHS	PW-87A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-88A			1 U	1 U	1 U	1 U	0.5 U	1.52	**7.68**	**21.79**	**21.5**	**10.3**	**17**	0.63	1.3
NHS	PW-89A			**20.3**	**5.6**	**10.9**	**8.6**	3.02	2.56	3.39	3.56	3.4	2.6	2.7	1.8	3
NHS	PW-91A			4.3	3	2	2.2	0.97	1.01	0.86	0.5 **U**	0.59	0.5 U	0.49 J	0.5 U	0.5 U
NHS	PW-92A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 **U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	TCE	5	5 U												
P	PW-76A			1 U	1.5	2.1	0.53	0.79	0.5 U	0.5 U	0.84	1.4	0.5 U	0.5 U	0.5 U	0.12 J
P	PW-77A			**50** U	**6.3**	4.8	2.89	2.41	3.04	2.74	4	4.1	4.2	3.4	3.7	3.8
P	PW-78A			2 U	1.6	2.2	1 U	1.9	1.51	1.5	1.28	1.8	1.3	1.7	1.5	1.9
P	PW-79A			1.4	1 U	2	1 U	2.24	3.21	1.96	1.44	2.4	2.5	3.2	2.6	2.8

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	PCE	5	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-02A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U
HS	MW-03A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-04A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-01A			1 U	1 U	1 U	1 U	1 U	0.51	0.5 U	0.52	0.5 U	0.5 U	0.5 U	0.2 J	0.15 J
HS	PW-03A			1.1	**14.7**	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.12 J
HS	PW-11			3.3	**14.4**	**15.2**	4	1.85	**8.87**	**11.56**	**19.32**	2.4	16.2	1.9	7.6	1.1
HS	PW-12			**34.2**	4.3	**5.7**	**5.7**	1.97	2.14	2.72	3.5	**7.7**	10.5	25 U	3.2	7.2
HS	PW-13			2.8	2.1	2.4	3.4	1.54	1.39	2.5 U	2.5 U	**5.1**	2.5 U	2.5 U	1.5	0.62
HS	PW-30A			1.3	1 U	1 U	1.2	1 U	1 U	2.5 U	2.5 U	2.5 U	1.1 U	0.75 J	1	0.77
HS	PW-42A			2.5	5	4	2.4	1.33	1.62	0.63	0.56	1.5	40.7	0.5 U	0.39 J	3.8
HS	PW-45A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.13 J	0.5 U	0.2 J
HS	PW-68A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-69A			**8.6**	**11.8**	**16.2**	**12.6**	**11.41**	**10.27**	**13.04**	**8.98**	**14.3**	12	13.4	7.6	11.7
HS	PW-71A			2.2	4.2	**6.5**	**12.8**	**8.54**	**10.06**	4.91	**13.39**	**11.3**	0.75	0.5 U	0.09 J	0.5 U
HS	PW-73B			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	PW-83A			1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J
HS	PW-85A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.26 J
HS	PW-86A			2.8	**6.4**	**5.3**	**5.8**	1 U	**9.1**	4.41	2.62	3.6	3.1	2.1	2.1	0.82
NHS	PW-10	PCE	5	2.1	4.7	4.9	3.33	2.69	2.62	2.39	2.8	1.9	2.1	1.9	2	3
NHS	PW-14			1 U												
NHS	PW-16A			1 U			1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.32 J	0.8	0.45 J
NHS	PW-19A			1 U										0.11 J	0.5 U	0.21 J
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-70A			1 U												
NHS	PW-72A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U				
NHS	PW-74B			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-75A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-80A			3.2	2.5	3	1.9	2.25	1.5	2.56	1.13	0.5 U	0.5 U	0.5 U	0.5 U	0.59
NHS	PW-81A			1 U												
NHS	PW-82A			1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.13 J	0.5 U	0.13 J
NHS	PW-84A			1 U	1 U	1 U	1 U	1 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.11 J
NHS	PW-87A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-88A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.14 J
NHS	PW-89A			1.1	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.36 J
NHS	PW-91A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-92A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	PCE	5	5 U												
P	PW-76A			1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-77A			**50** U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1 U	0.36 J	0.37 J	0.53 J
P	PW-78A			2 U	1 U	1 U	1 U	1 U	1 U	0.61	0.5 U	0.6	0.5 U	0.5	0.54	0.66
P	PW-79A			1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.59	0.5 U	0.76

Table 9
Summary of VOCs Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P)	Well Location	Parameter	ROD Standard	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	VC	2	**36.3**	**4.3**	1 U	1.2	0.69	1 U	**2.14**	0.5 U	0.74	0.5 U	0.5 U	0.5 U	0.17 J
HS	MW-02A			**166**	**137**	**155**	**161**	**143.6**	**172**	**160**	**141**	**100**	**136**	**125**	**128**	**106** D
HS	MW-03A			1.1	**7.2**	1 U	1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
HS	MW-04A			**29.3**	**22.2**	**7**	**22.4**	**12.91**	**19.21**	**7.75**	**14.27**	**6.9**	**7.2**	**6.4**	**10.2**	**4.6**
NHS	PW-10	VC	2	1 U	1 U	1 U	1.18	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 J
NHS	PW-14			1 U												
NHS	PW-16A			1 U			1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-19A			1 U										0.5 U	0.5 U	0.5 U
NHS	PW-20A			1 U												
NHS	PW-31A			1 U									0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-46A			1 U	1 U	1 U	1 U	0.98 J	1 U	**2.35**	0.63	1	0.5 U	1.4	0.5 U	1.4
NHS	PW-70A			1 U												
NHS	PW-72A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U				
NHS	PW-74B			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.52	0.7	0.61	0.58
NHS	PW-75A			1.8	1 U	1 U	1 U	1 U	1 U	0.51	0.5 U	0.5 U	0.5 U	0.5 U	0.62	0.5 U
NHS	PW-80A			1.2	1 U	1 U	1 U	0.95	1 U	0.82	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-81A			1 U												
NHS	PW-82A			1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-84A			1 U	1 U	1 U	1 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-87A			1 U	1 U	1 U	1 U	0.78	1 U	1.22	0.5 U	1.2	0.5 U	1.4	0.5 U	1
NHS	PW-88A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	1.1	0.95	0.5 U	0.98	0.5 U	0.5 U
NHS	PW-89A			1.2	1 U	1 U	1 U	0.73	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NHS	PW-91A			**3**	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.99	0.5 U	0.77	0.53	0.5 U	0.5 U
NHS	PW-92A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-15AR	VC	2	**5** U												
P	PW-76A			1 U	1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
P	PW-77A			**50** U	1 U	1.1	0.5 U	**3.18**	**9.55**	**14.8**	**19.4**	**12.5**	**11.5**	**3.7**	**5.5**	**2.7**
P	PW-78A			2 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.21 J	0.2 J
P	PW-79A			1 U	1 U	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Table 10
Summary of Ammonia, Fluoride, and Nitrate Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P	Well Location	Parameter	ROD Standard (MCL)	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	Fluoride	2	0.12												
HS	MW-02A			0.17					0.2							
HS	MW-03A			0.16												
HS	MW-04A			0.18												
HS	PW-01A			**20** U	**984**	0.972	0.92	1.01	0.68	0.17	0.55	0.67				
HS	PW-03A			1.44	1.91	1.52	1.39	1.02	1.57	0.89	1.54	0.86				
HS	PW-11			**2.44**	**4.33**	**2.398**	**2.08**	1.9	**2.3**	1.68	1.67	1.59	1.6	**2.8**	0.36	2.0
HS	PW-12			0.7	0.96	1.022	0.95	0.6	1.3	1.17	1.02	0.62	0.7	1.5	1.7	**2.1**
HS	PW-13			**43.2**	**34.4**	**24.716**	**9.67**	**14.7**	**12.8**	**19.6**	**10.6**		**11.8**	**14.3**	**18.4**	**10**
HS	PW-30A			0.38							0.25					
HS	PW-42A			0.16												
HS	PW-45A			0.1 U												
HS	PW-68A			0.15												
HS	PW-69A			**11**												
HS	PW-71A			1.1												
HS	PW-73B			0.15												
HS	PW-83A			0.16	1.21	0.48	0.89	0.13	0.25	0.1 U	0.12	0.1 U				
HS	PW-85A			1												
HS	PW-86A			0.1 U												
NHS	PW-10	Fluoride	2	**50**	**58.1**	**49.2**	**53.5**	**39.9**	**38.5**	**23.3**	**32.5**	**25.4**	**25**	**24.2**	**27.7**	**23.3**
NHS	PW-14			**2.06**												
NHS	PW-16A			0.1 U									0.1 U	0.12 J	0.11	0.1 U
NHS	PW-19A			0.1					0.11					0.31 J	0.21	0.16
NHS	PW-20A			0.27												
NHS	PW-31A			0.13						0.1	0.1 U	0.1 U				
NHS	PW-46A			0.29												
NHS	PW-70A			0.1 U												
NHS	PW-72A			**5.62**												
NHS	PW-74B			0.17												
NHS	PW-75A			0.8												
NHS	PW-80A			0.17	0.14	0.3	0.51	0.14	0.2	0.1	0.1 U	0.1 U	0.1 U	0.17	0.23	0.18
NHS	PW-81A			0.1 U												
NHS	PW-82A			0.42	0.88	0.55	1.12	0.25	0.49	0.23	0.32	0.23	0.1 U	0.46 J	0.53	0.52
NHS	PW-84A			0.83												
NHS	PW-87A			0.27												
NHS	PW-88A			0.4												
NHS	PW-89A			**17**	**12.8**	**19**	**9.16**	**15.4**		**16.8**	**19.9**	**17.6**				**17**
NHS	PW-91A			0.6						0.44		0.35				
NHS	PW-92A			0.23	0.5	0.54	1.25	0.31			0.17					
P	PW-15AR	Fluoride	2	0.1 U												
P	PW-76A			0.35	0.86	0.614	0.95	0.3	0.46	0.2	0.31	0.16	0.17	0.48	0.52	0.45
P	PW-77A			0.64	1.15	0.55	1.01	0.19	0.32	0.2	1 U	0.1 U	0.1 U	0.3 J	0.35	0.28
P	PW-78A			0.19	0.37	0.42	0.89	0.12	0.2	0.1	0.17	0.1 U	0.1 U	0.28	0.36	0.29
P	PW-79A			0.96	1.83	0.97	1.32	0.63	0.94	1.12	1.53	1.36	1.2	**2.4**	**3.1**	**2.8**

Table 10
Summary of Ammonia, Fluoride, and Nitrate Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P	Well Location	Parameter	ROD Standard (MCL)	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	Ammonia	250	0.1 U												
HS	MW-02A			0.2 U												
HS	MW-03A			0.1 U												
HS	MW-04A			0.14												
HS	PW-01A			3,530	**976**	**313**	**329**	53.4	188	12.5	**666**	162	**371**	**311**	62.2	**281**
HS	PW-03A			219	152	121	73	98	218	141	185	133	109	82	85.9	63.7
HS	PW-11			6												
HS	PW-12			1.3												
HS	PW-13			7												
HS	PW-30A			0.1 U												
HS	PW-42A			0.1 U									0.1 U			
HS	PW-45A			0.2												
HS	PW-68A			0.3												
HS	PW-69A			0.6												
HS	PW-71A			0.3									0.42			
HS	PW-73B			0.1 U												
HS	PW-83A			34.1	26	30.1	31.5	63.3	33.71	36	35	36	40.2	37	32.9	45
HS	PW-85A			0.35									20.4			
HS	PW-86A			0.7									0.1			
NHS	PW-10	Ammonia	250	1.4												
NHS	PW-14			0.1 U												
NHS	PW-16A			0.1 U												
NHS	PW-19A			0.1 U		0.3	0.1 U		0.15							0.1 U
NHS	PW-20A			0.1 U												
NHS	PW-31A			0.1 U					0.1 U	0.3	0.2	0.12				
NHS	PW-46A			0.3												
NHS	PW-70A			0.1 U												
NHS	PW-72A			0.1 U												
NHS	PW-74B			0.1 U												
NHS	PW-75A			0.5												
NHS	PW-80A			2.14												
NHS	PW-81A			0.1 U												
NHS	PW-82A			65.2	50.5	44.1	66.2	38.2	55.83	45	55	44.5				0.5 U
NHS	PW-84A			0.14									0.1 U	0.38	0.1 U	0.1 U
NHS	PW-87A			0.47									0.722			
NHS	PW-88A			5.22									4.7			
NHS	PW-89A			85.6	32.1	37.2	25.9	66.2		250	100	100	41.8	106	107	118
NHS	PW-91A			0.9						1.3		0.71				
NHS	PW-92A			7.02	6.9	5.3	6	5.6			5.9		4.84	5.5	5.9	7.2
P	PW-15AR	Ammonia	250	0.1 U												
P	PW-76A			0.1 U												
P	PW-77A			0.37												
P	PW-78A			0.1 U												
P	PW-79A			0.2												

Table 10
Summary of Ammonia, Fluoride, and Nitrate Concentrations in Groundwater, Fabrication Area

Well Type Hot Spot (H), Non-Hot Spot (NHS), Perimeter (P	Well Location	Parameter	ROD Standard (MCL)	Baseline Fall 2000	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
HS	MW-01A	Nitrate	10	0.10 U						0.11	0.57					
HS	MW-02A			0.10 U					0.01 U	0.10	0.10					
HS	MW-03A			0.10 U						0.10	0.10					
HS	MW-04A			1.22					0.41							
HS	PW-01A			**20** U	10 U	1.16	0.1 U	5.73	0.02							
HS	PW-03A			**13.1**	**15.4**	**24.6**	**21.8**	**29.1**	**14.6**							
HS	PW-11			**10.6**	**19.6**	7.759	8.5	6.3	**12.4**			9.13	**18.6**	**12.1**	**34.5**	9.2
HS	PW-12			0.1 U	0.78	1.767	1	0.93	0.3194	0.75	0.446	0.37	0.51	0.4	0.82	1.8
HS	PW-13			**97.5**	**61.2**	**63.219**	9.74	**47.6**	**14.5**	**58.5**	**26.7**		**39.5**	0.01 U	**26.5**	**10.1**
HS	PW-30A			0.66					0.46	0.86	2.431					
HS	PW-42A			0.1 U					0.01 U							
HS	PW-45A			0.1 U					0.048							
HS	PW-68A			2.33						2.42	2.43					
HS	PW-69A			0.1 U					0.01 U							
HS	PW-71A			0.12					0.01 U							
HS	PW-73B			0.1 U												
HS	PW-83A			3.41	3.53	4.38	4	**23.6**	6.24	**11.4**	7.98	4.7				
HS	PW-85A			1.02												
HS	PW-86A			0.1 U					1.4							
NHS	PW-10	Nitrate	10	0.1 U	1	1.11	0.75	0.4	0.5224			0.14	0.1 U	0.01 U	0.28	0.34
NHS	PW-14			0.1 U												
NHS	PW-16A			0.1 U									2.76	3.8	2.5	2.6
NHS	PW-19A			1.63					5.86					3.2	1.5	2.2
NHS	PW-20A			**10.1**												
NHS	PW-31A			4.66					7.03	**11.9**	**13.4**	**11.6**				
NHS	PW-46A			0.1 U						0.1 U	0.18					
NHS	PW-70A			0.1 U												
NHS	PW-72A			0.1 U												
NHS	PW-74B			0.23												
NHS	PW-75A			0.1 U					0.01 U							
NHS	PW-80A			4.22	4.39	7.66	3.86	4.83	2.13	2.63	1.679	1.78	1.6	0.01	1.5	2.6
NHS	PW-81A			0.1 U												
NHS	PW-82A			9.25	**13.5**	**11**	**13.6**	**25.2**	**16.4**	**16.3**	**12.665**	**12.7**	**12.5**	9	**10.6**	1.4
NHS	PW-84A			0.65								0.38				
NHS	PW-87A			0.1 U												
NHS	PW-88A			0.1 U					0.49							
NHS	PW-89A			**177**	**149**	**14.4**	**191**	**26.6**	**91**							**78.9**
NHS	PW-91A			0.1 U												
NHS	PW-92A			1.43	3.3	2.61	1.17	0.98	2.72							
P	PW-77A	Nitrate	10	0.1 U	0.01 U	1.4	0.92	0.13	0.01 U	0.1	0.17	0.1 U	0.1 U	0.01 U	0.01 U	0.75
P	PW-78A				0.73	1.11	1.08	0.37	0.64	0.61	0.45	0.25	0.21	0.01 U	0.13	0.24
P	PW-15AR			0.1 U												
P	PW-76A			0.62	0.77	1.33	0.98	0.25	0.01 U	0.1	0.5	0.24	0.45	0.01 U	0.36	0.33
P	PW-79A			7.54	1.41	3.3	4.64	9.93	**18.1**	**20.4**	5.79	6.27	6.1	0.013	9.7	0.85

Table 11
Summary of VOCs Concentrations in Surface Water from Murder and Truax Creeks
October 2006

Parameters	Units	Ambient Water Quality Criteria		Murder Creek				Truax Creek			
		Table 20[8]	Table 33A[9,10]	MC-1	MC-2	MC-3	MC-4	TC-1	TC-2	TC-3	TC-4
Field Parameters											
pH (Units)	S.U.	5 - 9	--	8.25	7.44	7.5	7.59	7.12	7.22	7.12	7.17
Temperature (Degrees Celsius)	°C	--	--	9.3	10.2	10.5	10.7	15.4	9.70	10.0	9.9
DO (mg/L)	mg/L	--	--	--	--	--	--	--	--	--	--
Specific Conductance	µS/cm	--	--	155	133	115	116	9020	938	828	834
Redox (mV)	mV	--	--	--	--	--	--	--	--	--	--
General Chemistry											
Ammonia	mg/L	--	1,000 [11]	--	NT	NT	--	9.4	3.2	2.1	0.55
Fluoride	mg/L	--	--	0.29	0.14	0.52	0.11	--	NT	NT	--
Nitrate	mg/L	--	10,000	0.42	0.14	0.36	0.12	--	NT	NT	--
Total Metals											
Arsenic	mg/L	0.0022	--	--	--	--	--	--	--	--	--
Barium	mg/L	--	1,000	--	--	--	--	--	--	--	--
Cadmium	mg/L	10	--	--	--	--	--	--	--	--	--
Copper	mg/L	--	1,300	--	--	--	--	--	--	--	--
Iron	mg/L	--	300	--	--	--	--	--	--	--	--
Manganese	mg/L	--	50	--	--	--	--	--	--	--	--
Nickel	mg/L	13.4	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds											
Benzene	µg/L	0.66	--	--	--	--	--	--	--	--	--
1,1 Dichloroethane (1,1-DCA)	µg/L	--	--	0.56	0.42 J	0.5 U	0.5 U	0.12 J	1.6	2.7	0.5 U
1,2-Dichloroethane (1,2-DCA)	µg/L	--	0.38	--	--	--	--	--	--	--	--
1,1-Dichloroethene (1,1-DCE)	µg/L	0.033	--	0.45 J	0.3 J	0.18 U	0.5 U	0.14 J	2.6	8.2	0.5 U
Cis 1,2-dichlorethene (Cis 1,2-DCE)	µg/L	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.15 J	4.9	15.7	0.5 U
Hexachlorobenzene	µg/L	--	0.00028	--	--	--	--	--	--	--	--
Methylisobutylketone (MIBK)	µg/L	--	--	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/L	--	0.17								
Tetrachloroethene (PCE)	µg/L	--	0.69	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.52	0.5 U
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	18.4	--	1.4	0.5 U	0.5 U	0.5 U	0.14 J	1.5	2.6	0.5 U
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	--	0.59								
Trichloroethene (TCE)	µg/L	--	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.7	1.7	0.5 U
Vinyl Chloride (VC)	µg/L	--	0.025	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**2.6**	**4.7**	0.5 U

Table 12
Summary of COCs Concentrations in Groundwater, Solids Area

Geologic Unit	Well	Sample Date	Total Manganese (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Total Radium (pCi/L)	Redox (mv)
WS	PW-07	Historic Max (a)	1	--	**14.8**	208	**12.1**	
		11/20/03	**2.44** =	**9.21** =	**17.917** =	127 =	2.5-3	--
		10/20/04	**1.8** =	1 U	5 U	48 =	< 5	--
		9/21/05	**1.5** =	1 U	5 U	47 =	5.9-10.9	--
		9/6/06	**1.3** =	1 U	5 U	56 =	< 10	-143
		6/6/07	**1.6** =	0.12 =	3.9 =	32.4 =	2.6	NA
	PW-09	Historic Max (a)	**7.51**	**4.18**	**54.2**	1241		
		11/20/03	**3.07** =	1.998 =	4.052 =	591 =		--
		10/20/04	**1.4** =	**3** =	6 =	160 =		--
		9/21/05	**0.97** =	**3** =	8 =	160 =		--
		9/7/06	**4**	1 =	--	910 =		-91
		6/6/07	**1.44** =	**3.6** =	--	89.5 =	--	NA
	PW-17B	Historic Max (a)	**23.7**	**2.5**	--	2947		
		11/18/03	**24.6** =	2 U	2 U	2190 =		--
		10/20/04	**19** =	1 =	5 U	1800 =		--
		9/21/05	**20** =	1 =	5 U	1700 =		--
		9/7/06	**15** =	1 =	--	1600		-156
		6/7/07	**17.3** =	0.37 =	--	2200 =	--	NA
	PW-18B	Historic Max (a)	**6.76**	**5.05**	--	1395		
		11/20/03	**0.981** =	**2.49** =	0.2 =	85.7 =		--
		10/20/04	**0.5** =	2 =	5 U	57 =		--
		9/21/05	**0.82** =	2 =	5 U	57 =		--
		9/8/06	**0.56**	**4** =	--	45 =		-176
		6/7/07	**0.214** =	1.9 =	--	34.6 =	--	NA
	PWA-1	Historic Max (a)	**26.6**	**3.67**	--	4090		
		11/18/03	**11.9** =	1 U	1 U	2370 =		--
		10/20/04	**8.8** =	1 U	5 U	1800 =		--
		9/21/05	**8.7** =	1 U	5 U	1600 =		--
		9/6/06	**9.7** =	--	--	2200 =		-175
		6/6/07	**11.3** =	--	--	2370 =	--	NA
	PWB-1	Historic Max (a)	**25**	**3.73**	0.1 U	4832		
		11/18/03	**0.984** =	**2.45** =	0.132 =	111 =		--
		10/20/04	**1** =	2 =	5 U	86 =		--
		9/21/05	**0.91** =	**3** =	5 U	80 =		--
		9/6/06	**1.1** =	2 =	--	60		-158
		6/7/07	**0.976** =	**2.1** =	--	57.3 =	--	NA
	PWC-1	Historic Max (a)	**1.35**	--	--	60		
		11/19/03	**0.623** =	0.33 =	0.1 U	4.72 =		--
		10/20/04	**0.79** =	1 U	5 U	10 U		--
		9/21/05	**1.4** =	1 U	5 U	23 =		--
		9/8/06	**1** =	--	--	10 U		-268
		6/6/07	**1.2** =	--	--	7.3 =	--	NA
	PWF-1	Historic Max (a)	**8.37**	1.19	--	659		
		11/19/03	**1.01** =	0.708 =	**32.4** =	206 =		--
		10/20/04	**0.68** =	1 U	7 =	99 =		--
		9/21/05	**0.74** =	1 =	5 U	170 =		--
		9/6/06	**0.13** =	--	5 U	10 =		-104
		6/5/07	**1.72** =	--	0.01 U	498	--	NA

Table 12
Summary of COCs Concentrations in Groundwater, Solids Area

Geologic Unit	Well	Sample Date	Total Manganese (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Total Radium (pCi/L)	Redox (mv)
LG	PWA-2	Historic Max (a)	**27.9**	--	--	7375		
		11/18/03	**20.4** =	2 U	2 U	5470 =		--
		10/20/04	**16** =	1 U	5 U	4500 =		--
		9/21/05	**17** =	1 U	5 U	4400 =		--
		9/6/06	**13** =	--	--	4100 =		-144
		6/6/07	**15.9** =	--	--	3870 =	--	NA
	PWB-2	Historic Max (a)	**1.91**	**4.05**	0.05 U	6270		
		11/18/03	**1.05** =	**2.427** =	0.107 =	117 =		--
		10/20/04	**0.96** =	2 =	5 U	87 =		--
		9/21/05	**0.84** =	**3** =	5 U	80 =		--
		9/6/06	**0.8** =	2 =	--	64 =		-161
		6/7/07	**0.969** =	**2.1** =	--	66.6 =	--	NA
	PWD-1	Historic Max (a)	**13**	2.5 U	--	2080		
		11/20/03	**10.5** =	0.1 U	0.1 U	1890 =		--
		10/20/04	**9.7** =	1 U	5 U	2000 =		--
		9/21/05	**8** =	1 U	5 U	1500 =		--
		9/8/06	**7.5** =	--	--	1600 =		--
		6/7/07	**9.25** =	--	--	1760 =	--	NA
	PWE-1	Historic Max (a)	**4.74**	**6.02**	0.34	3869 =		
		11/20/03	**2.01** =	**3.73** =	0.1 U	324 =		--
		10/20/04	**1.1** =	**5** =	5 U	110 =		--
		9/21/05	**1.1** =	**4** =	5 U	130 =		--
		9/8/06	**1.1** =	**4** =	--	140 =		-211
		6/6/07	**1.02** =	**4.1** =	--	106 =	--	NA
BC	PWB-3	Historic Max (a)	**30.1**	10 U	10 U	8993		
		11/18/03	**19.4** =	2 U	2 U	6760 =		--
		10/20/04	**14** =	2 =	5 U	6300 =		--
		9/21/05	**14** =	2 =	5 U	7600 =		--
		9/6/06	**9.1** =	2 =	--	5300 =		-98
		6/7/07	**14** =	1.7 =	--	6440 =	--	NA
	PWC-2	Historic Max (a)	**0.82**	--	--	22		
		11/19/03	**0.85** =	0.1 U	0.1 U	13.6 =		--
		10/20/04	**0.88** =	1 U	5 U	16 =		--
		9/21/05	**0.98** =	1 U	5 U	110 =		--
		9/7/06	**0.35** =	--	--	13 =		-240
		6/6/07	**0.955** =	--	--	13.5 =	--	NA
	PWD-2	Historic Max (a)	**0.86**	--	--	525		
		11/20/03	**0.948** =	0.1 U	0.225 =	699 =		--
		10/20/04	**0.99** =	1 U	5 U	730 =		--
		9/21/05	**1.1** =	1 U	5 U	880 =		--
		9/8/06	**1.1** =	--	--	920 =		--
		6/7/07	**1.3** =	--	--	947 =	--	NA
	PWE-2	Historic Max (a)	**10.1**	0.42	--	4645		
		11/20/03	**6.47** =	0.3 =	0.1 U	826 =		--
		10/20/04	**5.6** =	1 U	5 U	700 =		--
		9/21/05	**8.6** =	1 U	5 U	1100 =		--
		9/8/06	**13** =	1 U	--	2000 =		-220
		6/6/07	**13.9** =	0.18 =	--	1460 =	--	NA

Table 12
Summary of COCs Concentrations in Groundwater, Solids Area

Geologic Unit	Well	Sample Date	Total Manganese (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Total Radium (pCi/L)	Redox (mv)
	PWF-2	Historic Max (a)	**4.29**	--	--	2504		
		11/19/03	**0.899** =	0.864 =	**32.1** =	341 =		--
		10/20/04	**0.43** =	1 U	8 =	110 =		--
		9/21/05	**0.5** =	1 =	5 U	190 =		--
		9/6/06	**0.12** =	--	5 U	29 =		-129
		6/5/07	**3.5** =	--	0.01 U	1400 =	--	NA

Table 13
Summary of VOCs Concentrations in Groundwater, Farm Ponds Area

CVOC	Concentration (µg/L)								
	ROD Standard	Sep-00	Sep-01	Sep-02	Sep-03	Sep-04	Sep-05	Sep-06	June-07(3)
Willamette Silt									
Monitor Well - PW-40S									
PCE	5	2.5	1.8	0.54	1 U	0.5 U	0.77	0.13 J	1.1
TCE	5	**15.9**	**8.5**	**5.63**	4.11	1.82	1.5	0.83	1.3
Cis 1,2-DCE	70	45	37.6	41.76	40.89	31.9	21.8	23.7	10.5
VC	2	**2.4**	**4.2**	**4.55**	**3.19**	**2.97**	1.7	**2.7**	0.85
1,1,1-TCA	200	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-PCA	0.055	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.05 J
1,1,2-TCA	3	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.32 J
1,1-DCA	810	45.8	35	31.03	29.35	28.09	30.5	29.8	31.8
DCE	7	2.5	1.9	1.93	1.46	0.87	0.67	0.52	0.38 J
1,2-DCA	5	**6.6**	3.6	4.73	4.28	2.57	1.8	1.8	0.86
Monitor Well - SS									
PCE	5	**22.5**	**16**	**8.7**	**12.72**	**14.22**	**14.7**	**26.3**	**40.4**
TCE	5	**6.2**	3.9	2.91	3.66	3.35	3.8	**7.1**	**11.3**
Cis 1,2-DCE	70	2.9	1.7	1.22	1.27	0.88	1.1	1.5	3.9
VC	2	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-TCA	200	0.6 J	1 U	0.5 U	1 U	0.5 U	0.5 U	0.7	1.2
1,1,2,2-PCA	0.055	**1.3**	**0.8 J**	**0.57**	1 U	**0.59**	**0.58**	**0.84**	**1.3**
1,1,2-TCA	3	**5.8**	**3.7**	**3.4**	**3.61**	**3.91**	**4.6**	**7.5**	**13.9**
1,1-DCA	810	2.3	1.7	1.51	1.83	1.79	2.3	4.7	8.4
DCE	7	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.69	1.5
1,2-DCA	5	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.56	1.4
Linn Gravel									
Monitor Well - PW-40A									
PCE	5	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
TCE	5	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Cis 1,2-DCE	70	7.1	3.7	1.82	2.33	1.37	0.93	0.48	0.73
VC	2	**3.4**	**2.6**	1.09	1.12	0.88	0.58	0.5 U	0.48 J
1,1,1-TCA	200	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-PCA	0.055	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TCA	3	1 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DCA	810	9.1	6.8	3.95	4.35	3.47	5.3	5.2	5.2
DCE	7	0.5 J	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DCA	5	1.1	0.9 J	0.54	1 U	0.5 U	0.5 U	0.5 U	0.25 J

Notes:
Laboratory analysis of samples collected from monitor wells PW-43s, PW-44s and PW-64s did not detect CVOCs above the 0.5 ug/L reporting limit. At PW-65s, 1,1-DCA was detected at 3.4 ug/L, 1,2-DCA at 0.51 ug/L and 1,1,2-TCA at 0.18 J ug/L. These detected values are below ROD standards.

Table 14
Monitoring Wells Identified to Further Evaluate Attainment of ROD Cleanup Levels by GETS

Well ID	Analyte
Thermite Building Group	
PW-10	Fluoride
PW-11	DCE and TCE
PW-12	TCA
PW-13	DCE and Fluoride
PW-77A	DCE
PW-78A	DCE
AS Storage Well Group	
PW-01	DCE, TCE, and VC
PW-42A	TCE
PW-71A	TCE
PW-86A	TCE, and VC
PW-88A	TCE
Dumpmaster Well Group	
MW-02	VC
MW-04	VC
PW-30A	TCA, DCE