UNITED STATES ENVIRONMENTAL
PROTECTION AGENCY

REGION 3

RECORD OF DECISION

Ravenswood PCE Superfund Site
Ravenswood, West Virginia

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APPENDICES

LIST OF ACRONYMS

AR	Administrative Record
ARARs	Applicable or Relevant and Appropriate Requirements
AS	air sparging
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
DNAPL	dense non-aqueous phase liquid
DPT	direct push technology
EPA	United States Environmental Protection Agency
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESL	ecological screening level
EW	extraction wells
FS	Feasibility Study
GAC	granular activated carbon
gpm	gallons per minute
HHRA	Human Health Risk Assessment
HI	Hazard Index
HSCA	Hazardous Site Cleanup Act
HQ	Hazard Quotient
ICs	Institutional Controls
ICR	incremental cancer risk
MCL	Maximum Contaminant Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	non-detect
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OU	Operable Unit
O&M	operation and maintenance
PA/SI	Preliminary Assessment and Site Inspection
PCE	Tetrachloroethylene or Perchloroethylene
ppb	parts per billion
ppm	parts per million
PRDI	pre-remedial design investigation
PW	production wells
RA	Remedial Action
RAO	Remedial Action Objective
RBC	Risk Based Concentration
Rfd	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure

ROD	Record of Decision
ROI	radius of influence
SARA	Superfund Amendments and Reauthorization Act of 1986
SLERA	Screening Level Ecological Risk Assessment
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
TRI	Toxics Release Inventory
TS	Treatability Study
μg/L	microgram per liter
UUUE	unlimited use and unrestricted exposure
VI	vapor intrusion
VOC	volatile organic compound
VPGAC	vapor phase granular activated carbon
WVDEP	West Virginia Department of Environmental Protection
WVRWA	West Virginia Rural Water Authority

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PART I- THE DECLARATION

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I. The Declaration

A. Site Name and Location

The Ravenswood PCE Superfund Site (Site) is located in the City of Ravenswood (City), Jackson County, West Virginia. The Site consists of groundwater contaminated with perchloroethylene (PCE) which generally lies beneath the City's downtown area. The National Superfund Database Identification Number for the Site is WVSFN0305428. This action covers Operable Unit-1 (OU1), groundwater. Operable Unit-2 (OU2) will address vapor intrusion, which will be addressed in a separate decision document. See Figure-1 for a depiction of the general Site location.

B. Statement of Basis and Purpose

This Record of Decision (ROD) presents EPA's "Selected Remedy" for OU1, groundwater, of the Site. This is the final action for Operable Unit-1, groundwater. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C. § 9601 et seq, as amended, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300, as amended.

This decision document is based on the Administrative Record for the Site, which was developed in accordance with Section 113 (k) of CERCLA, 42 U.S.C. § 9613(k). This Administrative Record file is available for review online at http://www.epa.gov/arweb, at the U.S. Environmental Protection Agency Region III Records Center in Philadelphia, Pennsylvania, and at the Jackson County Library in Ravenswood, West Virginia. The Administrative Record Index (Appendix A) identifies each document contained in the Administrative Record upon which the selection of the remedy is based.

The State of West Virginia concurs with the Selected Remedy.

C. Assessment of the Site

The response action selected in this ROD is necessary to protect human health and the environment from actual or threatened releases of hazardous substances into the environment.

D. Description of the Selected Remedy

Site contamination will be addressed in two Operable Units. This ROD is for OU1, groundwater. OU2, vapor intrusion, will be addressed separately. The Selected Remedy will remediate the PCE contaminated groundwater to the Maximum Contaminant Level (MCL) of 5µg/L, codified at 40 CFR § 141.61, and promulgated pursuant to the Safe Drinking Water Act, 42 U.S.C. § 300g-l.

The groundwater plume is defined as the area of groundwater contaminated with perchloroethylene (PCE). The groundwater plume extends from the intersection of Broadway Street and Walnut Street approximately 1,400 feet northeast to the City's well supply field. See Figure-2 for a current plume map.

The components of the Selected Remedy are described in detail in Section L.2- of this ROD. In summary, the major components of the Selected Remedy are:

- In-Situ Air Sparging with Soil Vapor Extraction (AS/SVE) which will include the continued operation of the AS/SVE system put in place for the Treatability Study, monitoring of vapors, and an expansion of AS and SVE wells in areas that will effectively treat all contamination;

- Groundwater monitoring throughout the contaminated groundwater plume and near the Ohio River, which may require the installation and monitoring of additional wells;

- Continued well-head treatment on the City's contaminated production wells prior to distribution, as needed;

- A Pre-Remedial Design Investigation (PRDI) to ensure the proper placement of the air sparging and soil vapor extraction wells; and

- Institutional Controls (ICs) to prevent the installation of new production wells in the contaminated portion of the aquifer.

E. Performance Standards

Groundwater

1. The remedial action for groundwater will continue until the Maximum Contaminant Level (MCL) for PCE is achieved throughout the contaminated plume (as currently delineated in Figure-2). The current MCL for PCE is 5µg/L. Remediating to the MCL will bring cumulative risk to within the $1x10^{-4}$ to $1x10^{-6}$ risk range, with an HI of less than 1.

Institutional Controls (ICs)

1. Installation of new potable or extraction wells within the area of contaminated groundwater will be prevented through the use of institutional controls until MCLs are achieved throughout the plume. The plume boundaries are defined in Figure-2.

F. Statutory Determinations

The Selected Remedy meets the mandates of CERCLA § 121 and the regulatory requirements of the NCP. This remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate requirements (ARARs) to the remedial action, is cost effective, and utilizes a permanent solution to the maximum extent practicable.

The Selected Remedy also satisfies the statutory preference for treatment as a principle element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances through treatment). The Selected Remedy will address the PCE contaminated groundwater throughout the entire plume area using active in-situ treatment.

ICs that restrict the installation of new wells in the plume will be necessary until the groundwater cleanup goals are achieved. A statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Five year reviews will be conducted at least every five years after the date of the initiation of the remedial action and continue until hazardous substances no longer remain present above levels that allow for unlimited use and unrestricted exposure.

G. ROD Certification Checklist

The following information is included in the Decision Summary (Part II) of this ROD, while additional information can be found in the Administrative Record file for the Site:

- Chemicals of concern (COCs) and their respective concentrations;
- Baseline risk represented by the COCs;
- Cleanup levels established for COCs and the basis for these levels;
- How source material constituting principal threats are addressed;
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD;
- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy;
- Estimated capital, annual O&M, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected; and
- Key factors that led to selecting the remedy.

H. Authorizing Signature

This ROD documents the Selected Remedy for OU1, contaminated groundwater at the Ravenswood PCE Site, and is based on the Administrative Record for the Site. EPA selected this remedy with the concurrence of the West Virginia Department of Environmental Protection (WVDEP). The Director of the Hazardous Site Cleanup Division for EPA Region III has approved and signed this ROD.

Approved by: [signature]

Ronald J. Borsellino, Director
Hazardous Site Cleanup Division

Date: May 23, 2011

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PART II- THE DECISION SUMMARY

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II. THE DECISION SUMMARY

A. Site Name, Location and Description

The Ravenswood PCE Superfund Site (Site) (CERCLIS Identification No. WVSFN0305428) is located in the City of Ravenswood, Jackson County, West Virginia. The Site is generally compromised of the downtown area of Ravenswood, which is underlain by groundwater contaminated with tetrachloroethene, which is also known as perchloroethylene or (PCE).

The area encompassing the Site is approximately three miles long by one mile wide. See Figure-1 for a general map of the Site area. It is bounded on its western edge by the Ohio River. Sandy Creek, which flows into the Ohio River, bounds the City to the south. The plume extends from the intersection of Broadway Street and Walnut Street approximately 1,400 feet northeast to the City of Ravenswood water supply well field located adjacent to Virginia Street. See Figure-2 for a current plume map. The City of Ravenswood water supply well field currently includes seven production wells (PW-1 to PW-7) which supply water to approximately 6,000 people.

EPA is the lead Agency for the Site and the West Virginia Department of Environmental Protection (WVDEP) is the support Agency. The cleanup is being financed with funding from the Superfund Program of the EPA. This action addresses OU1, groundwater at the Site; OU2 for vapor intrusion, will be addressed in a separate decision document.

B. Site History and Enforcement Activities

This section of the ROD provides the history of the Site and a discussion of EPA and WVDEP investigations and response activities. The “Proposed Rule” proposing the Site to the National Priorities List (NPL) was published in the *Federal Register* on March 8, 2004. The “Final Rule” adding the Site to the NPL was published in the *Federal Register* on September 23, 2004.

B.1. History of Activities That Led to Contamination

To date sampling data have not shown a definitive source area. It is likely that a series of small releases of PCE led to the groundwater contamination.

B.2. History of Previous Environmental Investigations

In September 1989, during routine health department water analysis, PCE contamination was detected in the City’s production wells (PWs), PW-2, PW-3 and PW-5, at levels exceeding the Maximum Contaminant Level (MCL) for PCE in drinking water which is 5 micrograms per liter (5µg/L) as set forth at 40 CFR § 141.61. MCLs are the standards for drinking water established by the Safe Drinking Water Act, 42 U.S.C. § 300g-l.

PCE concentrations that exceeded the MCL were detected five times from 1989-1998 in the finished water that was distributed to the public. Following the identification of PCE in the drinking water supply, various Site investigations took place during the period between 1998 and 2010.

In 1998, the West Virginia Rural Water Authority requested EPA’s assistance in addressing the PCE contamination in the municipal water supply. Under EPA’s direction, a contractor conducted two soil gas surveys covering an area of 75 acres. The surveys focused on areas in which there were potential sources of PCE contamination. During the study, PCE was detected in moderate concentrations at three locations but no significant source area was found.

In 1999, based on the results of the soil gas survey, EPA utilized another contractor to attempt to locate the source of the groundwater contamination. EPA's contractor installed four monitoring wells, EPA-01 to EPA-04. While the wells were being installed EPA collected soil samples to be analyzed for the presence of PCE. No PCE was detected in any of the soil samples analyzed.

In addition to sampling the four newly installed monitoring wells EPA also sampled the five City production wells then in operation. PCE was detected in all production wells sampled except for PW-4 which showed no PCE contamination. The highest detection of PCE in this sampling event came from PW-3 which had PCE detected at 29.8µg/L.

In 2000, EPA's contractor prepared a Site Inspection Narrative Report to assess the possible threat to human health and the environment from the PCE contamination in groundwater. The report concluded that PCE was present in municipal well samples and that the PCE plume posed a threat to human health and the environment.

In 2000, the City added a Venturi air stripper to its treatment process to remove PCE from the drinking water and to eliminate the health threat from using contaminated groundwater as a water supply. City production wells PW-3 and PW-5, which historically had been the most contaminated, were treated with the air stripper before being blended with water from non-contaminated wells.

During this time, the West Virginia Department of Environmental Protection (WVDEP) obtained an EPA Site Assessment Grant and directed a contractor to further delineate the PCE plume. In 2000, there were 37 direct push points (a direct push type rig allows for a sample to be taken without having to install a permanent well) advanced near suspected source areas. The four EPA- installed monitoring wells and the City production wells were also sampled during this time. All the data collected at this time was presented in the Interim Investigation Report which is part of the Administrative Record (AR) for the Site. PCE sample results from the direct push sampling ranged from non-detect (ND) to 152µg/L.

In 2001, the WVDEP took an additional 18 direct push samples and installed seven permanent monitoring wells. One well, DEP-05S, was installed in shallow groundwater. The remaining wells, DEP-05D through DEP-10, were installed in deeper groundwater. The previously installed monitoring wells were sampled along with 55 samples taken from temporary soil borings. These results were presented in the 2001 Investigation Summary Addendum #1, which is also available in the AR for the Site. PCE concentration found in groundwater during this sampling event ranged from non-detect to 325µg/l in DEP-05S.

In 2002, WVDEP directed a contractor to sample the existing groundwater wells during two sampling events. From March to April 2002, 11 monitoring wells and five City production wells were sampled. PCE detections ranged from non-detect to 410µg/L in DEP-05S. The second round of sampling took place in September 2002. This time, samples were collected from six monitoring wells and three City production wells. Again PCE concentrations ranged from non-detect to 200µg/L in DEP-05S.

In 2004, the Site was added to the National Priorities List (NPL).

EPA's Removal Program installed two new production wells that went online in August 2004. The wells (PW-6 and PW-7) were installed in an up-gradient location that is not contaminated with PCE. These wells serve as uncontaminated water sources that are blended with water from the City's other five production wells. Sampling was conducted quarterly from 2003 to 2007 by EPA's Removal Program. This data is available in the Administrative Record for the Site.

A map of all the monitoring wells is shown in Figure-5.

In 2007, EPA directed its contractor to take an additional round of samples from 11 monitoring wells and five City production wells. This information was used to support a conceptual site model (CSM) which better detailed the characteristics of the plume. The highest concentration of PCE found during this sampling event was 1,200µg/L in DEP-05S.

In November 2008, as part of the Remedial Investigation (RI), EPA initiated a Treatability Study (TS) at the Site to provide engineering data to support a final remedy decision for OU1 of the Site. Air sparging with soil vapor extraction (AS/SVE) was selected due to its operational success at the similar Vienna PCE Superfund Site in Vienna, West Virginia. In November 2008, fifteen wells were installed as part of the AS/SVE system study. The system included: nine air sparging wells, three soil vapor extraction wells, two groundwater monitoring wells and one vapor monitoring well. A portable AS/SVE system was moved from the Vienna PCE Site and was installed at the Ravenswood PCE Site in June 2009. See Figure-3 for a depiction of the Treatability Study layout.

The air sparging wells inject air into the water table which volatilizes (changes from an aqueous phase to a vapor phase) the PCE. The volatilized PCE then moves upward into the vadose zone (the area extending from the top of the groundwater to the land surface). The PCE is then captured by the soil vapor extraction wells. The SVE wells work by creating a vacuum in the vadose zone. The PCE vapors captured by these wells are transported via piping to a vapor-phase granular activated carbon (VPGAC) unit which is located in the TS building. The VPGAC works as a filter to remove the PCE from the air. The treated clean air is then discharged to the atmosphere.

Operation of the TS system began in phases. This allowed EPA to gather enough sampling data to ensure that the vapor extraction system captured all PCE vapors and no risk from PCE vapors was created from operating the system. In June 2009, the soil vapor extraction system was activated which resulted in the removal of any existing PCE vapors from the subsurface. Sampling was conducted of the SVE system frequently during the first month of the SVE system operation. Once the vapor data confirmed that there were not high levels of PCE in the subsurface, the AS system was phased into operation.

The AS system was activated at half capacity in August 2009. Starting the system at half capacity ensured that the system did not rapidly mobilize high concentrations of PCE into the subsurface that could not be captured by the SVE wells. Once additional vapor monitoring data confirmed that there were no elevated PCE concentrations in the subsurface, the AS system was activated at full capacity in September 2009.

Groundwater and vapor sampling were conducted as part of the Treatability Study system operation and evaluation. Vapor samples were collected during the start up of the SVE system on day 1, day 2, day 3, day 7 and day 13 of SVE operation. After the AS system was started, vapor samples were collected on day 1 and day 2, and were then taken monthly to June 2010. Data from the vapor samples confirm that PCE is being volatilized with the air sparging and PCE mass is being removed from the aquifer. To date, over five pounds of PCE have been removed from the aquifer.

Groundwater sampling was also conducted as part of the TS and it began with a baseline sampling event during the AS/ SVE installation in November and December 2008. Samples were collected from thirteen monitoring wells and the seven City production wells, along with screening level samples taken during the well installations for the AS/SVE system. The highest PCE concentration identified during this sampling effort came from a sample taken from an air sparging well, AS-02, where PCE was detected at 210µg/L. The highest detection from a monitoring well, 370µg/L, came from DEP-05S. Samples from the monitoring wells were collected again in September 2009, February 2010, and May 2010, as part of the TS system operation. In May 2010, PCE levels in DEP-05S had been reduced to 96µg/L, indicating the AS/SVE is effective in removing

PCE. All of the results from the sampling events are available in the Administrative Record and all indicate that the air sparging/soil vapor extraction system is effective in removing PCE from the groundwater. The air sparging/soil vapor extraction system continues to operate in order to gather more data of its effectiveness and to help control the PCE plume.

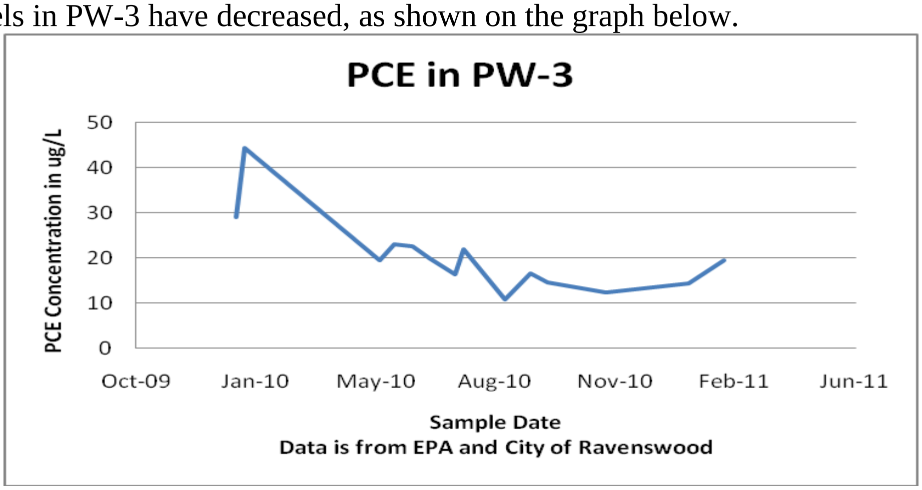
In February 2010, EPA's contractor mobilized to Ravenswood to begin a Direct Push Technology (DPT) sampling effort. The sampling focused on further delineating the boundaries of the plume. This information was gathered in support of the RI for OU1 and to support the RI for OU2. OU2 will focus on vapor intrusion into buildings situated above the plume. Sampling efforts were focused on delineating the plume in areas where PCE concentration exceeded the MCL of 5µg/L. During the sampling effort a total of 33 locations were sampled. Sampling proceeded in a step-out fashion.

The first sets of samples taken were MCL delineation points, which were taken in areas assumed to contain PCE levels near- 5µg/L and in areas with the greatest plume boundary uncertainty. While the results of the first set of samples were being analyzed, there were five source identification point samples collected in areas of higher PCE concentration in the interior of the plume. These points were sampled to determine if a more definitive source area could be found. Once the analytical results from the first round of samples were received, additional step out point samples were collected in areas where PCE levels were still above the MCL concentrations.

The highest PCE concentration, 220µg/L, found during this mobilization was located near the intersection of Mulberry Street and Washington Street. This is an area that has historically had higher levels of PCE. No definitive source areas were found during this sampling effort, but a complete model of the plume was obtained. See Figure-4 for the DPT points and current plume map.

In January 2010, the City production well, PW-3, had an increased level of PCE of 44µg/L, up from an annual average of 24µg/L. In February 2010, PW-3 was taken offline by the City due to the increased PCE levels. PW-3 was historically pumped at approximately 200,000 gallons per day (gpd). This high pumping rate controlled the spread of the PCE plume into the other City production wells. When PW-3 was taken offline by the City, PW-5 and PW-2 showed increased levels of PCE.

In May 2010, in order to maintain control of the plume, the City obtained a temporary National Pollutant Discharge Elimination System (NPDES) permit, as mandated by the Clean Water Act, to pump PW-3 through the air stripper and then discharge the water to the Ohio River at a rate of approximately 100,000 gpd. The increase of PCE in PW-3 is thought to be caused by a pocket of high PCE concentrations in the plume (identified in the DEP-05S sample collected in May 2007) which was drawn into PW-3. Since January 2010, PCE levels in PW-3 have decreased, as shown on the graph below.



As of February 2011, water from wells PW-3 and PW-5 was being blended and run through the Venturi air stripper before being blended with uncontaminated wells and then distributed. Sampling data from February 2011, show PCE levels in PW-3 at 19.4µg/L, PW-5 at 1.2µg/L, PW-2 at ND, effluent from the air stripper at 1.8µg/L, and blended water at ND.

B.3. EPA Removal Action

As noted previously, EPA conducted a Removal Action to provide for the installation of two new uncontaminated wells up-gradient of the plume to the City of Ravenswood in 2004. This Removal Action took place as an intermediate response effort to allow the City of Ravenswood to continue to distribute potable water in compliance with MCLs.

C. Community Participation

Initial community involvement activities at the Site consisted of the distribution of a fact sheet and a public availability session prior to the beginning of the Treatability Study in 2008.

During the Proposed Plan process EPA hosted a public meeting to engage the local community, and distributed a fact sheet to update the community on EPA's activities. These community participation activities meet the public participation requirements in CERCLA § 121 and the NCP 40 CFR § 300.430 (f)(3).

The RI/FS Report and Proposed Plan for the Ravenswood PCE Superfund Site were made available to the public in January 2011. These documents can be found in the Administrative Record file located in the EPA Region III Office, the Jackson County Library in Ravenswood and online at www.epa.gov/arweb. The notice of the availability of these documents was published in the Parkersburg News and Sentinel on Monday January 10, 2011. A public comment period was held from January 10, 2011, to February 9, 2011.

In addition, a fact sheet detailing the Proposed Plan was mailed to local citizens on January 10, 2011. A public meeting was held on January 20, 2011, to present the Proposed Plan to the community and solicit their comments on the Proposed Plan. At this meeting representatives from EPA and the WVDEP answered questions about the Site and the remedial alternatives. EPA's responses to comments received during this period are included in the Responsiveness Summary, which is part of this Record of Decision.

D. Scope and Role of Operable Unit or Response Action

EPA has organized the work at the Ravenswood PCE Site into two Operable Units (OUs).

- Operable Unit 1: Contaminated Groundwater
- Operable Unit 2: Vapor Intrusion

This action will be the final action for OU1, groundwater at the Site. OU2, vapor intrusion, will be addressed separately. The past Removal Action, which was an intermediate response and included sampling and analysis of monitoring wells and the City's production wells and installing two new production wells for the City, has concluded.

This Remedial Action will address contaminated groundwater. Ingestion of untreated contaminated groundwater poses a potential risk to human health because PCE concentrations exceed EPA's acceptable risk range and concentrations of PCE are greater than the respective MCL for drinking water. The Selected Remedy will restore the entire plume of contaminated groundwater to its beneficial use in a timely and efficient manner. The Selected Remedy will permanently reduce the toxicity, mobility and volume of PCE in the groundwater.

Work on OU2, vapor intrusion is scheduled to begin in 2011. The Remedial Investigation for vapor intrusion including indoor air and subslab sampling in homes and businesses situated above the PCE plume will occur while work on OU1 proceeds.

E. Site Characteristics

This section of the ROD provides an overview of the Site's geology and hydrogeology; the sampling strategy used during the RI; and the nature and extent of contamination. More in-depth information regarding the nature and extent of contamination and the current groundwater concentrations can be found in the RI/FS documents.

E.1. Overview of the Site

The Site is located in northwestern West Virginia along the Ohio River. The Site itself is generally comprised of the downtown area of Ravenswood, West Virginia, which is underlain by groundwater contaminated with PCE. The PCE plume is approximately 400 feet wide by 1400 feet long. The boundaries of the plume defined in the March 2010 DPT investigation include Broadway Street to the south, Sycamore and Washington Streets on the southeast, and the City well field to the north. The Site is bounded by the Ohio River to the west and Sandy Creek to the south. The River and Creek form a natural hydraulic boundary. See Figure-1 for a map of the general Site area.

Groundwater is located approximately 50 to 60 feet (ft) below ground surface (bgs). Bedrock is encountered at approximately 90 ft bgs. The maximum thickness of the saturated zone is 40 feet. It is assumed that 20 feet make up the shallow zone and that 20 feet make up the deeper zone. When referring to shallow and deep zones at the Site, both describe the same alluvial aquifer. Shallow refers to the uppermost portion of the aquifer and deep refers to the area that is closer to bedrock. PCE contamination is found primarily in the shallow portion of the aquifer. There is a total estimated volume of 50.8 million gallons of water in the shallow and deep zones, with approximately 25 million gallons making up the shallow portion of the contaminated groundwater aquifer.

The City's production wells influence strong control over the direction of groundwater flow, drawing in most of the contaminated plume to the City well field. This pumping has created a long thin plume. See Figure-2. In the absence of pumping the City production wells, the PCE would likely migrate with the natural groundwater flow to the Ohio River and Sandy Creek. While the highest concentrations of PCE are located within the capture zone of the City wells, there is a small portion of the plume that is found southwest of the capture zone, in an area where the groundwater flow is towards the River. The location of this zone fluctuates about one city block depending on the river pool stage (the pool stage is used to describe the depth of the Ohio River), of the Ohio River. See Figure-6 for stagnation zone. During the 2010 DPT sampling event PCE levels in this area were either non-detect or below the MCL; there has been limited evidence from previous sampling events of natural breakdown of PCE in samples taken closest to the River. Natural breakdown of PCE has not been observed in any other areas.

The City of Ravenswood uses treated groundwater as its water supply for distribution. The City has a network of seven production wells, three of which have or have had PCE contamination. Wells PW-3 and PW-5, which have had the highest PCE levels, are treated using a Venturi air stripper before being blended with water from the uncontaminated wells. Sampling of the City's water supply has confirmed that PCE levels are below the MCL.

Near Ravenswood, the Ohio River is considered a riverine wetland and a high quality fishery area.

E.2. Geology and Hydrogeology

The contamination addressed in the Response Action for OU1 is limited to groundwater at the Site. More detailed information regarding the Site geology and hydrogeology can be found in the Remedial Investigation which is part of the Administrative Record for the Site.

E.2.1. Geology

The Site lies in a portion of the Ohio River floodplain known as the Ravenswood Bottom. Two hydrogeologic units that are significant to the movement of groundwater are present in the area: Pennsylvania and Permian Age (245-325 million years ago), Dunkard Group bedrock and the overlying Pleistocene Age (11,000-1.8 million years ago) alluvium. There is a third unit of fine grained, fluvially-deposited sediments that overlies the alluvium, but it does not penetrate below the water table. Units that lie beneath the Dunkard Group are assumed to be insignificant to the flow of groundwater in the area due to the low permeability of the Dunkard Unit compared to the overlying hydrostatigraphic unit.

Bedrock in the area consists primarily of sandstone which is encountered from 65 to 90 feet below ground surface. Overlying the bedrock are unconsolidated, glacial outwash, alluvial deposits of sand and gravel which form two prominent terraces on the Ravenswood Bottom. Soil boring logs from the Site show that the sand and gravel alluvium is encountered from 5 to 30 feet below the ground surface and ranged in thickness from 48-85 feet. Generally across the Site medium-grained sands dominate this layer. The water table occurs within this unit. This sand and gravel aquifer is considered to be unconfined.

Overlying the glacial outwash deposits are fluvially-deposited, fine-grained silts, clays and sand deposited primarily by floods. This layer begins at ground surface and ranges in thickness from 5 to 30 feet. This unit occurs within the unsaturated zone in the study area.

E.2.2. Hydrogeology

Groundwater contamination at the Site occurs in the alluvial aquifer situated above bedrock. The median hydrologic conductivity for the Dunkard Group bedrock is 3.3 feet per day. This value is two orders of magnitude lower than the values for the sand and gravel alluvium which is 77 to 500 feet per day. It is therefore concluded that the occurrence and movement of groundwater in the bedrock is negligible compared to the occurrence of groundwater movement in the alluvium. The horizontal conductivity for the fine grained alluvium is 0.1 to 8 ft/day.

Bedrock is located approximately 90 feet below ground surface in the vicinity of the City Maintenance Building. Groundwater is encountered from 25 feet bgs near the Ohio River to 58 feet bgs farther away from the River. The effective porosities for the sand and gravel unit range from 0.30 to 0.34, which is typical for sand and gravel. The effective porosities for the fine grained alluvium range from 0.20 to 0.35.

Groundwater flow would naturally flow in a southerly direction towards the Ohio River at the Site. However, the City's high pumping rates (an average of 800,000 gpd) have reversed groundwater flow and it is drawn northerly to the City's water supply well field. If the City were to discontinue pumping it is assumed that groundwater flow would revert back towards the Ohio River. The City's PW-3 captures most of the PCE plume and protects the additional City production wells from becoming contaminated. PW-3 is pumped at an average rate of 200,000 gpd.

There is a transition zone which divides the water that is captured by the City's production wells and the groundwater which is still flowing towards the Ohio River. The location of this zone varies depending on the River pool stage. This transition zone is illustrated in Figure-6**.**

The vertical conductivities are estimated to be low in the contaminated aquifer. The estimated vertical conductivities are .3 ft/day bedrock, 8 to 50 ft/day for the sand and gravel, and 0.01 to 0.8 ft/ day for the fine grained alluvium. There are several well pairs screened at different depths at the Site. Data from these well pairings largely indicate that there is very little if any vertical movement. PCE contamination is largely found only in the shallow (upper) portion of the aquifer.

At the Ravenswood PCE Site, a small release or a series of releases of PCE historically occurred from potential source(s) in the vicinity of the intersection of Mulberry and Washington Streets to just north of the intersection of Virginia and Sycamore Streets. It is in this vicinity where the highest concentrations of PCE have been observed. The data collected throughout the duration of the RI indicate that no residual Dense Non Aqueous Phase Liquid (DNAPL) exists and that a significant source area of PCE is not present in the vadose zone or within the saturated aquifer. When the PCE release occurred, the PCE migrated through the 50-foot to 60-foot thick vadose zone to groundwater, most likely through leaching by precipitation. Once the PCE reached the groundwater, migration was controlled by the direction of the groundwater flow, predominately the horizontal flow.

E.3. Sampling Strategy

Sampling activities were completed as part of the RI to address the following elements:

- Characterize the nature and extent of contamination.
- Better understand the physical parameters affecting contaminant fate and transport.
- Provide a comprehensive assessment of the current and potential human health and environmental risks associated with the Site.
- Use the RI data to evaluate potential environmental response clean-up options and to support the FS.

The RI was initiated in 2005 by EPA and expanded upon the previous sampling events conducted by EPA and the WVDEP from 1998-2004. The RI for OU1 was completed in 2010.

E.4. Conceptual Site Model

A conceptual site model (CSM) is a convenient way to present an overall understanding of a site. A CSM may be developed at the beginning of a project and refined and updated as more information becomes available.

Contaminated groundwater is the primary focus of the CSM for OU1 of the Site. OU2 will separately address the potential for vapor intrusion and findings from that RI will be incorporated into the CSM as data become available. It is believed that the groundwater became contaminated by a release or series of releases of PCE to soils. The PCE then was carried by precipitation into the groundwater and was then drawn in a northeastern direction by the pumping of the City's wells. Since 2000, the City has treated wells PW-3 and PW-5 before distribution to the public since they have historically been the most contaminated. Other VOCs and SVOCs have been detected at various times at the Site, at levels below MCLs and in no discernable plume and therefore they were not carried over as COCs during the Human Health Risk Assessment. PCE is the only COC driving risk at the Site and it has only been identified in groundwater.

The City's pumping of its extraction wells has controlled the PCE plume, resulting in a long thin plume of PCE contamination. The plume is approximately 400 feet wide and 1400 feet long and extends from the intersection of Broadway Street and Walnut Street to the City's water supply well field. The water table is located approximately 50 to 60 feet below ground surface. Bedrock is encountered at 90 feet below ground surface

The majority of the PCE contamination is found in the upper (shallow) portion of the aquifer which has a calculated volume of 25,400,000 gallons. The total calculated volume in the aquifer is 50.8 million gallons. The current plume as defined in March 2010 is pictured in Figure-2**.**

E.5. Nature and Extent of Contamination

Sampling data taken during the RI by EPA from 2005-2010 were compiled with previous data generated by the WVDEP and EPA to write a comprehensive RI. All of the groundwater data collected show a significant amount of PCE contamination in the shallow portion of the aquifer. The plume measures approximately 400 feet wide by 1400 feet long and is heavily controlled by the City's production wells. Most of the plume is drawn into the City's well field and is captured by wells PW-3 and PW-5. However, a small portion of the plume flows in the direction of the Ohio River (River) depending on the River pool stage. The PCE levels near the area of the Ohio River are very low and some data from this area indicate that PCE is naturally breaking down and therefore there is currently no impact to the River.

The majority of the PCE contamination is found in the shallow (upper) portion of the aquifer. Currently the highest concentration of PCE in the shallow portion of the aquifer, which was seen during the 2010 DPT sampling effort, is 220µg/L in DP-15. The historic high concentration from the shallow portion of the aquifer was 1,200µg/L in DEP-05S in May 2007. See Figure-7 for an illustration of the May 2007 plume. The highest concentration observed in the deep part of the aquifer was 32µg/L. This concentration was observed in February 2010 in DEP-08 which is located on Mulberry Street. PCE levels in the City's production wells currently (as of February 2011) range from non-detect (ND) to 19.4µg/L in PW-3. February 2011 sampling data indicate that the water distributed to the public is non-detect for PCE.

As previously discussed, there has been no evidence of a continuing source area of PCE and no definitive source has been identified to date. No PCE has been detected in soils at the Site. Sampling data from the RI also indicates that the presence of DNAPL is unlikely.

E.6. Potential Routes of Human Exposure

Potential exposure pathways identified for the Site are exposure to untreated groundwater. Human exposure to contaminated groundwater could occur through ingestion, dermal contact and inhalation of PCE vapors while showering. As previously noted, the City currently treats the contaminated groundwater with a Venturi air stripper prior to distribution to the public, and sampling of the City's water supply has confirmed that levels of PCE are below the MCL.

E.7. In- Situ Air Sparging with Soil Vapor Extraction Treatability Study

In 2008, EPA initiated a Treatability Study at the Ravenswood PCE Site using air sparging and soil vapor extraction. This technology was successful in treating PCE contamination at the similar and nearby Vienna PCE Superfund Site. The Treatability Study was initiated in order to obtain engineering and sampling data to determine whether AS/SVE could be a successful treatment option to consider at Ravenswood.

Air sparging involves the injection of air from an air compressor into the groundwater, which volatilizes the PCE into a vapor. The PCE vapors migrate into the unsaturated zone where they are captured by the soil vapor extraction wells. The captured PCE vapors are piped back into the treatment building where they are filtered through a vapor phase granular activated carbon (VPGAC) unit and clean air is discharged through an exhaust stack.

As part of the TS, EPA installed nine air sparging wells, three soil vapor extraction wells, two monitoring wells and one vapor monitoring point. A small treatment building which houses the air condenser, vacuum, VPGAC, manifolds and electronic controls was transferred from the Vienna Site to the Ravenswood Site. All of the wells, with the exception of AS-09, had their soil cores logged and baseline groundwater samples taken. The wells were installed to intercept the highest concentration of PCE before it reaches the City water supply well field. During the well installation, the highest concentration of PCE detected in groundwater was from AS-02 at 210µg/L. Soil borings taken during the well installations confirmed that the subsurface consists of uniform, high quality sands which are ideal conditions for air sparging and soil vapor extraction.

TS system startup was conducted in phases to ensure that all PCE vapors would be captured by the SVE wells and no additional risk would be created. First the SVE wells' radius of influence (ROI) were tested. The ROI was tested by applying a vacuum to each SVE well individually and measuring the vacuum influence in each of the surrounding monitoring wells. The results of the ROI test show that each SVE well's ROI extends at least 65 feet and may extend beyond 75 feet. This indicated that the SVE wells would be able to effectively and safely extract the PCE vapors from the subsurface.

The next step in TS system initiation was to activate the SVE system to sweep the subsurface of any PCE vapors present before sparging occurred. Samples during this time were collected on day 1, day 2, day 4, and after 1 and 2 weeks. All of the sampling vapor data collected during this time indicated very low levels of PCE in the subsurface which further helped to confirm the lack of a significant or ongoing source area.

The air sparging wells' ROI were also tested during this time by applying pressure to one well at a time and measuring the influence on the neighboring monitoring wells. The ROI for the AS wells was estimated to be approximately 45-50 feet. Air sparging wells are screened directly above bedrock so that they influence the entire vertical extent of the aquifer.

After sampling data showed that there were no unsafe levels of PCE in the subsurface and that the AS/SVE ROI would be effective, the air sparging wells were activated. The AS wells were initially activated at a reduced flow rate, to ensure that the SVE wells could effectively capture the PCE vapors being generated. After sampling data confirmed that the SVE system was effectively capturing all of the PCE vapors, air sparging was activated at full strength in September 2009.

The system is operated using a pulsing schedule. This schedule rotates the AS and SVE wells that are operational in 20 minute increments alternating with 20 minutes of down time. Operating the system in this manner allows for the maximum effectiveness of the air sparging system and minimizes the creation of preferential flow paths in the subsurface.

During the first year of operation, groundwater and vapor samples were collected on a monthly basis to monitor system effectiveness. Sampling data show that PCE concentrations in groundwater within the area of the TS influence have decreased. Well DEP-05S, which had the historic high of 1,200µg/L in May 2007, had a PCE level of 370µg/L in December 2008 (baseline). In May 2010, levels in this well decreased to 96µg/L. Well MW-11S, which was installed as part of the TS, had a baseline concentration in December 2008 of 96µg/L, which decreased to 51µg/L in May 2010. A full report of the sampling data from the TS can be found in the AR for the Site.

Vapor data collected during the TS have shown relatively constant levels of PCE in the vapor monitoring points. As of October 2010, the system had removed 5.1 pounds of PCE from over 25,000,000 standard cubic feet of extracted soil vapor.

The TS system has proven to be an effective way to safely remove PCE from the groundwater, and the system continues to operate. Two more rounds of samples are planned to be taken in 2011. To date, the system has had no significant down time and routine maintenance has been completed as needed.

F. Current and Future Potential Land Use and Water Use

The property in the vicinity of the groundwater plume has a mix of residential and commercial uses. Future land use will likely remain the same. Groundwater is in use by the City of Ravenswood as a potable water source for its citizens and for sale to the Northern Jackson County Public Service District. Contaminated groundwater is currently drawn into PW-3, PW-5, and occasionally PW-2. These production wells are treated prior to distribution to below the MCL. Contact with untreated groundwater, either through the use of private wells or untreated City water presents an unacceptable risk to the residents of Ravenswood. It is estimated that it will take ten years, using the selected remedy, to return groundwater to its full beneficial use.

G. Summary of Site Risks

This section summarizes the results of the human health risk assessment and the ecological risk assessments that were performed during the RI. These baseline risk assessments (before any cleanup) provide the basis for taking a response action and indicate the exposure pathway(s) that need to be addressed by the remedial action. The potential risks related to the no-action scenario are also described. As part of the RI, the current and future risks posed to human and ecological receptors by the contamination at the Site were evaluated. The risk assessment performed during the RI and FS evaluated the potential for health risks, based on current and potential future conditions, to people exposed to Site contamination, such as the risk of developing cancer, and risk of non-cancer health impacts (such as adverse impacts to organs). The screening level ecological risk assessment (SLERA) evaluated the current and future potential risk to ecological receptors.

HOW IS HUMAN HEALTH RISK CALCULATED?

A Superfund human health risk assessment estimates the baseline risk. The baseline risk is an estimate of the likelihood of developing cancer or non-cancer health effects if no cleanup action were taken at a site. To estimate baseline risk at a Superfund site, EPA undertakes a four-step process:

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, EPA looks at the concentrations of contaminants found at a site as well as past scientific studies on the effects these contaminants have had on people (or animals, when human studies are unavailable). Comparison between site-specific concentrations and concentrations reported in past studies helps EPA to determine which concentrations are most likely to pose the greatest threat to human health.

In Step 2, EPA considers the different ways that people might be exposed to contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency and duration of exposure. Using this information, EPA calculates a "reasonable maximum exposure" scenario, which portrays the highest level of exposure that could reasonably be expected to occur.

In Step 3, EPA uses the information from Step 2 combined with information on the toxicity of each chemical to assess potential risks. EPA considers two types of risk: cancer and non-cancer risk. The likelihood of any kind of cancer resulting from a Superfund site is generally expressed as an upper bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that could be exposed, one extra cancer may occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than would normally be expected to from all other causes. For non-cancer health effects, EPA calculates a "hazard index." The key concept here is that a "threshold level" (measured usually as a hazard index of less than 1) exists below which non-cancer health effects are no longer predicted.

In Step 4, EPA determines whether site risks are great enough to cause health problems for people at or near the Superfund site. The results of the three previous steps are combined, evaluated, and summarized. EPA adds up the potential risks from the individual contaminants and exposure pathways and calculates a total site risk. Generally, cancer risks between 10^{-4} and 10^{-6}, and a non-cancer hazard index of 1 or less are considered acceptable for EPA Superfund sites.

G.1. Summary of Human Health Risk Assessment

The baseline human health risk assessment followed a four-step process which included the following:

a) Identification of contaminants of concern
b) Exposure assessment
c) Toxicity assessment
d) Risk characterization

As part of the RI/FS, EPA conducted a baseline risk assessment (based on the contamination present before taking a response action) to determine the current and future effects of contaminants on human health and the environment. The current uses of the Site are a mix of residential and commercial. Future land uses are expected to remain the same. Since the City of Ravenswood draws drinking water from the contaminated groundwater, current use of groundwater exposure scenarios was evaluated. The pathways included dermal and ingestion exposure routes for residential children and adults (adults only) as well as inhalation by adults while showering. For the purpose of the risk assessment, exposure scenarios assume contact with untreated groundwater. However, the City currently treats the groundwater prior to distribution so no exposure takes place.

G.1.1. Identification of Contaminants of Concern (COCs)

Contaminants of potential concern (COPCs) at the Site in various media (i.e., soil, groundwater, surface water, and air) are identified, based on factors such as toxicity, frequency of occurrence, fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation. EPA performs statistical analysis of the samples collected from given media in order to determine the above parameters. The COPCs are then screened against risk-based screening criteria to identify COCs. Any COPCs which exceed Risk Based Concentrations (RBCs) are identified as a COCs to be carried through the risk assessment.

Once COCs are identified, EPA's risk assessment identifies which COCs are the primary risk drivers on the basis of the relative maximum exposure (RME) scenario for the entire contaminated media. In the case of this Site, PCE is the contaminant that poses the greatest threat to human health.

COCs are also identified by comparing their concentration to ARARs. For groundwater, examples of ARARs at the Site are Federal MCLs. Those COCs that have average concentrations exceeding the ARARs are retained. It is possible to have contaminants present that exceed MCLs but that do not contribute significant risk. These are retained as COCs because they exceed a specific ARAR. PCE at the Site exceeds both the level of acceptable risk ($1x10^{-4}$) and the MCL.

The groundwater underlying the Site is a drinking water source for the surrounding area. The City of Ravenswood draws water from the aquifer to distribute to its residents and to sell to the Northern Jackson County Public Service District. All together approximately 6,000 people receive water from the Ravenswood Water Supply.

The COC at the Site, PCE, was selected by evaluating its contribution to risk to human health and by comparing its relative concentrations to Federal MCLs.

Concentrations of PCE in groundwater ranged from a high of 1,200µg/L in DEP-05S in May 2007, to a current high of 220µg/L in DPT point DP-15. Current sampling data provided by the City show that the water being distributed to the public is below the MCL for PCE.

G.1.2. Exposure Assessment

The objectives of the exposure assessment are to evaluate potential current and future human exposures to PCE in groundwater. As described in the Conceptual Site Model section above, the primary medium of concern in OU1 of the Site is groundwater. The City addresses the immediate health threat to PCE exposure by treating the groundwater prior to distribution to the public; however the NCP sets forth a general expectation that contaminated groundwater be restored to its beneficial use. Therefore, EPA has evaluated the risk posed by groundwater to both future adults and children, who may come into contact with untreated groundwater because EPA assumes a future use of groundwater.

Exposure pathways and routes identified for the Site, which are driving the remedial activities specified in this ROD, are based on the groundwater exposure pathway. Exposure to PCE in groundwater was evaluated through ingestion, and dermal routes for residential children and adults (ingestion only), as well as inhalation by adults while showering.

G.1.3. Toxicity Assessment

Toxicity assessment defines the relationship between the magnitude of exposure and possible severity of adverse health effects, and weighs the quality of available toxicological evidence. The toxicity assessment is accomplished by hazard identification and assessing dose-response. Hazard identification is the process of determining whether exposure to a chemical is associated with a particular adverse health effect and characterizes the inherent toxicity of a compound. A dose-response assessment correlates the magnitude of the intake of a particular compound with the probability of toxic effects. Toxicity values are then derived that can be used to estimate the potential for adverse effects from the potential exposure to the chemical.

When performing risk assessments, EPA evaluates carcinogenic and noncarcinogenic effects of various chemicals present at a site. Cancer and noncarcinogenic contaminents are evaluated independently due to the different toxological endpoints, relevant exposure duration, and methods used to characterize risk. Slope factors are applicable for estimating the lifetime probability of human receptors developing cancer as a result of exposure to known or potential carcinogens. The reference dose (RfD) is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is based solely on the noncarcinogenic effects of chemical substances.

PCE is the only COC at the Site. PCE is a manufactured chemical that is widely used for dry cleaning fabrics and for metal degreasing. According to the Agency for Toxic Substances and Disease Registry (ATSDR) high concentrations of PCE can cause dizziness, headaches, sleepiness, confusion, nausea, difficulty speaking and walking, unconsciousness and death.

Long term health effects from PCE exposure can include liver and kidney damage. PCE is reasonably anticipated to be a human carcinogen.

G.1.4. Risk Characterization

The human health risk assessment used a conservative approach to evaluate risk levels under various exposure scenarios. The potential for carcinogenic effects due to exposure to Site-related contamination is evaluated by estimating the excess lifetime carcinogenic risk. The cumulative risk of exposure to multiple chemicals is also evaluated by adding the risk from individual chemicals. When the cumulative risk to an individual receptor exceeds one in ten thousand ($1x10^{-4}$), EPA generally requires an action be taken. The City has been treating the contaminated groundwater since 2000 and no exposure or risk is currently known to affect the population.

Noncarcinogenic health risks are estimated by comparing the calculated exposure levels to threshold concentrations or (RFDs). The calculated intake is then calculated to be a hazard quotient (HQ). If the HQ exceeds 1.0, there is the potential for adverse health effects. When assessing multiple chemicals for noncarcinogenic health effects a hazard index (HI) approach is used. This assumes that the effects of multiple chemicals are additive. When the HI exceeds 1.0, EPA generally takes an action. The results of the risk assessment are discussed below:

Adult Resident-Current/Future Summary: The results of the current/future risk evaluation for the adult resident for ingesting and showering with contaminated groundwater were $2.3x10^{-3}$, which exceeds EPA's acceptable risk range. PCE is the predominant cancer risk driver.

The current/future risk evaluation HI's for noncancer health effects was HI=2, which exceeds EPA's acceptable threshold of HI=1 and indicates that noncancer health effects may occur. When the HI is broken out by target organ the HIs do not exceed 1.

Child Resident- Current/Future Summary: The results of the current/future cancer risk evaluation for child residents ingesting and bathing with contaminated groundwater were $2.4x10^{-3}$ which exceeds EPA's acceptable risk range. PCE is again the predominant risk driver.

The noncancer risk evaluation for child residents was a HI=4, which exceeds EPA's acceptable level of HI=1, which indicates that non-cancer health effects may occur. When the HI is broken out by target organ the HI exceeds 1 for effects to the liver and to body weight. The noncancer risk driver is PCE.

Lifetime Resident-Current/future Summary:

The current/future cancer risk for lifetime residents is $4.7x10^{-3}$ for showering/ bathing and ingesting contaminated groundwater. This exceeds EPA's acceptable risk range. PCE is the cancer risk driver.

G.2. Ecological Risks

A screening level ecological risk assessment (SLERA) was completed for the Site as part of the RI. The objective of the SLERA was to evaluate the future potential ecological impacts of contaminants from the Site on the Ohio River and Sandy Creek. Sandy Creek borders Ravenswood to the south and flows into the Ohio River which borders Ravenswood on the west. The Conceptual Site Model, discussed in Section E.4 explains that while there is a portion of the plume that may eventually reach the Ohio River, the City's production wells' influence on the groundwater gradient have to date prevented this from happening. Groundwater flow models indicate that the PCE plume does not flow to Sandy Creek.

The SLERA was conducted in a manner consistent with *EPA's Ecological Risk Assessment Guidance for Superfund (ERAGS)* guidance document. The SLERA examined all sampling data collected for the Site to date and used the highest concentrations found in those samples. This examination included Volatile Organic Compounds (VOCs), Semi-Volatile Compounds (SVOCs), inorganics such as metals, and pesticides. The SLERA then examined potential exposure pathways and receptors for exposure such as fish and birds. The SLERA identified several Contaminants of Potential Concern (COPCs) using conservative assumptions. Any contaminants found above the Ecological Screening Level (ESL) were included as COPCs. The full list of COPCs can be found in the AR for the Site. The SLERA found that potential future risk exists where groundwater discharges into the surface water.

The risk assessment concluded that while there could be future potential risks to ecological receptors exposed to contaminated groundwater discharging to the Ohio River and Sandy Creek, the current data indicate that the plume has not reached the Ohio River or Sandy Creek and no risk currently exists.

G.3. Basis for Remedial Action

In summary, the baseline human health risk assessment conducted for the Site demonstrates that unacceptable risks are present because of the groundwater contaminated with PCE. If the City changes its pumping rates or groundwater begins to reach the Ohio River, there could be the potential for ecological risk to exist. Currently, the City is treating its contaminated production wells before distributing the groundwater to the public; however EPA's objective is to restore groundwater to its beneficial use. Therefore it is EPA's determination that the Selected Remedy is necessary to protect human health and the environment from actual or threatened releases of hazardous substances into the environment.

H. Remedial Action Objectives (RAOs)

The Remedial Action Objectives (RAOs) provide general descriptions of what the cleanup is designed to accomplish. They are established on the basis of the nature and extent of contamination at a site, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. These objectives typically address both a contaminant level and an exposure route, because protectiveness may be achieved by reducing exposure as well as by reducing actual contaminant levels in the media of concern. The specific criteria for establishing RAOs can be found in the NCP § 300.430(e)(2)(i).

H.1. Groundwater RAOs

The medium of concern for OU1 of the Site is groundwater. The ROAs for the Site assume that the current and future uses of the Site will remain a mix of residential and commercial, and that groundwater will continue to be used as a drinking water source in the future. The ROAs for OU1 groundwater are:

- Prevent human exposure, including ingestion, inhalation, and dermal contact, by current and future residents and industrial workers to contaminated groundwater that exceeds EPA's acceptable level of risk of $1x10^{-4}$;

- Prevent down-gradient and offsite migration of contaminants in the groundwater to the Ohio River and Sandy Creek; and

- Restore contaminated groundwater to meet the ARAR which is the Maximum Contaminant Level (MCL).

H.2. Basis and Rational for Remedial Action Objectives

The basis for the RAOs for groundwater is to remediate the Site to residential standards, which is one of the current and anticipated future land uses for the Site. PCE is in groundwater at levels above the MCL. The NCP requires EPA to take action at sites where contaminants exceed MCLs unless a waiver is invoked pursuant to Section 121(d)(4) of CERCLA, 42 U.S.C. § 9621(d)(4).

The remedial action will restore groundwater to beneficial use as an uncontaminated source of drinking water. The Selected Remedy will restore groundwater to the MCLs, reduce the cumulative risk presented by all remaining Site-related compounds to a 10^{-4} to 10^{-6} cancer risk level, and reduce the noncancer risk to a HI of less than 1.

I. Description of Alternatives

CERCLA requires that any remedial action selected under CERCLA Section 121, to address contamination at a Superfund site be protective of human health and the environment, cost effective, in compliance with regulatory and statutory provisions that are Applicable or Relevant and Appropriate Requirements (ARARs), and compliant with the NCP, to the extent practicable. The Feasibility Study (FS) for the Site was prepared by EPA and evaluated the alternatives for the final Site cleanup.

I.1. Common Elements of Each Remedial Component

This section of the ROD describes those components that are common to each of the remedial alternatives, except for the No Action Alternative, in which nothing would be done.

Institutional Controls: Three of the alternatives require Institutional Controls (ICs) to restrict the installation of new extractions wells in the area of the groundwater contamination until MCLs are achieved. The implementation of ICs will prevent exposure to the contaminated groundwater.

Groundwater Monitoring: Groundwater monitoring is required by all three of the alternatives that require an action. Groundwater samples will be collected throughout the Site to monitor levels of contaminants in the plume. Additional monitoring wells may need to be installed. The sampling data will be used to evaluate the effectiveness of the remedy.

Pre-Remedial Design Investigation: Three of the alternative would require a pre- remedial design investigation to ensure the proper placement of the remedial components.

Five-Year Reviews: Five year reviews are a common element for each of the four alternatives, since hazardous substances will remain on Site, pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9621 (c), EPA will conduct a five-year review after the initiation of the remedial action to assure that human health and the environment are being protected by the selected remedial action. Five year reviews are required at all Superfund sites when there is waste that is left in place resulting in a site that does not meet the criteria of unlimited use and unrestricted exposure (UUUE). At Ravenswood, five year reviews will be conducted every five years, beginning at the construction of the remedial action, until the final groundwater standards are met.

I.2. Remedial Alternatives

Alternative 1- No Action

Estimated Cost: $0
Estimated Annual Cost: $0
Estimated Present Worth Cost: $0
Estimated Time to Completion: hundreds of years

This alternative is developed and retained as a baseline scenario to which the other alternatives may be compared. Under this alternative, EPA would take no action at the Site to prevent exposure to the groundwater contamination.

Alternative 2- Groundwater Extraction and Granular Activated Carbon (GAC) Treatment using a New Extraction Well

Estimated Capital Cost:
Alternative 2a: $578,500
Alternative 2b: $513,800
Estimated Annual Cost: $35,650
Estimated Present Worth:
Alternative 2a: $1,675,000
Alternative 2b: $1,610,000
Estimated Time to Completion: 30 years

This alternative would involve extracting groundwater and treating it using a granular activated carbon (GAC) treatment system. A new extraction well would be installed to capture and pump contaminated groundwater to the surface for treatment. The most likely location for the installation of the new extraction well would be in the area near PW-3, which would allow the extraction well to capture the contaminated groundwater before it reaches the City water supply. Once the groundwater was pumped to the surface, the GAC treatment system would remove the PCE through adsorption to the surface of the carbon particles. A pre-filter would be placed in the system before the GAC to remove any suspended particles. Once the carbon became exhausted it would be replaced.

Two potential discharge options have been considered:

- Alternative 2a assumes the treated groundwater would be discharged to the Ohio River.
- Alternative 2b assumes the treated groundwater would be blended with the water from the City production wells and connected to the City water supply.

A groundwater monitoring program, including the installation of additional monitoring wells and routine sampling, would be needed to monitor the migration and concentration of the plume. Institutional Controls would be put in place to prohibit the installation of any additional productions wells in the plume area. It would also be necessary to continue treatment of the contaminated City production wells until PCE levels are reduced to MCLs.

This option could take 25-50 years to achieve the clean-up standards.

Alternative 3- Venturi Air Stripping Using a New Extraction Well

Estimated Capital Cost: $325,900
Estimated Annual Cost: $874,800
Estimated Present Worth: $1,201,000
Estimated Time to Completion: 30 years

This alternative would involve installing a new Venturi air stripper on a newly installed extraction well to increase the City's capacity to treat contaminated groundwater compared to its current capacity. The extracted groundwater would pass through the new Venturi air stripper to remove PCE prior to the treated water being blended with the water from the City's other wells. The new extraction well would be placed in the vicinity of PW-3. The number of wells needed to control the contaminated groundwater would be determined by groundwater modeling performed as part of the Remedial Design.

Treatment using the Venturi air stripper would increase the amount of uncontaminated groundwater being blended in the City water supply. It would be necessary to continue treatment of the City's production wells until PCE levels are reduced to MCLs.

A groundwater monitoring program, including the installation of additional monitoring wells and routine sampling, would be needed to monitor the migration and concentration of the plume. Institutional Controls would be put in place to prohibit the installation of any additional production wells in the plume area.

This option could take 25-50 years to achieve the clean-up standards.

Alternative 4- In-Situ Air Sparging with Soil Vapor Extraction

Estimated Capital Cost: $282,400
Estimated Annual Cost: $23,186.67
Estimated Present Worth: $978,000
Estimated Time to Completion: 10 years

This alternative would involve in-situ air sparging and soil vapor extraction to remove PCE from the groundwater. In-situ air sparging is a technique in which air is injected into the groundwater to transfer aqueous phase volatile organic contaminants to the vapor phase. Typically, it is used in conjunction with soil vapor extraction which eliminates the migration of vapors.

Air is injected into the groundwater through air sparging wells which disturbs the PCE and causes it to go into a vapor state. The PCE vapors then travel up into the unsaturated zone of soil where the soil vapor extraction wells capture the vapors and send them via underground piping into the treatment building. In the building, the vapors are filtered in a carbon adsorption unit, which removes the PCE from the air and discharges clean air into the atmosphere. Vapors would be monitored and, as in the Treatability Study, the system would be initiated in a way that prevents exposure to the vapors produced from the remediation by ensuring all vapors were extracted using the vapor extraction wells.

The TS which is operating on-Site was installed so that, if needed, additional air sparging wells and soil vapor extraction wells could be added to the system. The results of the ongoing TS would be used to confirm the air flow rates needed and the radius of influence of the air sparging wells before the design is finalized. Additional sampling prior to the Remedial Design may be needed to determine PCE concentrations and placement of additional air sparging and soil vapor extraction wells.

A groundwater monitoring program, including the installation of additional monitoring wells and routine sampling, would be needed to monitor the migration and concentration of the plume. Institutional Controls would be put in place to prohibit the installation of any additional productions wells in the plume area.

Based on the results of a nearby system treating PCE in similar conditions, EPA estimates it will take ten years to reach MCLs in groundwater. This option should take a considerably less amount of time then the other options considered.

A baseline risk assessment was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. The baseline risk assessment focused solely on groundwater for the Site. The potential for vapor intrusion and the risks associated with that will be assessed in the OU2 risk assessment.

I.3. Expected Outcomes of Each Alternative

With the exception of the No Action Alternative, each of the alternatives considered for the Site are expected to reduce the risk to human health and environment over time. All of the treatment alternatives will eventually restore groundwater to MCLs. Alternative 4 is expected to achieve MCLs within ten years. Alternatives 2a, 2b and 3 are calculated to take upwards of 50 years to achieve the same. Each of the alternatives is expected to control the migration of contaminants to the Ohio River.

The outcome of the remedy is not expected to change the land and groundwater use at the Site because it will likely remain residential and commercial. Implementation of the Selected Remedy will reduce the potential risk to human health and restore the groundwater to drinking water standards, eliminating the risk to the Ravenswood water supply.

J. Comparative Analysis of Alternatives

The alternatives discussed above were compared with the nine criteria set forth in the NCP at 40 C.F.R § 300.430(e)(9)(iii) in order to select a remedy for the Site. These nine criteria are categorized according to three groups: threshold criteria; primary balancing criteria; and modifying criteria. These evaluation criteria relate directly to the requirements in Section 121 of CERCLA, 42 U.S.C § 9621, which determine the overall feasibility and acceptability of the remedy.

Threshold criteria must be satisfied in order for a remedy to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs among remedies. State and community acceptance are modifying criteria formally taken into consideration after public comment is received on the Proposed Plan. A summary of each of the criteria is presented below, followed by a summary of the relative performance of the alternatives with respect to each of the nine criteria. These summaries provide the basis for determining which alternative provides the "best balance" of trade-offs with respect to the nine criteria. The "Comparative Analysis of Alternatives" can be found in the FS.

Threshold Criteria:

1. Overall Protection of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

2. Compliance with ARARs evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the Site, or whether a waiver is justified.

Primary Balancing Criteria:

3. Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.

4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5. Short-term Effectiveness considers the risks that might be posed to the community during implementation of the alternative; the potential impacts on workers during the remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action; and the length of time until protection is achieved.

6. Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. Cost includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

Modifying Criteria:

8. State/Support Agency Acceptance considers whether the State agrees with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.

9. Community Acceptance considers whether the local community agrees with EPA's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

DETAILED ANALYSIS OF THE PROPOSED REMEDIAL ALTERNTIVES

1. Overall Protection of Human Health and the Environment

Alternative 1 would not provide any protection of human health and the environment. No risk reduction is anticipated under the "no action" alternative.

Alternative 2a, 2b and 3 would be protective of human health and the environment. Since extraction would be used in 2a, 2b and 3 and only the extracted water would be treated, the contaminated groundwater would remain in the aquifer until remediated. This would take a significantly longer period of time than Alternative 4 and the contamination could potentially impact Sandy Creek and the Ohio River. Alternative 2a, 2b and 3 would minimize the potential for contaminated groundwater to impact the City's production wells since the movement of groundwater would be controlled by the extraction wells. However, since these alternatives provide wellhead treatment only, these alternatives would take significantly more time to reduce overall concentrations of PCE in the aquifer.

Alternative 4 would also be protective of human health and the environment through in-situ treatment of the contamination in the aquifer. The air sparging system would be designed to treat the center of the plume before it is drawn into the City's production wells. EPA anticipates that it will take ten years for the MCLs to be reached in the aquifer. Continued treatment of the contaminated City production wells would be necessary until PCE levels are reduced to the MCL in the aquifer.

2. Compliance with ARARs

Alternative 1- No Action provides no protection to human health and the environment and would not achieve compliance with ARARs. Alternatives 2a, 2b, 3 and 4 would all be expected to comply with chemical, location, and action specific ARARs set forth in Appendix D. The ARARs would include drinking water standards required by the Safe Drinking Water Act, 42 U.S.C. § 300g-l, and set forth at 40 CFR § 141.61, and applicable emission standards for process vents required by RCRA and set forth at 40 C.F.R. Part 264, during remedial activities. Alternatives 2a, 2b, and 3 would meet MCLs in drinking water by extracting and treating the groundwater prior to distribution to the public. Alternative 4 would meet MCLs in drinking water by implementing the air sparging/soil vapor extraction system to capture PCE from the contaminated plume.

3. Long Term Effectiveness and Permanence

Alternative 1 would have no long term effectiveness and permanence since there would be no treatment of groundwater.

Alternatives 2a, 2b, 3 and 4 would all provide long-term protection for the Ravenswood municipal water supply.

EPA estimates that Alternative 4 will meet MCLs in the aquifer in approximately ten years. Alternatives 2a, 2b and 3 are assumed to need to operate for at least 30 years with the possibility that it could take longer than 50 years to treat the groundwater within the capture zone of the extraction well. Despite the time to achieve MCLs, all alternatives except for the No Action Alternative will achieve a permanent reduction of PCE contamination.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume since no treatment would occur. Additionally, Alternative 1 would not meet the statutory preference for treatment since remedial activities would not be performed.

Alternatives 2a, 2b, 3 and 4 would all utilize various treatment technologies to reduce the mobility and volume of PCE in the groundwater. Alternatives 2a, 2b, and 3 would all slightly reduce the volume of PCE by extracting and treating the groundwater prior to distribution to the public, and the toxicity of the extracted groundwater would be reduced through the treatment. Alternatives 2a and 2b would contain the extracted PCE in an aqueous phase carbon system. Alternative 3 would remove the PCE as vapors, which would be discharged in accordance with ARARs. Alternatives 2a, 2b and 3 would not reduce the mobility of PCE in the aquifer beyond the area of influence of the groundwater extraction well.

Alternative 4 would be the most effective in preventing high concentrations of PCE from migrating to the Ohio River, since it will remove PCE from the aquifer in the least amount of time. Alternative 4 would reduce the mobility of contaminants in the aquifer by the in-situ treatment of PCE, this would be accomplished by the reduction of the higher concentration of contaminants in portions of the plume which would reduce dispersion and further movement of the PCE. The volume of the PCE in the aquifer would be reduced by the volatilization of and capture of the PCE vapors by the SVE wells. The toxicity of the groundwater in the aquifer would be reduced as contaminants were removed from the aqueous phase. Because Alternative 4 will directly treat a large portion of the plume, it is expected to be the most effective at reducing toxicity throughout the entire plume. The carbon filter will capture the PCE vapors preventing PCE vapors from reaching the atmosphere.

5. Short-term Effectiveness

Alternative 1 would have no short-term impacts since no remedial actions would be performed.

Alternatives 2a, 2b, 3 and 4 would all have limited short-term impacts on Site workers conducting the construction activities related to the remedial action. Because PCE is only found in groundwater, the risks would be considered very low and could be controlled by standard health and safety practices.

It would be necessary to continue treatment of the City's production wells prior to distribution to the public until PCE levels are reduced to MCLs with all of the alternatives.

Alternatives 2a, 2b and 3 are expected to take 25-50 years to capture all of the PCE in the contaminated aquifer.

Alternative 4 is expected to meet MCLs in the aquifer in approximately ten years giving it the greatest short-term effectiveness.

6. Implementability

There are no implementation issues related to Alternative 1 since no action would be taken.

Alternatives 2a, 2b, 3 and 4 are all relatively easy to implement since they use standard construction equipment and services. Due to the location of the plume, the placement of the treatment equipment associated with all the alternatives would need to be evaluated to ensure no interruptions to the current land uses.

Construction of Alternatives 2a, 2b and 3 might cause some disruptions to streets depending on the locations of the wells, treatment systems and discharge pipes. Alternatives 2a and 2b could be harder to implement depending on the size of the carbon unit required. Alternative 3 may also be more difficult to implement due to the difficulty in obtaining replacement parts for the Venturi air stripper. Access to public and private property (public streets, land and/or private residence yards) may be needed for the placement of the wells, piping and remedial components for all these alternatives which may cause delays.

Alternative 4 may create a short-term disruption to the surrounding area and streets as more wells are installed. As described for Alternatives 2a, 2b and 3, access may also be an issue. The original Treatability Study system was installed in such a way as to allow for more wells to be hooked up to it, making the system easy to expand. All additional wells and piping would use common drilling and construction techniques.

7. Cost

The retained alternatives are ranked from least to most expensive using the present worth. Alternative 1 is not included in the table since no actions would be taken and there would be no associated costs.

Alternative 4 would be the least expensive alternative with a capital cost of $282,400 and a long-term present worth Operation and Maintenance (O&M) cost of $695,600. Alternative 3 would be in the middle of the cost range with a capital cost of $325,900 and a long-term present worth O&M cost of $874,800. Alternative 2 would be the most expensive alternative with a capital cost of $578,500 for discharge to the Ohio River (2a) and $513,800 for discharge to the City water supply (2b). The long-term present worth O&M cost for both 2a and 2b would be $1,096,500. All O&M costs are based on a standard 30-year O&M period. However Alternatives 2a, 2b, and 3 could take 25-50 years to capture all of the contaminated groundwater. Alternative 4 is expected to take ten years for groundwater in the aquifer to meet MCLs. Ten years of biannual O&M and sampling were assumed for this Alternative with a decrease to annual sampling after 20 years.

Alternative	**Capital Cost**	**Present Worth of O&M Costs**	**Present Worth**
Alternative 2	a- $578,500 b- $513,800	a- $1,096,500 b- $1,096,500	a- $1,675,000 b- $1,610,000
Alternative 3	$325,900	$874,800	$1,201,000
Alternative 4	**$282,400**	**$695,600**	**$978,000**

8. State Acceptance

The West Virginia Department of Environmental Protection (WVDEP) concurs with EPA's Selected Remedy for the Site; a concurrence letter was received by EPA on April 12, 2011.

9. Community Acceptance

EPA conducted a public meeting for the Proposed Plan on January 20, 2011. EPA's Preferred Alternative, Alternative 4- In-Situ Air Sparging with Soil Vapor Extraction, was well received by those in attendance. Questions and concerns that were raised during the public meeting along with EPA's responses are provided in Section III of the ROD, the Responsiveness Summary. Additional comments that were submitted to EPA during the comment period are also addressed in the Responsiveness Summary.

K. Principal Threat Waste

Principal threat waste has not been identified onsite and therefore treatment of principal threat waste is not discussed in this document.

L. Selected Remedy: Description and Performance Standards

Based on consideration of the CERCLA requirements and analysis of alternatives using the nine evaluation criteria, including public comments, EPA has determined that Alternative 4- Air Sparging with Soil Vapor Extraction is the most appropriate remedy for the Ravenswood PCE Site. The Selected Remedy will be implemented by expanding upon the existing air sparging and soil vapor extraction system. Additional air sparging wells and soil vapor extraction wells will be installed and tied into the existing sysyem once the Pre-Remedial Design Investigation has been completed. ICs will be implemented to ensure that no new wells are installed in the plume area.

L.1. Summary of the Rational for the Selected Remedy

Air Sparging with Soil Vapor Extraction (AS/SVE)

EPA chose AS/SVE treatment for contaminated groundwater because of the demonstrated success of effectively and rapidly removing PCE from the aquifer and reducing PCE concentrations. The AS/SVE system will treat the PCE contamination in a much shorter time frame than the other options explored, and has a significantly lower cost than the other options. EPA has determined that the Selected Remedy will be protective of human health and the environment, complies with ARARs, is cost effective, and utilizes a permanent solution to the maximum extent practable.

Institutional Controls (ICs)

EPA will rely upon ICs to ensure protection of human health until the RAOs are met. The City currently treats its water supply, which is drawn out of the contaminated aquifer, using a Venturi air stripper prior to distribution to the public. ICs will be implemented in order to prevent the installation of new potable or extraction wells within the area of contaminated groundwater until the groundwater reaches MCLs. This will ensure that no one is exposed to untreated groundwater.

L.2. Description of the Selected Remedy

Following is a description of each component of the Selected Remedy- Air Sparging with Soil Vapor Extraction. Although EPA does not expect significant changes to this remedy, it may change somewhat as a result of the design and construction process. Any significant changes to the remedy described in this ROD would be documented by a memorandum to the file, an Explanation of Significant Differences, or a ROD Amendment, as appropriate and consistent with the applicable regulations and guidance.

Groundwater

The Selected Remedy will address elevated PCE concentrations present within the plume until they are at or below the MCL which is currently 5µg/L. The plume area in which PCE is above the MCL is about 400 feet wide by 1400 feet long, based on data collected in 2010. The maximum thickness of the saturated zone is 40 feet. The volume of contaminated groundwater has been calculated to be approximately 50.8 million gallons with approximately 25.4 million gallons being in the contaminated shallow zone of the aquifer.

The existing nine air sparging wells, three soil vapor extraction wells, monitoring wells and the existing air sparging/soil vapor extraction piping and treatment building will be used as part of the final Remedial Action. The Treatability Study was designed such that it can be easily expanded upon, allowing for the installation of additional air sparing wells and soil vapor extraction wells. Prior to determining where the additional air sparging and soil vapor extraction wells will be placed, a Pre-Remedial Design Investigation (PRDI) will take place. The PRDI will consist of additional groundwater and soil sampling that will take place in areas of the greatest plume uncertainty. The information from the PRDI will be used to identify areas of expansion for the AS/SVE, and areas where additional monitoring wells are needed.

Once the PRDI has taken place and AS/SVE wells are installed in the most appropriate areas, a phased start-up similar to the beginning of the Treatability Study is expected. The phased approach to system start-up will ensure that the radius of influence of both the SVE and AS wells allow for the system to safely and effectively operate. It is expected that the existing AS/SVE treatment system will continue to operate until the expansion is completed.

EPA expects that the City will have to continue to operate its Venturi air stripper as a treatment of its drinking water until levels of PCE have decreased throughout the plume. Pre-treatment of the groundwater prior to distribution is necessary in order to prevent risk from PCE exposure. EPA will work with the City to ensure that the Venturi air stripper continues to operate as intended and continues to effectively treat the groundwater.

Groundwater and vapor monitoring will occur throughout the Remedial Action. Groundwater will be sampled on a schedule determined during the Remedial Design. Monitoring wells will be placed near the Ohio River to ensure PCE does not migrate to the River. Sampling will allow EPA to evaluate PCE levels in the aquifer and ensure that the plume is not migrating and is being effectively treated by the AS/SVE system. Once the MCLs are met throughout the plume, EPA will evaluate ending the AS/SVE treatment. Criteria for discontinuing the AS/SVE operation will be developed in more depth during the Remedial Design and the development of the sampling and monitoring plan. Additionally, vapor monitoring will occur on a schedule determined during the Remedial Design. Vapor sampling will allow EPA to calculate the amount of PCE being removed from the aquifer and will ensure that the SVE system is working as intended. Both the groundwater and vapor monitoring and sampling plan will be developed during the Remedial Design.

Institutional Controls

To ensure there is no human consumption or exposure to untreated contaminated groundwater prior to achieving MCLs in the aquifer, Institutional Controls will be put in place. Institutional Controls will be developed with the State of West Virginia and the City of Ravenswood to determine the most effective way to prevent additional wells from being drilled in the vicinity of contaminated groundwater.

The Institutional Controls could be implemented through zoning restrictions, notice to drillers, County or City ordinances or notifications from the State. Figure-2 depicts the most current plume boundary in which ICs could be expected.

L.3 Cost Estimate for the Selected Remedy

Appendix E includes details of the estimated costs to construct and implement the Selected Remedy. The estimated total cost to construct and implement the Selected Remedy is $978,000. The information in this cost estimate is based upon the best available information regarding the anticipated scope of the Remedial Action.

Some changes to the cost estimates are expected to occur during implementation of the remedy. Major changes may be documented in the form of a memorandum to the file, an ESD, or a ROD amendment, as appropriate. This cost estimate is expected to be within +50 to -30 percent of the actual project cost.

L.4 Performance Standards

Groundwater

1. The Remedial Action for groundwater will continue until the Maximum Contaminant Level (MCL) for PCE is achieved throughout the contaminated plume (as currently delineated in Figure 2). The current MCL for PCE 5µg/L. Remediating to the MCL will bring cumulative risk to within the $1x10^{-4}$ to $1x10^{-6}$ risk range, with an HI of less than 1.

Institutional Controls

2. Installation of new potable or extraction wells within the area of contaminated groundwater will be prevented through the use of institutional controls until MCLs are achieved throughout the plume. The current plume boundaries are defined in Figure-2.

L.5 Expected Outcomes of the Selected Remedy

Available Land Uses

The remedy will not alter the current land use at the Site, which includes mixed commercial and residential use. Property at the Site will continue to be used for residential and commercial purposes when the final performance standards are met.

Available Groundwater Uses

The remedy will be protective of groundwater because active treatment of the plume will reduce the concentrations of PCE to below the MCLs, reduce risk to the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ and an HI less than 1. Once the final performance standards are met, the groundwater at the Site can be used as an uncontaminated drinking water source. The planned implementation of the ICs will help restrict the use of groundwater until cleanup goals are met. The active remediation at the Site will prevent the further migration of contaminants in the groundwater.

Restoring groundwater to its full beneficial use will also alleviate financial burden for the City as it will no longer have to maintain the Venturi air stripper which frequently breaks down and adds significant costs to the City.

M. Statutory Determinations

Under CERCLA § 121 and the NCP § 300.430(f)(5)(ii), EPA must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery to the maximum extent possible. There is also a preference for remedies that use treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the Selected Remedy meets these statutory requirements.

M.1. Protection of Human Health and the Environment

The Selected Remedy will be protective of human health and the environment. Active treatment of the contaminated groundwater throughout the plume is expected to restore groundwater to drinking water standards. Monitoring of subsurface vapors will ensure all PCE vapors generated by the air sparging are effectively captured by the SVE wells. Continued well-head treatment of the City’s contaminated production wells will ensure that there is no exposure to contaminated groundwater until MCLs are achieved throughout the plume. Implementation of ICs restricting the installation of extraction wells within the contaminated plume until cleanup goals are met will ensure the remedy remains protective.

M.2. Compliance with Applicable or Relevant and Appropriate Requirements

The NCP § 300.430(f)(5)(ii)(B) and (C) require that a ROD describe Federal and State ARARs that the Selected Remedy will attain or provide a justification for any waivers. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, or contaminant; remedial action; location; or other circumstance at a CERCLA site. Relevant and appropriate requirements, while not legally applicable to circumstances at a particular CERCLA site, address problems or situations similar to those encountered at the site such that their use is considered relevant and appropriate.

The ARARs that will be met during implementation of the Selected Remedy are presented in Appendix D of this ROD.

M.3. Cost Effectiveness

Cost effectiveness is determined by evaluating the remedy's long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short-term effectiveness. If the overall cost of the remedy is proportional to its overall effectiveness, then it is considered to be cost effective. The Selected Remedy satisfies the criteria listed above because it offers a permanent solution through the destruction of contaminants in the groundwater, and costs significantly less than the other protective remedies that were evaluated. Therefore, the Selected Remedy is cost effective.

M.4. Utilization of Permanent Solutions to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment are practicable at the Site. When compared to the other protective alternatives that were evaluated, EPA has determined that the Selected Remedy provides the best balance of tradeoffs in terms of the five balancing criteria, as well as the preference for treatment as a principal element. The Selected Remedy also has State and community acceptance.

The Selected Remedy will meet the statutory preference for treatment as a principal element since it treats the principle threat waste at the Site. This is done through the injection of air into the subsurface which mobilizes PCE to a vapor which is then extracted and treated.

M.5. Five Year Review Requirements

CERCLA § 121(c) and the NCP § 300.430(f)(4)(ii) provide the statutory and legal bases for conducting Five Year Reviews. Since the Selected Remedy is expected to take at least ten years to achieve the cleanup levels for groundwater, it will result in hazardous substances remaining onsite in groundwater above levels that allow for unrestricted use and exposure. A statutory review will be conducted within five years after initiation of the Remedial Action to ensure the remedy is, or will be, protective of human health and the environment.

N. Documentation of Significant Changes from the Preferred Alternative of the Proposed Plan

There have been no significant changes from the Preferred Alternative in the Proposed Plan. The Proposed Plan was released for public comment on January 10, 2011. The public comment period for the Proposed Plan was held from January 10, 2011, to February 9, 2011. EPA held a public meeting on January 20, 2011, to present the preferred alternative in the Proposed Plan. EPA has reviewed and responded to verbal and written comments submitted during the public comment period in Part 3 of the ROD, the Responsiveness Summary.

O. State Role

WVDEP, on behalf of the State of West Virginia, has reviewed the Remedial Alternatives presented in the ROD and has indicated its concurrence with the Selected Remedy. WVDEP has also reviewed the list of ARARs to determine if the Selected Remedy is in compliance with appropriate State environmental laws and regulations.

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PART III- THE RESPONSIVENESS SUMMARY

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III. Responsiveness Summary

This section summarizes the questions and comments received during the public comment period for the Ravenswood PCE Site. The Proposed Plan was released for public comment January 10, 2011. The public comment period was from January 10, 2011 to February 9, 2011. A public meeting was held at the Ravenswood Fire Hall on the evening of January 20, 2011.

A. Questions Raised During the January 20, 2011 Public Meeting

Q1: A citizen asked how long the groundwater has been contaminated and how the contamination was identified.

EPA Response: PCE contamination in groundwater was first identified during routine sampling of the City's water supply in 1989.

Q2: A citizen wanted to know if PCE is still being used in Ravenswood.

EPA Response: PCE is used as a dry cleaning fluid and a metal degreaser and industrial solvent. Sampling data at the Site indicate that there is no likely source area and no continuing source of PCE contamination. A search of EPA's Toxics Release Inventory (TRI) does not indicate any current businesses using PCE in Ravenswood; however, it should be noted that many businesses that may use PCE would not be required to report to the TRI.

Q3: A citizen asked what other Sites have utilized air sparging and soil vapor extraction units and what their success rate was.

EPA Response: Air sparging and soil vapor extraction are commonly used remedial technologies. The Ravenswood treatment unit has actually been taken from the nearby Vienna PCE Site where air sparging and soil vapor extraction has been in use as the remedial action since 2005. The unit was taken from a small portion of the plume that was effectively remediated to MCLs in three years. The larger air sparging/soil vapor extraction unit at the Vienna Site has removed over 2,000 pounds of PCE. Air sparging and soil vapor extraction is very effective in removing PCE from groundwater. To date EPA has removed over five pounds of PCE from the Ravenswood Site.

Q4: A citizen asked if there were a higher incidence of health problems or cancer occurrences in the area.

EPA Response: The Agency for Toxic Substances and Disease Registry did a Public Health Assessment for Ravenswood in 2007. The report concluded that "exposure to PCE at this site poses *no apparent public health hazard for the past and present*" (ATSDR, 2007). EPA is not aware of any elevated cancer occurrence in the Ravenswood area as compared to the rest of West Virginia.

Q5: A citizen from Ohio was concerned about health risks in their community and questioned why they received the mailing for the Ravenswood Site.

EPA Response: The mailing for this Proposed Plan was quite large and EPA is working on a more concise and appropriate mailing list. Anyone who lives in Ohio on the western bank of the Ohio River is not affected by the Ravenswood Site. If groundwater were to reach the Ohio River, which current data show it does not, the River itself would form a natural barrier for contamination and it is unlikely that anyone from Ohio would be expected to come into contact with Site contamination.

Q6: A citizen asked what the highest concentration of PCE was at the Site and what the regulatory limit for PCE is.

EPA Response: Data collected as part of the March 2010 DPT sampling event showed the current highest level of 220µg/L taken at DP-15 near the intersection of Washington Street and Mulberry Street. The regulatory limit for PCE, the Maximum Contaminant Level (MCL) promulgated by EPA, pursuant to the Safe Drinking Water Act, is 5µg/L. The water that is distributed to the public is in compliance with the MCL.

Q7: A citizen asked if there was flooding from the Ohio River if their drinking water supply would be affected.

EPA Response: Flooding from the Ohio River should not affect the Ravenswood water supply and should not affect PCE levels in the water supply system. Since the City draws its water from groundwater, flooding does not affect its system.

Q8: A citizen asked if the high concentrations of PCE stay in the same place or if they move around.

EPA Response: Groundwater flows generally in the direction of the City's production wells at a rate dependent on the City's pumping rates. The two highest concentration areas which are near the intersection of Virginia and Sycamore Street and the intersection of Washington Street and Mulberry Street have historically had the highest concentrations of PCE.

Q9: A citizen asked how many air sparging wells were installed as part of the Treatability Study and how many more were expected to be installed.

EPA Response: Currently there are nine air sparging wells installed as part of the Treatability Study. At this time EPA does not know how many additional wells will be installed as part of the permanent remedy at this Site. The decision regarding how many wells will be needed and their physical placement will be made after the Pre-Remedial Design is completed. The treatment building located in Ravenswood has the capacity to operate a number of additional wells.

Q10: A citizen asked how deep EPA drilled during investigation activities.

EPA Response: Bedrock is present at 90 feet and acts as an impermeable layer. EPA has wells screened in both the shallow and deep portions of the aquifer and took Direct Push Technology (DPT) points in both the shallow and deep portions of the aquifer. The shallow wells are screened at around 40-60 feet below ground surface. The deeper wells are screened above bedrock.

Q11: A citizen asked if PCE can build up in pipes like calcium does.

EPA Response: PCE would not build up in the pipes of homes.

Q12: A citizen asked what percentage of PCE vapors was captured by the SVE system.

EPA Response: Operation of the TS system began in phases. This phased approach allowed EPA to gather enough sampling data to ensure that the vapor extraction system captured all PCE vapors and no risk from PCE vapors was created from operating the system. In June 2009, the soil vapor extraction system was activated which resulted in the removal of PCE vapors from the subsurface. Sampling was conducted of the SVE system frequently during the first month of the SVE system operation. Once the vapor data confirmed that there were not high levels of PCE in the subsurface, the AS system was phased into operation. The AS system was activated at half capacity in August 2009, after two months of vapor monitoring; which ensured that the system did not rapidly mobilize high concentrations of PCE into the subsurface that could not be captured by the SVE wells. Once additional vapor monitoring data confirmed that there were not elevated PCE concentrations in the subsurface, the AS system was activated at full capacity in September 2009.

A vapor intrusion study to determine whether vapors from the untreated portion of the plume are a risk to human health is scheduled to begin in 2011.

Q13: A citizen wanted to know if the Site was still on the NPL and if so where it was ranked, and if it was on the NPL due to the City of Ravenswood selling its groundwater to a lot of people.

EPA Response: The Ravenswood Site is still listed on the NPL and will not be deleted from the NPL until all response actions have been completed. Sites are not ranked in order of severity. Being listed on the NPL allows EPA to take an action and use federal funds to pay for the cleanup. Listing on the NPL is dependent upon a multitude of criteria and population affected would have been considered.

Q14: A citizen wanted to know if PCE can be absorbed through the skin and if they were being exposed while showering.

EPA Response: PCE can be absorbed through the skin and is one of the exposure scenarios evaluated in the Human Health Risk Assessment. The City currently treats the groundwater prior to distribution and PCE levels in the distributed groundwater are below the MCL and therefore do not pose any risk of being absorbed through the skin.

Q15: A citizen wanted to know what the symptoms of PCE exposure would be.

EPA Response: PCE is classified by ATSDR as a reasonably anticipated human carcinogen. Long term health problems can develop in the nervous system, and the respiratory system and prolonged exposure can cause developmental problems. Exposure to very high concentrations of PCE can cause headaches, dizziness, sleepiness, confusion, nausea, difficulty talking and walking, and even death.

Q16: A citizen asked if there were any other chemicals in the groundwater.

EPA Response: Sampling data collected at the Site have shown the presence of other chemicals in the groundwater, but nothing that is over any acceptable risk level and nothing that indicates a cohesive plume of any other contaminant. PCE was the only chemical identified as posing a risk to human health.

Q17: A citizen wanted to know why Ravenswood is not affected by Perfluorooctanoic acid (PFOA or C8) when other communities in the area have an issue with that contaminant.

EPA Response: Ravenswood's municipal supply wells are offset from the Ohio River by 2,000-2,500 feet. Communities that were having a PFOA issue often had their production wells installed within 30-50 feet of the Ohio River. The distance of the City's water supply wells from the River has protected the Ravenswood water supply from any PFOA contamination. In any event, the City had its wells tested recently to ensure that there was no PFOA contamination and the samples came back showing no PFOA contamination.

Q18: A citizen wanted to know if groundwater levels got too low would water from the Ohio River enter the aquifer.

EPA Response: Seasonal fluctuation of the Ohio River does affect a small area of the groundwater in Ravenswood, but it is not part of the groundwater that is drawn into the City's water supply.

Q19: A citizen wanted to know if the Ohio River was safe.

EPA Response: EPA does not have specific data on the Ohio River as it relates to the Ravenswood Site since the contaminated groundwater from Ravenswood does not interface with the River at this time. The West Virginia Department of Natural Resources has information on its website regarding fish advisories for surface water bodies in the State, and the State of West Virginia Department of Health and Human Resources would post any swimming advisories.

Q20: A citizen wanted to know if EPA would be posting updates on its website as progress is made at the Site.

EPA Response: EPA will update the Ravenswood Site page, http://www.epa.gov/reg3hwmd/super/sites/WVSFN0305428/index.htm as progress is made at the Site. The State Department of Environmental Protection's Project Manager's contact information was also added to the website.

B. Stakeholder Comments

Comments received from the WVDEP on February 7, 2010.

C1: The DEP expressed their opinion that the air sparging/soil vapor extraction alternative is the most cost effective approach and should prove to be effective in meeting remedial objectives within an acceptable timeframe.

EPA Response: EPA agrees with the WVDEP.

C2: Comment as submitted: "In summary, it is difficult to evaluate the total remedial approach without a better understanding of the contaminant distribution in the aquifer, notably in the area trending southwesterly from MW-06S to the reported location of a former dry cleaning establishment on Washington Street.

WVDEP requests that the proposed Remedial Design Investigation adequately characterize the nature and distribution of contamination in this as of yet uncharacterized portion of the known plume extent."

EPA Response: EPA agrees that additional characterization should be done in the aforementioned area to ensure the proper placement of air sparging/soil vapor extraction wells and monitoring wells. EPA will ensure WVDEP is involved with the scoping and development of the PRDI when it takes place.

The additional comments re-submitted by the WVDEP were already incorporated into the Proposed Plan for the Site.

Comments received from the West Virginia Rural Water Association (WVRWA)

C1: The WVRWA suggested that EPA consider installing additional municipal production wells. The WVRWA's concerns stem mainly from the fact that PCE has been identified as a candidate for a lower MCL, potentially of 0. An additional concern is that the City may need to install additional production wells in order to keep up with system growth and the Institutional Controls that would be put in place would limit where these new wells could be installed.

EPA Response: EPA understands the concerns regarding the potential for the MCL to be lowered below the current level of 5µg/L. At this time, the risk assessment for PCE is still underway and EPA has not made any recommendation regarding what the lower MCL should be. If the MCL is lowered, EPA is confident that the air sparging/soil vapor extraction system will effectively remove more PCE from the aquifer which will make it easier for the City to treat and distribute the water supply.

EPA also understands the concerns regarding the limitation on new well installation within the plume area; however, it is necessary that this protection be put in place. The Institutional Controls, when developed, will only affect areas over the plume. In August 2004, EPA's Removal program installed two additional production wells up-gradient of the contamination. EPA is confident that the City would be able to find similar up-gradient locations to install any additional production wells. If the City does install new productions wells, not only will it add capacity to the system, but additional clean water will help to lower the PCE levels even more in the distributed water. Data provided by the City on its blended water show that on February 9, 2011, the blended water for distribution was non-detect for PCE. The combined efforts of the air sparging/soil vapor extraction system and the City treating its contaminated wells should allow the City to keep distributing water below the MCL even if the MCL is lowered.

Additionally, EPA does not have the authority to expand a water treatment system based upon anticipated future growth. It is the responsibility of the water authority to expand its system to adequately address growth.

C. Additional Comments Received

EPA also received two verbal comments from citizens voicing their support for the air sparging/soil vapor extraction remedy.

APPENDIX A- ADMINISTRATIVE RECORD INDEX

III. REMEDIAL RESPONSE PLANNING

1. Report: Interim Investigation Report, Volume I of II, Ravenswood PCE Site, Ravenswood, West Virginia, prepared GAI Consultants, Inc., 7/13/01. P. 3000013000569. A June 7, 2002, cover letter to Mr. Eric Newman, U.S. EPA, from Mr. Peter Costello, West Virginia Department of Environmental Protection (WVDEP), is attached.

2. Report: Interim Investigation Report, Volume II of II, Ravenswood PCE Site, Ravenswood, West Virginia, prepared by GAI Consultants, Inc., 7/13/01.
P. 300570-300790.

3. Report: 2001 Investigation Summary, Addendum No. 1,Ravenswood PCE Site, Ravenswood, West Virginia, prepared by GAI Consultants, Inc., 5/02. P. 300791301065.

4. Report: Draft Hydrogeological Analysis Report, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 3/31/06. P. 301066-301287. A March 31, 2006, cover letter to Mr. Anthony Iacobone, U.S. EPA, from Ms. Lynne France, CDM, is attached.

5. Report: Draft Site Management Plan Addendum, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 10/14/08. P. 301288-301502.-Related documents are attached.

6. Report: Working Draft Treatability Study Plan, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 10/27/08. P. 301503-301571.

7. Report: Final Site Management Plan Addendum, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 12/17/08.
P. 301572-301581. A December 17, 2008, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, and a December 22, 2008, letter to Ms. Lynne France, CDM, from Ms. Laura Johnson, U.S. EPA, regarding approval of the Final Site Management Plan Addendum, are attached.

8. Report: Final Treatability Study System ** Installation and Baseline Conditions Report, Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 1/4/10. P. 301582-301812. A January 4, 2010, letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, regarding approval of the Draft Treatability Study System Installation and Baseline Conditions Report, is attached.

9. Report: Final Site Management Plan Addendum 2, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 1/19/10.
P. 301813-301884. A January 19, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

10. Technical Memorandum to Ms. Laura Johnson, U.S. EPA, **from Ms. Lynne France, CDM, re: Interim Evaluation of Treatability Study Effectiveness, 3/29/10. P. 301885-301898. A March 29, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

11. Report: Final Human Health Risk Assessment, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson

County, West Virginia, prepared by CDM, 3/31/10.
P. 301899-302253.

12. Report: Final Screening Level Ecological Risk ** Assessment (SLERA), Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 6/28/10. P. 302254-302327. A June 28, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

13. Report: Final Feasibility Study, Ravenswood PCE ** Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 10/18/10. P. 302328-302481. An October 18, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

14. Report: Final Remedial Investigation Report, ** Ravenswood PCE Superfund Site, Ravenswood, Jackson County, West Virginia, prepared by CDM, 10/20/10.
P. 302482-302806. An October 20, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

15. Technical Memorandum to Ms. Laura Johnson, U.S. EPA, **from Ms. Lynne France, CDM, re: Interim Evaluation of Treatability Study Effectiveness, 10/28/10.
P. 302807-302828. An October 28, 2010, cover letter to Ms. Laura Johnson, U.S. EPA, from Ms. Lynne France, CDM, is attached.

16. Proposed Plan, Ravenswood PCE Superfund Site, Operable Unit 1, 1/11. P. 302829-302859.

IV. REMOVAL RESPONSE PROJECTS

1. Report: Trip Report, June 2006 Sampling Event, Ravenswood PCE Site – Removal Project, Ravenswood, West Virginia, prepared by TechLaw, Inc., 9/7/06.
P. 400001-400046.

APPENDIX B-SITE FIGURES

List of Figure:

Figure-1 Site Location

Figure-2 Current Plume Map

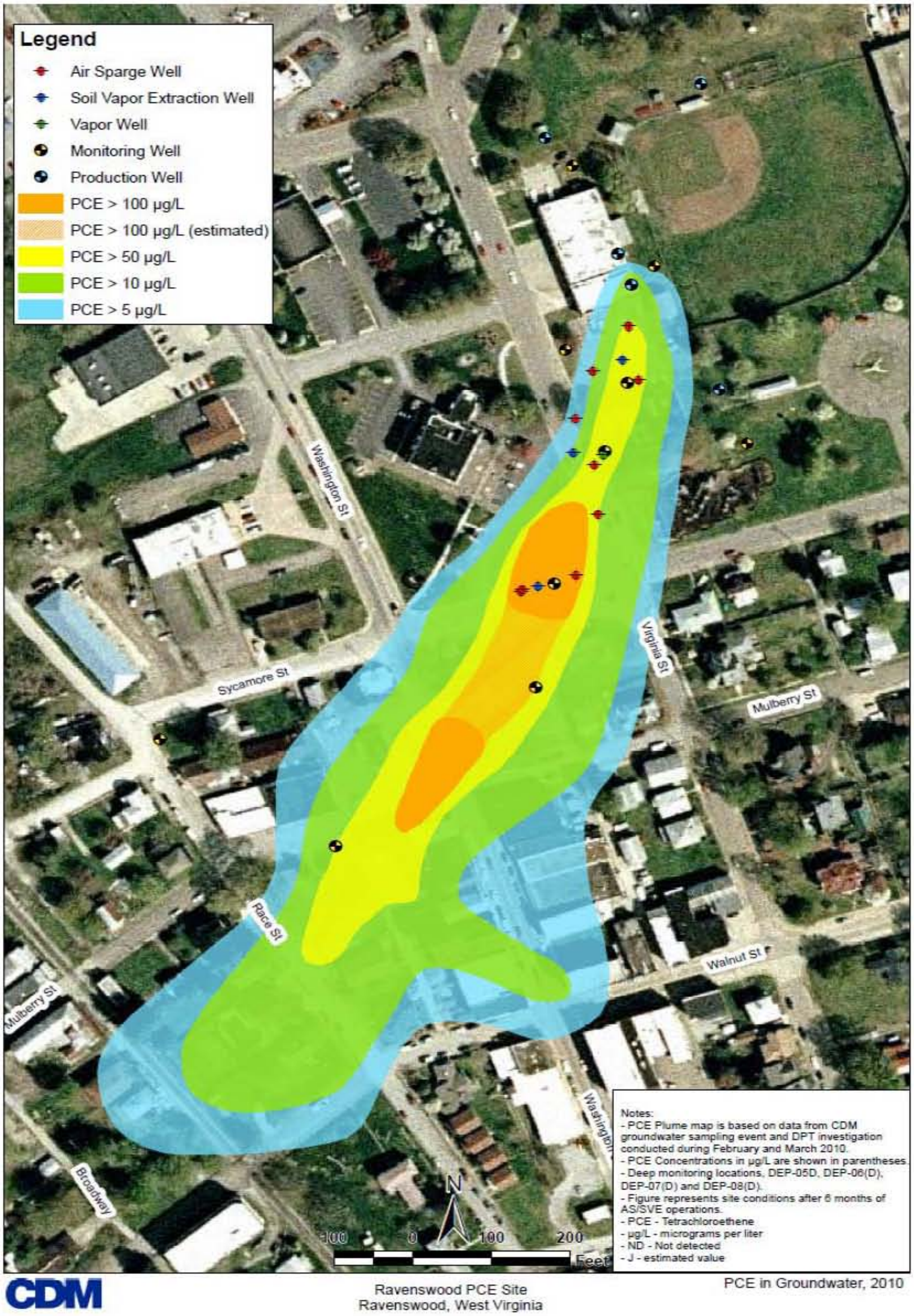


Figure- 3 Treatability Study Layout

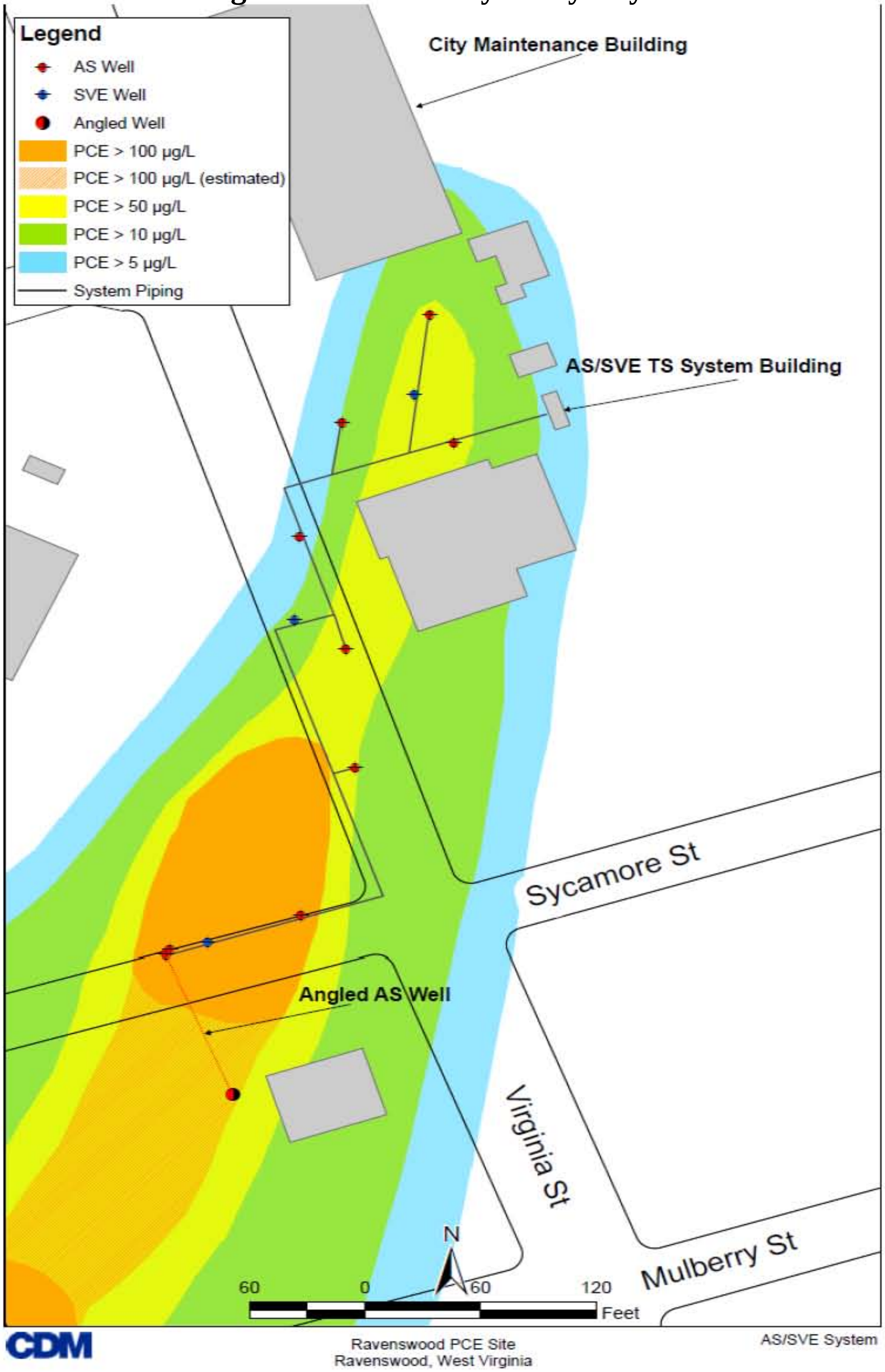


Figure-4 2010 DPT Points and Plume

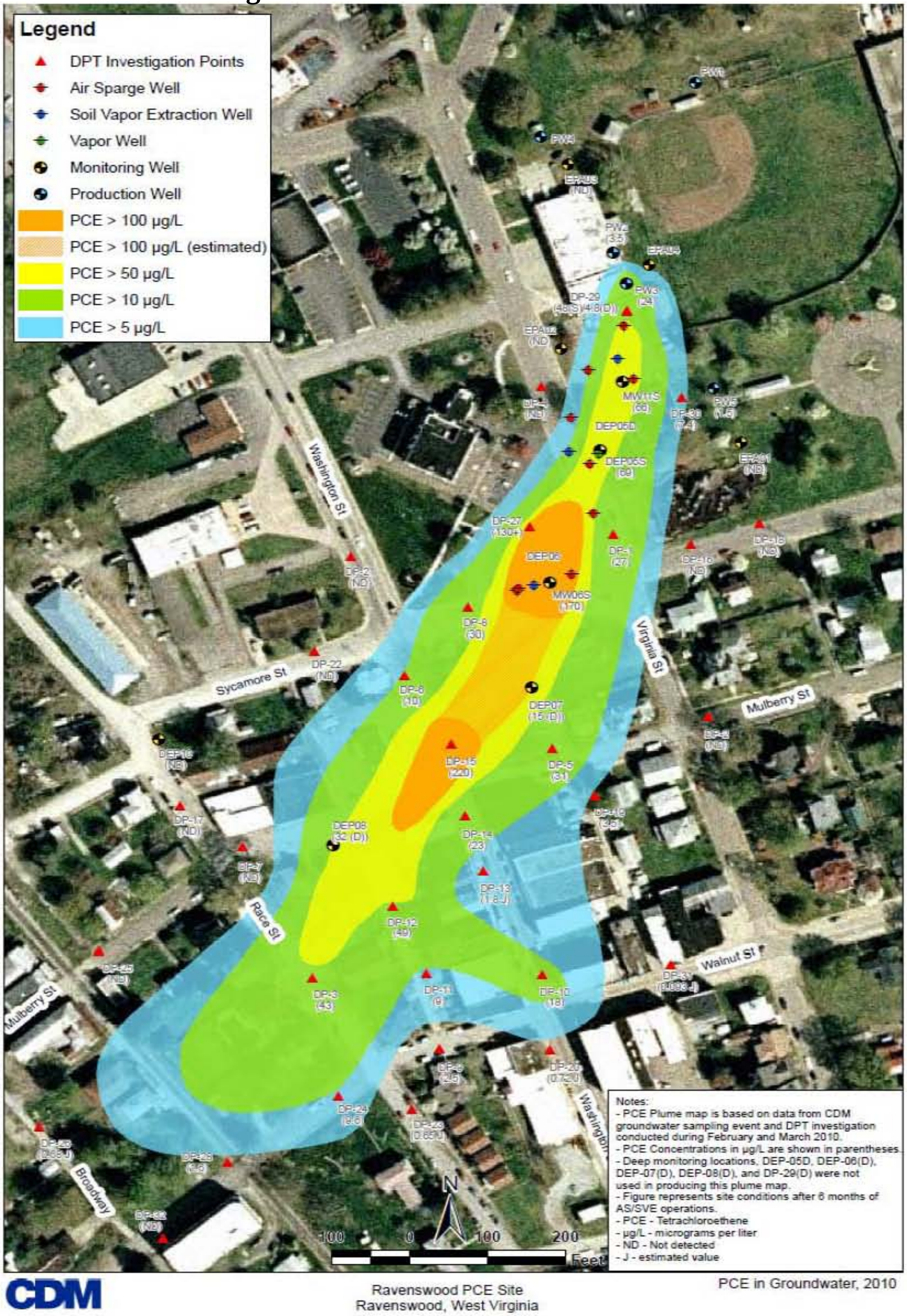


Figure-5 Monitoring Well Network

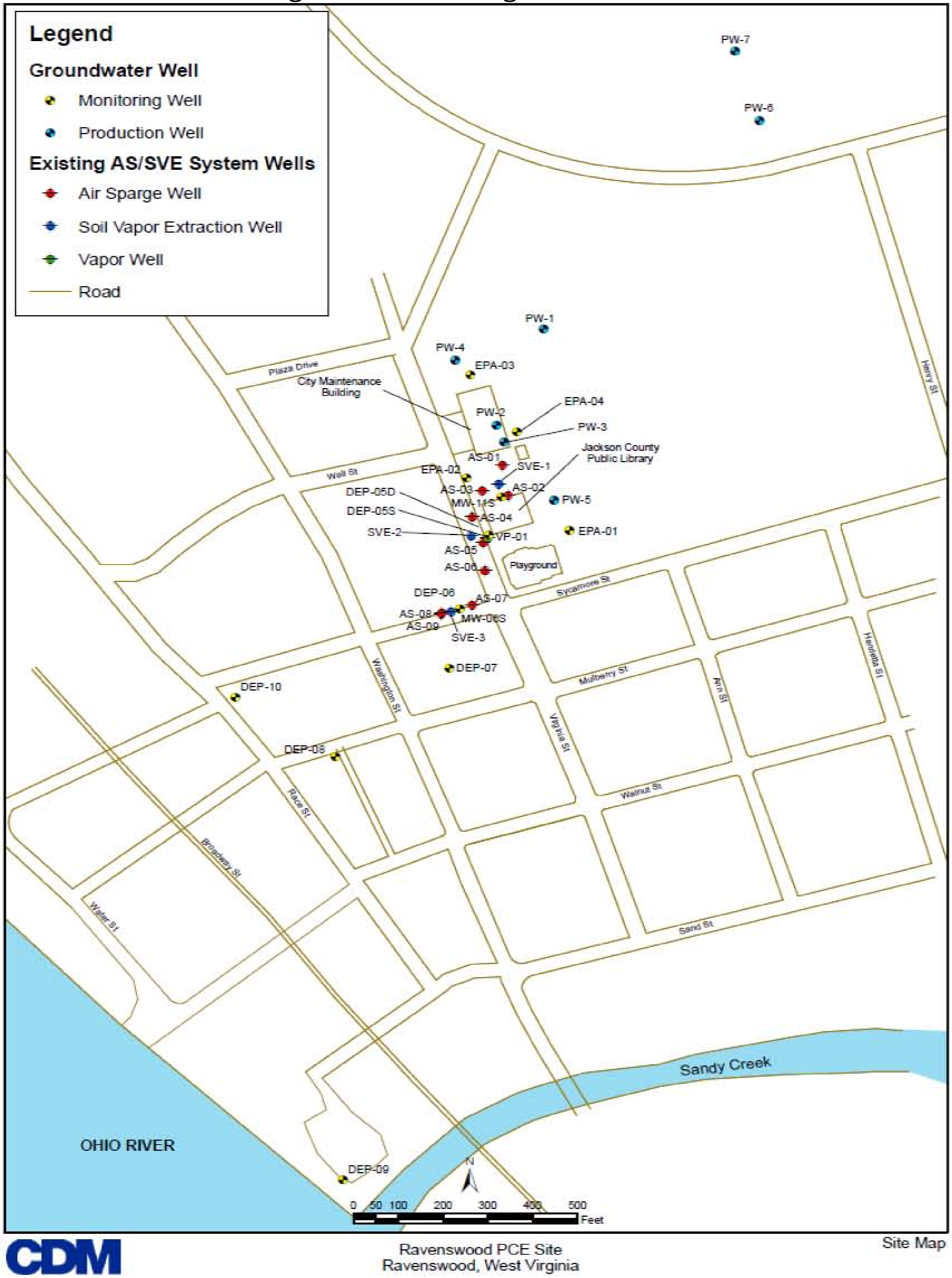


Figure-6 Approximate Stagnation Zone

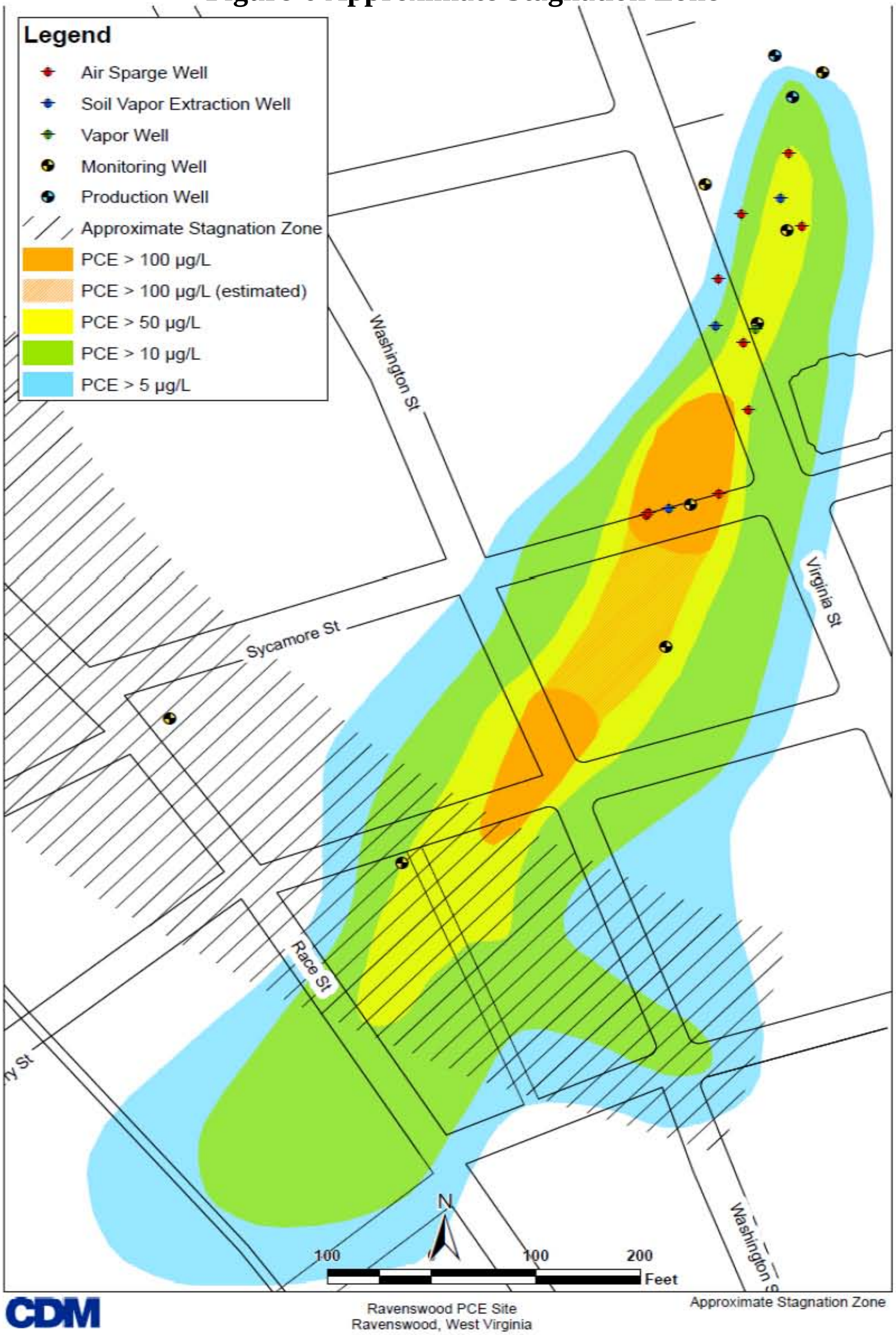
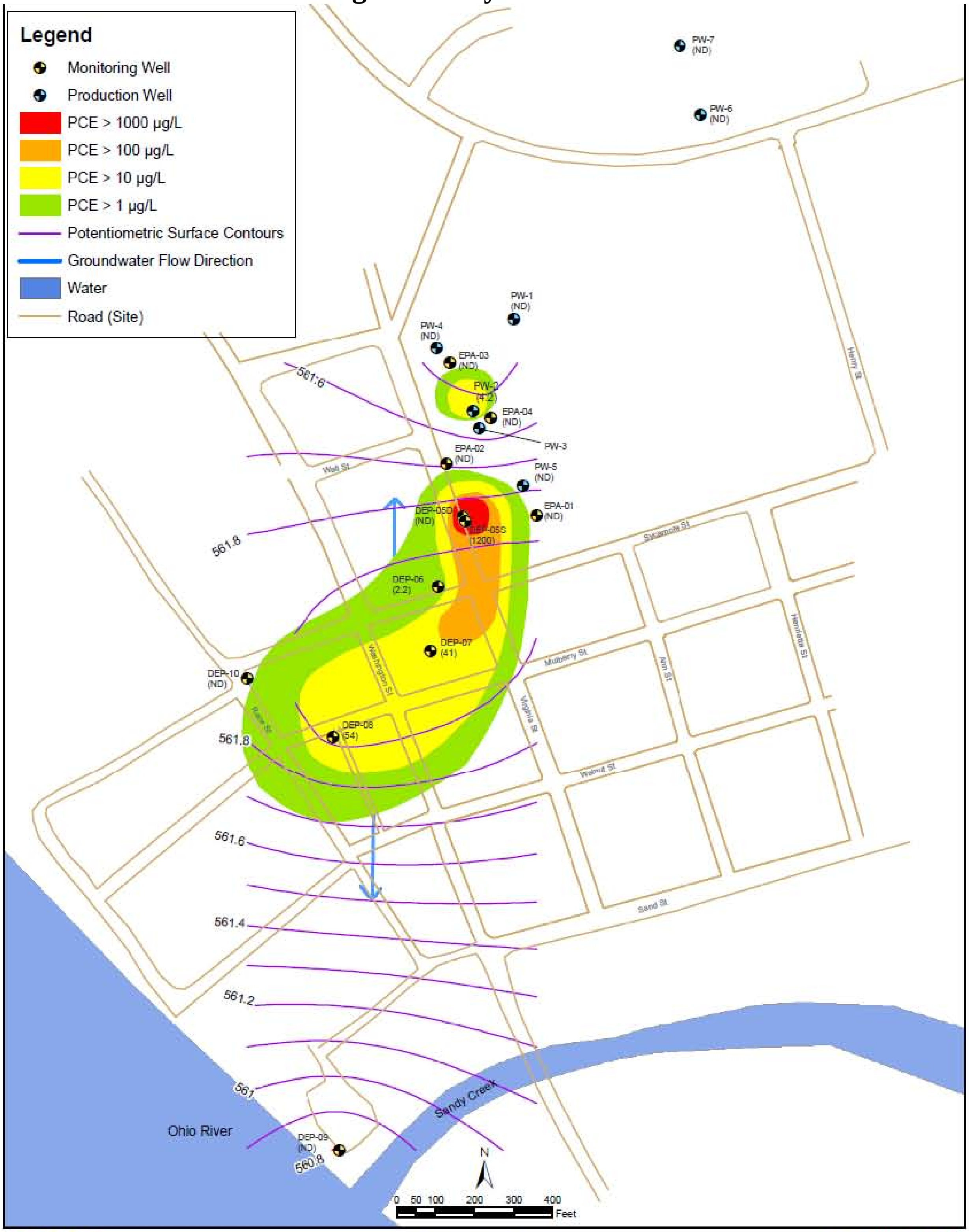


Figure-7 May 2007 Plume



CDM

Ravenswood PCE Site
Ravenswood, West Virginia

PCE in Groundwater
May 2007

Notes:
- PCE concentrations in µg/L are shown in parentheses.
- Elevations are measured in feet mean sea level (ft msl).

APPENDIX C-RISK CALCULATIONS

Adult Resident Reasonable Maximum Exposure

ADULT RESIDENT RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Ravenswood PCE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk: Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Non-Carcinogenic Hazard Quotient: Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap water from Aquifer	Bromodichloromethane										
			Tetratchloroethene	2.2E-03				2.2E-03					
			Trichloroethene										
			Arsenic										
			Chromium										
			Cobalt										
			Iron										
			Manganese										
			Nickel										
			Chemical Total	2.2E-03				2.2E-03					
		Exposure Point Total						2.2E-03					
	Exposure Medium Total							2.2E-03					
	Air	Water Vapors f Showerhead	Bromodichloromethane										
			Tetratchloroethene										
			Trichloroethene										
			Chemical Total										
		Exposure Point Total											
	Exposure Medium Total												
Medium Total								2.2E-03					
Receptor Total							Receptor Risk Total	2.2E-03					

NA = Not Available
Results from Table 9.1.RME
This table represents risk drivers for a receptor total exceeding a hazard index of one and the target risk level of 10E-04. The cancer risk driver is PCE.

Child Resident Reasonable Maximum Exposure

CHILD RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Ravenswood PCE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: External (Radiation)	Carcinogenic Risk: Exposure Routes Total	Non-Carcinogenic Hazard Quotient: Primary Target Organ(s)	Non-Carcinogenic Hazard Quotient: Ingestion	Non-Carcinogenic Hazard Quotient: Inhalation	Non-Carcinogenic Hazard Quotient: Dermal	Non-Carcinogenic Hazard Quotient: Exposure Routes Total
Groundwater	Groundwater	Tap water from Aquifer	Bromodichloromethane										
			Tetratchloroethene	1.6E-03		7.3E-04		2.4E-03	Liver/Body Weight	0.8		2	2
			Trichloroethene										
			Arsenic										
			Chromium										
			Cobalt										
			Iron										
			Manganese										
			Nickel						Body Weight	0.1		0.01	0.1
			Chemical Total	1.6E-03		7.3E-04		2.4E-03		0.9		2	2
		Exposure Point Total						2.4E-03					2
	Exposure Medium Total							2.4E-03					2
Medium Total								2.4E-03					2
Receptor Total							Receptor Risk Total	2.4E-03				Receptor HI Total	2

NA = Not Available

Results from Table 7.2.RME

Total HI Liver = 2

Total Body Weight = 2

This table represents risk drivers for a receptor total exceeding a hazard index of one and the target risk level of 10E-04. The cancer risk driver is PCE.

The noncancer risk drivers is PCE.

Lifetime Resident Reasonable Maximum Exposure

LIFETIME RESIDENT RME

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

Ravenswood PCE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult + Child (lifetime)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Groundwater	Groundwater	Tap water from Aquifer	Bromodichloromethane					
			Tetratchloroethene	3.8E-03		7.3E-04		4.5E-03
			Trichloroethene					
			Arsenic					
			Chromium					
			Cobalt					
			Iron					
			Manganese					
			Nickel					
			Chemical Total	3.8E-03		7.3E-04		4.5E-03
		Exposure Point Total						4.5E-03
	Exposure Medium Total							4.5E-03
	Air	Water Vapors from Showerhead	Bromodichloromethane					
			Tetratchloroethene					
			Trichloroethene					
			Chemical Total					
		Exposure Point Total						
	Exposure Medium Total							
Medium Total								4.5E-03
Receptor Total						Receptor Risk Total		4.5E-03

NA = Not Available

Results from Table 9.3.RME

Conclusions: The cumulative cancer risk exceeds the EPA target risk range (1.0E-04 to 1.0E-06).

APPENDIX D- ARARs

APPENDIX D
Applicable or Relevant and Appropriate Requirements (ARARs)
and To Be Considered Material (TBCs) for the Selected Remedy for OU1
Ravenswood PCE Superfund Site

ARAR or TBC	Legal Citation	Type of ARAR	Classification	Summary of Requirement	Further Detail Regarding ARARs in the Context of the Selected Remedy
FEDERAL					
Groundwater Safe Drinking Water Act Maximum Contaminant Levels (MCLs)	42 U.S.C. 300g-l 40 CFR Part 141.61	Chemical-specific	Applicable	MCLs are enforceable standards for public drinking water supply systems which have at least 15 service connections or are used by at least 25 persons. These requirements are directly applicable because groundwater in the vicinity of the Site is used as private drinking water supply.	The groundwater cleanup levels for COPCs will meet MCLs.
Maximum Contaminant Level Goals (MCLGs)	40 CFR Part 141.50-51	Chemical-specific	TBC	MCLGs are non-enforceable health goals for public water supplies which have at least 15 service connections or are used by 25 persons. Under the circumstances of this Site, MCLGs are requirements which were considered in establishing groundwater cleanup levels.	The groundwater remedy will consider these requirements.
Air Resource Conservation and Recovery Act (RCRA) Air Emission Standards for Process Vents	40 CFR Part 264.1030 - 264.1034 and 40 CFR Part 264.1053 - 264.1063	Action-specific	Applicable	Establishes requirements for process vents and equipment leaks.	To the extent the groundwater remedy includes treatment by air stripping or other processes that would generate air releases, these requirements would apply.
Regulations Governing Hazardous Air Pollutants (NESHAPS)	40 CFR Part 61.242-1 through 61.244	Action-specific	Applicable	Requires emissions of Hazardous Air Pollutants (HAPs) from new/existing sources to be quantified; establishes ambient air quality standards and emissions limitations for HAP emissions from new sources.	To the extent the groundwater remedy includes treatment by air stripping or other processes that would generate air releases, these requirements would apply.
Clean Air Act State Implementation Plan to Meet National Ambient Air Quality Standards (NAAQS)	42 U.S.C. Section 110	Action-specific	TBC	Requires states to adopt a plan for the implementation, maintenance, and enforcement of NAAQS.	To the extent the groundwater remedy includes treatment by air stripping or other processes that would generate air releases, these requirements would be reviewed for their applicability.

APPENDIX D
Applicable or Relevant and Appropriate Requirements (ARARs)
and To Be Considered Material (TBCs) for the Selected Remedy for OU1
Ravenswood PCE Superfund Site

ARAR or TBC	Legal Citation	Type of ARAR	Classification	Summary of Requirement	Further Detail Regarding ARARs in the Context of the Selected Remedy
Control of Air Emissions from Air Strippers at Superfund Groundwater Sites	OSWER Directive 9355.0-28, June 15,1989	Action-specific	To Be Considered	This policy guides the decision of whether additional controls (beyond those required by statute or regulation) are needed for air strippers at Superfund groundwater sites.	This policy would be considered in determining the necessary emission controls. Sources most in need of additional controls are those with emission rates in excess of 3 lbs/hour or a potential rate of 10 tons/year of total VOCs.
Waste Handling and Disposal RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR Part 264, Subpart E	Action-specific	Applicable	Applicable to the manifesting and transportation of hazardous waste defined in 40 CFR Part 261.	These requirements will apply to spent carbon generated during groundwater treatment system operation and to transportation of soil for off-site disposal if excavated soils are determined to be hazardous.
Pre-Transport Requirements	40 CFR Part 262.30-34	Action-specific	Applicable	Pre-Transport Requirements for Generators of Hazardous Waste re: packaging, labeling, placarding, and accumulation on site.	These requirements will apply to spent carbon generated during groundwater treatment system operation and to transportation of soil for off-site disposal if excavated soils are determined to be hazardous.
STATE OF WEST VIRGINIA					
Groundwater WV Groundwater Standards	WV CSR •47-12-3.1 to -3.5.a and Appendix A	Chemical-specific	Applicable	Establishes minimum standards of pureness and quality for groundwater resources within the State.	The groundwater remedy will comply with these standards to the extent they are more stringent than the federal standards.
WV Requirements Governing Water Conditions Not Allowable in State Waters	WV CSR •47-2-3.2 a-g	Action-specific	Relevant and Appropriate	Sewage, industrial waste, and other waste present in waters of the State will not contribute to certain conditions including odors in the vicinity of waters, materials in concentrations which are harmful, hazardous, or toxic to man, animal, or aquatic life.	Discharge from the Site, such as discharge associated with pump and treat operations, if any, into the waters of the State will comply with these requirements.

ARAR or TBC	Legal Citation	Type of ARAR	Classification	Summary of Requirement	Further Detail Regarding ARARs in the Context of the Selected Remedy
Anti- Degradation Policy	WV CSR •47-2-4.a.,b.	Action-specific	Relevant and Appropriate	Requires protection of existing uses of State waters. Requires all new and existing point sources to achieve highest established requirements and employ best management practices for non-point sources.	Any point source discharge from the Site into the Ohio River will meet the substantive requirements of this regulation.
Subsurface borings	WV CSR •47-58.4.2	Action-specific	Relevant and Appropriate	Subsurface borings will be constructed, operated, and closed in a manner that protects groundwater.	To the extent the remedial activities include subsurface borings, this requirement will be met.
Groundwater monitoring stations	WV CSR •47-58-4-9.d. to 4.9g.	Action-specific	Applicable	Establishes standards for location and construction of groundwater monitoring	The remedy will comply with these requirements.
Groundwater remediation	WV CSR •47-58-8.1.b.	Action-specific	Applicable	Cleanup action will not rely primarily on dilution and dispersion of the substance if active remedial measures are technically and economically feasible.	The remedy will achieve these requirements.
Groundwater monitoring	WV CSR •47-58-8-1.c.	Action-specific	Applicable	Requires adequate groundwater monitoring to demonstrate control and containment of the substance.	The remedy will comply with these requirements.
Monitoring Well Design Standards	WV CSR •47-60-1 to -60-21	Action-specific	Applicable	This rule establishes minimum acceptable documentation and standards for the design, installation, construction, and abandonment of monitoring wells and for the abandonment of all boreholes.	The substantive requirements of this regulation will be met.
WV Groundwater Protection Regulations Practices for Industrial Establishments	WV CSR •47-58-4.10	Location-specific	Relevant and Appropriate	Facility or activity design must adequately address the issues arising from locating in karst, wetlands, faults, subsidences, or delineated wellhead protection areas determined vulnerable by the Director.	The substantive requirements of this regulation will apply if implementation of the remedy affects such vulnerable areas.
Air Facility Requirements for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) facilities	WV CSR •45-25-4.3	Action-specific	Applicable	Requires owners and operators of hazardous waste surface impoundments, waste piles, land treatment units, and other units to operate and manage such facilities to minimize the possibility of release of hazardous waste constituents into the air.	Applies to any remedial activities that may result in the release of hazardous waste constituents into the air.

ARAR or TBC	Legal Citation	Type of ARAR	Classification	Summary of Requirement	Further Detail Regarding ARARs in the Context of the Selected Remedy
Operating Permit Requirements	WV CSR •45-30-1 to -30-6	Action-specific	Applicable	Establishes requirements for permitting of air emission sources.	The substantive standards of these requirements will be complied with to the extent that remedial activities will result in emissions of air pollutants. No permit will be required.
Proof of Proper Solid Waste Disposal	WV CSR •33-7-2	Action-specific	Applicable	Specifies that any residence or business must provide proof that solid waste is disposed of at an approved solid waste facility.	The requirements will apply if any solid waste is generated.

APPENDIX E- DETAILED COST ESTIMATE

Detailed Cost Estimate- In-Situ Air Sparging with Soil Vapor Extraction
Ravenswood PCE Superfund Site
Ravenswood, WV

Item No.	Item Description	Quantity	Unit Cost		Unit	Extension	
1.	Work Plan Preparation	1	$	17,640	LS	$	17,640
2.	On-Site Facilities	1	$	3,000	LS	$	3,000
3.	Construction Management	1	$	18,018	LS	$	18,018
4.	Treatment System Expansion	1	$	120,121	LS	$	120,121
5.	Institutional Controls	1	$	17,700	LS	$	17,700
	SUBTOTAL CONSTRUCTION COSTS					$	176,479
	General Contractor Fee (10% construction)					$	17,648
	Design Engineering (20% Construction)						35,296
	Resident Engineering/Inspection (10% construction)					$	17,648
	Contingency (20%)					$	35,296
	TOTAL CAPITAL COSTS					**$**	**282,367**
ANNUAL MONITORING COSTS							
6.	Project Planning and Organization	1	$	1,700	LS	$	1,700
7.	Sampling Labor	1	$	7,200	LS	$	7,200
8.	Sampling Equipment	1	$	4,960	LS	$	4,960
9.	Sample Analysis and Data Validation	1	$	13,200	LS	$	13,200
10.	Data Evaluation and Reporting	1	$	19,200	LS	$	19,200
	Total Annual Monitoring Costs					**$**	**46,260**
ANNUAL O&M COSTS							
11.	Annual Operations and Maintenance	1	$	24,204	LS	**$**	**24,204**
FIVE YEAR REVIEW							
12.	Five Year Review Report	1	$	35,300	LS	**$**	**35,300**
PRESENT WORTH OF COSTS							
13.	Total Capital Costs					$	282,367
14.	Long-term Monitoring					$	449,185
15.	Long-term O&M (10 year duration)					$	169,997
16.	Five-Year Reviews (30 year duration)					$	76,171
	TOTAL PRESENT WORTH					**$**	**977,719**
					Assume	**$**	**978,000**