Department of Energy

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AUG 19 2013

Mr. Todd Mullins
Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

PPPO-02-2001643-13

Ms. Jennifer Tufts
Remedial Project Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Mullins and Ms. Tufts:

TRANSMITTAL OF THE REMEDIAL ACTION WORK PLAN FOR OPTIMIZATION OF THE NORTHEAST PLUME INTERIM REMEDIAL ACTION AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-1280&D2

Please find enclosed for approval the certified D2 *Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1280&D2 (RAWP). This RAWP incorporates the comments received on the D1 version in letters received on May 29, 2013, from the Kentucky Department for Environmental Protection and on June 4, 2013, and June 19, 2013, from the U.S. Environmental Protection Agency. Comment response summaries for these comments and a redline version of the document also are provided. This version of the document has been modified further to provide key language that is consistent with the *Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northeast Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1291&D2 (ESD), which was issued on August 2, 2013. Because these RAWP modifications were made to provide consistency with the ESD and were a result of ESD comments, an Other Changes Response Summary has been included with this D2 RAWP document.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Jennifer Woodard
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. RAWP (Clean version)
2. RAWP (Redline version)
3. Comment Response Summary for KDEP
4. Comment Response Summary for EPA Comments
5. Other Changes Summary
6. Certification Page

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CERTIFICATION

Document Identification: ***Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

LATA Environmental Services of Kentucky, LLC

Mark J. Duff, Paducah Project Manager — 8-15-13 Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy (DOE)

Rachel H. Blumenfeld, Acting Paducah Site Lead
Portsmouth/Paducah Project Office — 8-19-13 Date Signed

DOE/LX/07-1280&D2
Primary Document

Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Primary Document

Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—August 2013

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-10CC40020

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PREFACE

This *Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2, was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The objectives of this plan are to (1) describe the purpose and scope of the changes to the interim remedial action and the planned optimizations, (2) identify the project organization, (3) present the project working schedule, and (4) identify other key project documents and plans.

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CONTENTS

FIGURES

TABLES

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CQCP	construction quality control plan
DMIP	data management implementation plan
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ESD	explanation of significant differences
EW	extraction well
FFA	Federal Facility Agreement
H&S	health and safety
IRA	interim remedial action
KAR	*Kentucky Administrative Regulations*
KEEC	Kentucky Energy and Environment Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	*Kentucky Revised Statues*
LDR	land disposal restriction
LLW	low-level waste
NEPCS	Northeast Plume Containment System
O&M	operation and maintenance
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RFD	Request for Disposal
RGA	Regional Gravel Aquifer
ROD	record of decision
RWP	radiological work permit
TCLP	Toxicity Characteristic Leaching Procedure
TRU	transuranic waste
TSCA	Toxic Substance Control Act
TSDF	treatment, storage, and disposal facility
TU	treatment unit
TVA	Tennessee Valley Authority
USEC	United States Enrichment Corporation
VOC	volatile organic compound
VOHAP	volatile organic hazardous air pollutants
WAC	waste acceptance criteria
WKWMA	West Kentucky Wildlife Management Area
WMC	waste management coordinator
WMP	waste management plan

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EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE) and operated by the United States Enrichment Corporation. DOE is conducting environmental restoration activities at PGDP in compliance with the requirements of the Commonwealth of Kentucky and the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). PGDP was placed on the National Priorities List in 1994 and DOE, EPA, and the Commonwealth of Kentucky entered into a Federal Facility Agreement in 1998 (EPA 1998).

The Northeast Plume Interim Remedial Action (IRA) is a CERCLA action documented in a record of decision located in the Administrative Record at http://www.paducaheic.com/media/41288/i-00213-0004-ARI34.pdf. The post-decision Administrative Record is located at the Environmental Information Center or may be reviewed electronically by pressing control and clicking: http://www.paducaheic.com/search.aspx?i=PDI09&. Since initiation, the scope of the Northeast Plume IRA has been the following:

1. Extract groundwater from the Northeast Plume using two extraction wells (EWs) located approximately 3,000 ft (914 m) east of the PGDP industrial facility near Ogden Landing Road (Kentucky Highway 358) (see Figure 1);

2. Convey the contaminated groundwater to water cooling towers at the PGDP industrial facility operated by the United States Enrichment Corporation (USEC) to remove trichloroethene (TCE) contaminant by air stripping; and

3. Convey the treated water via pipeline to an outfall that releases the water to the Bayou Creek.

This Northeast Plume IRA optimization project is intended to increase volatile organic compound mass removal and enhance capture of contaminants migrating in the Northeast Groundwater Plume at the eastern edge of the PGDP industrial facility (see Figure 1). This optimization action was initiated in response to recommendations that are documented in past system evaluations and assessments, negotiations with the Federal Facility Agreement parties, and the expected future operational closure of the gaseous diffusion plant systems. The modification of Northeast Plume IRA was recommended in the in the FY 2011 Site Management Plan, DOE/LX/07-0348&D2/R1, (DOE 2011) and the 2008 CERCLA Five-Year Review (DOE 2009), as well as in two independent technical reviews performed in 2006.

The wellfield optimization effort was undertaken using the updated PGDP groundwater flow model documented in *2008 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (DOE 2008a). The updated PGDP groundwater flow model was coupled with Brute Force, a particle tracking optimization code based on sequential MODFLOW-2000 (Harbaugh et al. 2000) and MODPATH (Pollack 1994) modeling software. Simulation runs for multiple well scenarios were executed for typical, minimal, and maximum recharge conditions (with and without anthropogenic recharge) to determine the dissolved mass capture efficiency of contaminants migrating in both the Northeast and Northwest Plumes. Groundwater modeling predicts that mass capture will be in excess of 90% using existing Northwest Plume EW, EW232, pumping at 220 gpm, an EW located in the vicinity of C-400 pumping at 80 gpm, and two Northeast Plume optimized EWs located in the high-concentration portion of the Northeast Plume along the eastern edge of the PGDP industrial facility and if the wells have a combined extraction rate of 300 gpm (150 gpm each). The target pumping rate for each new EW will be 150 gpm, for a total production of 300 gpm for the optimized IRA.

USEC notified DOE in 2011 that it might discontinue uranium enrichment operations at PGDP as early as 2013. As a result of the expected cessation of uranium enrichment operations at PGDP, the use of the C-637 Cooling Towers as an air stripper facility for TCE-contaminated groundwater will be discontinued for this IRA because cooling water no longer will flow through towers. Once the cooling towers no longer are available, it will be necessary to provide an alternate means of treating the contaminated groundwater until the IRA is optimized completely with two new EWs and associated treatment units (TUs) (two modular units are planned to address the capacity needs of the new wells). To support the continued operation of the IRA until the optimization project is complete, one of the TUs, which is planned to be installed as part of extraction system optimization, will be installed and located near the planned location for EW234. This TU will be plumbed temporarily to the pipeline that conveys groundwater from the existing EWs (EW331 and EW332, located approximately 3,000 ft northeast of the plant site near Ogden Landing Road) and will be used temporarily to continue treatment of groundwater from the two existing Northeast Plume EWs (EW331 and EW332). This arrangement will continue until the optimization project is completed and the use of the existing EWs is discontinued.

The optimization project will include installation of two new EWs—EW234 and EW235—in optimized locations and two associated TUs. As part of the optimization project, the TU, located near planned EW234, will be replumbed to allow it to treat groundwater from EW234. The TU then will become part of the optimized system servicing EW234. One additional TU will be installed and plumbed to allow treatment of groundwater extracted from the planned optimization extraction well, EW235.

The two TU systems will include, but not be limited to, a skid-mounted treatment system consisting of a high efficiency air stripper, air blower, effluent pump, influent bag filters, and process control system. The equipment will be enclosed in a heated weatherproof enclosure. In addition, the EW234 TU will include a tie-in point to the existing Northeast Plume IRA EWs. Separate TUs will be used to treat extracted water from each new optimized EW (EW234 and EW235) and will be located in the same general area as the new optimized extraction wells. Following removal of the TCE contamination by each TU associated with EW234 and EW235, the water will be released through CERCLA outfalls to tributaries of Little Bayou Creek.

The planned treatment process accommodates the treatment of volatile organic compounds (primarily TCE and associated breakdown products) using air stripping, which essentially mimics the process provided by the C-637 Cooling Towers. Both treatment systems will contain contingency process treatment capacity in the unlikely event that concentrations of technetium-99 (Tc-99) exceed release criteria. (Tc-99, although not a contaminant of concern in the record of decision, is the other contaminant present in groundwater at PGDP that is mapped as a plume. Tc-99 currently requires treatment as part of the Northwest Plume treatment system.) Contingency capacity will consist of equipment footprint capacity, interface connections such as piping connections, utilities capacity and connection, logic control interface connections, and other connections. No additional treatment equipment is included in the original treatment units beyond what now is required to replace the current air stripping capacity mechanism.

1. INTRODUCTION

In August 1988, volatile organic compounds (VOCs) and radionuclides were detected in private water wells north of the Paducah Gaseous Diffusion Plant (PGDP). The principal contaminants of concern discovered in off-site groundwater in this area were trichloroethene (TCE) and technetium-99 (Tc-99). Contaminated groundwater emanating from the eastern portion of PGDP industrial facility is referred to as the Northeast Plume, and an interim remedial action (IRA) was identified in the early 1990s in response to contaminants associated with the Northeast Plume. The *Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (ROD)(DOE 1995), was signed in June 1995 (DOE 1995). As stated in the Declaration for the ROD, "the primary objective of this interim remedial action is to implement a first-phase remedial action as an interim action to initiate hydraulic control of the high concentration within the Northeast Plume that extends outside the plant security fence." Also, stated in the ROD in the Summary of Site Risks Section is, "The principal goal of this interim remedial action is to implement control measures which will mitigate migration of the contaminants."

The Northeast Plume Containment System (NEPCS) construction was completed in 1997. Specifically, integrated system testing and start-up operations were conducted in February 1997. Normal operations began on February 28, 1997, and the system has been running in normal operation and maintenance (O&M) phase since that time.

Two extraction wells (EWs) currently comprise the NEPCS. Each of these EWs is equipped with a submersible pump, riser pipe, and electrical service. After extraction, the groundwater is pumped through a transfer line to an underground equalization tank. A transfer pump moves the groundwater from the EW tank through approximately 5,500 linear ft of transfer piping leading to the PGDP C-637 cooling tower system. The transfer line is connected to existing cooling tower piping, and water is discharged into the top of either cooling tower C-637-2A or C-637-2B. Cooling Tower C-637-2A is the primary destination for NEPCS groundwater. If it is offline for maintenance of other reasons, NEPCS flow is transferred to tower C-637-2B. The water then flows through the cooling tower where the TCE is stripped. Treated groundwater is then added to and circulated through the gaseous diffusion plant recirculated cooling water system as makeup water. During blowdown operations of the recirculated cooling water system, the treated water is then ultimately discharged to the U.S. Department of Energy (DOE) permitted Outfall 001.

This remedial action work plan (RAWP) is intended to provide background information, identify scope optimization elements, define the project organization, identify project plans and procedures, and present a project planning schedule for optimization of the Northeast Plume IRA.

1.1 PURPOSE OF THE INTERIM REMEDIAL ACTION OPTIMIZATION

The Northeast Plume IRA optimization project is to serve as an interim measure to remove VOC mass and enhance capture of the Northeast Plume contamination in the vicinity of the eastern edge of PGDP industrial facility and to reduce further migration off-site. This action was initiated in response to recommendations documented in the following documents:

- Sitewide Remedy Review (DOE 2006, May)
- Review Report: Groundwater Remedial System Performance Optimization at PGDP, Paducah, Kentucky (DOE 2007, May)

- 2008 Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Review (DOE 2009, May)

- Site Management Plan (DOE 2012, February)

The planned implementation of the optimized IRA was evaluated along with other Groundwater Operable Unit projects relative to site priorities. The prioritization was performed by the Federal Facility Agreement (FFA) managers, with consideration given to the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of off-site groundwater migration followed by a final action for the overall dissolved-phased plume. This evaluation resulted in the optimization of the Northeast Plume IRA being prioritized above the dissolved-phase plume decision documents. The results of this prioritization were documented in an April 2011 Modification to the Paducah Federal Facility Agreement (Knerr 2011).

The Site Management Plan for fiscal year 2012 identified an evaluation of the Northeast Plume extraction system similar to the Northwest Plume IRA system optimization in the DOE planning assumptions for the Life Cycle Baseline.

Additionally, the uncertainty regarding future uranium enrichment operations at PGDP provides further need to address the circumstances, which has resulted in the loss of the C-637 cooling tower as of June 28, 2013. New CERCLA outfalls are being identified because there are no DOE Kentucky Pollutant Discharge Elimination System-(KPDES-) permitted outfalls in the vicinity of the new alternate treatment unit location.

1.2 SCOPE OF THE INTERIM REMEDIAL ACTION OPTIMIZATION

United States Enrichment Corporation (USEC) notified DOE in 2011 that it might discontinue uranium enrichment operations at PGDP as early as 2013. As a result of the expected cessation of uranium enrichment operations at PGDP, the use of the C-637 Cooling Towers as an air stripper facility for TCE-contaminated groundwater will be discontinued for this IRA because cooling water no longer will flow through towers. Once the cooling towers no longer are available, it will be necessary to provide an alternate means of treating the contaminated groundwater until the IRA is optimized completely with two new EWs and associated treatment units (TUs) (two modular units are planned to address the capacity needs of the new wells). To support the continued operation of the IRA until the optimization project is complete; one of the TUs will be installed and located near the planned location for EW234. This TU will be plumbed temporarily to the pipeline that conveys groundwater from the existing EWs (EW331 and EW332, located approximately 3,000 ft northeast of the plant site near Ogden Landing Road) and will be used temporarily to continue treatment of groundwater from the two existing Northeast Plume EWs (EW331 and EW332). This arrangement will continue until the optimization project is completed and the use of the existing EWs is discontinued.

The optimization project will include installation of two new EWs—EW234 and EW235—in optimized locations and two associated TUs. As part of the optimization project, the TU, located near planned EW234, will be plumbed to allow it to treat groundwater from EW234. The TU then will become part of the optimized system servicing EW234. One additional TU will be installed and plumbed to allow treatment of groundwater extracted from the planned optimization extraction well, EW235.

The two TU systems will include, but not be limited to, a skid-mounted treatment system consisting of a high efficiency air stripper, air blower, effluent pump, influent bag filters, and process control system. The equipment will be enclosed in a heated weatherproof enclosure. In addition, the EW234 TU will include a tie-in point to the existing Northeast Plume IRA EWs. Separate TUs will be used to treat extracted water from each new optimized EW (EW234 and EW235) and will be located in the same general area as the new optimized EWs. Following removal of the TCE contamination by each treatment unit associated with EW234 and EW235, the water will be released through CERCLA outfalls to tributaries of Little Bayou Creek.

The Northeast Plume IRA System optimization will include the following:

(1) Design and installation of two new EWs along with necessary subsurface equipment;

(2) Design and installation of up to 18 new associated monitoring wells to support the aforementioned EWs;

(3) Design and installation of new pipelines with monitoring and process control systems for conveying the extracted Regional Gravel Aquifer (RGA) water to the new alternative treatment systems;

(4) Design and installation of process controllers, and electrical service for transferring the water to the treatment systems;

(5) Design and installation of new treatment equipment and/or associated equipment for EW234 and EW235;

(6) Interface with other stake holders including USEC, West Kentucky Wildlife Management Area (WKWMA), EPA, Commonwealth of Kentucky (KY), and the public, as necessary;

(7) Placement of existing EWs, pipelines, and facilities into a stand-by condition that allows their use with minimal amount of start-up maintenance and calibration; and

(8) Performance of integrated system testing and startup of systems and facilities. Training of operations staff is included as a part of this project. Changes to the system operation will be documented in a revision to the O&M plan.

Operation of the optimized IRA system will be initiated upon completion of construction and start-up testing. The optimization of the Northeast Plume IRA is intended to increase TCE and 1,1-dichloroethene (DCE) mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The key components of the optimization are discontinuing the use of the two existing EWs and replacing those wells with two new EWs located, as shown in Figure 1, near the eastern edge of the PGDP facility. The optimization of the IRA is expected to assist PGDP in attaining positive environmental indicators. Additionally, the increase in contaminant mass removal will enhance the control of the Northeast Plume.

2. REMEDIAL ACTION APPROACH

The DOE Environmental Restoration (ER) contractor has overall contractor responsibility for the planning, design, procurement, construction, and testing and then the follow-on O&M, waste management, and waste disposal associated with the remedy. The major activities for this remedial action are outlined in this section.

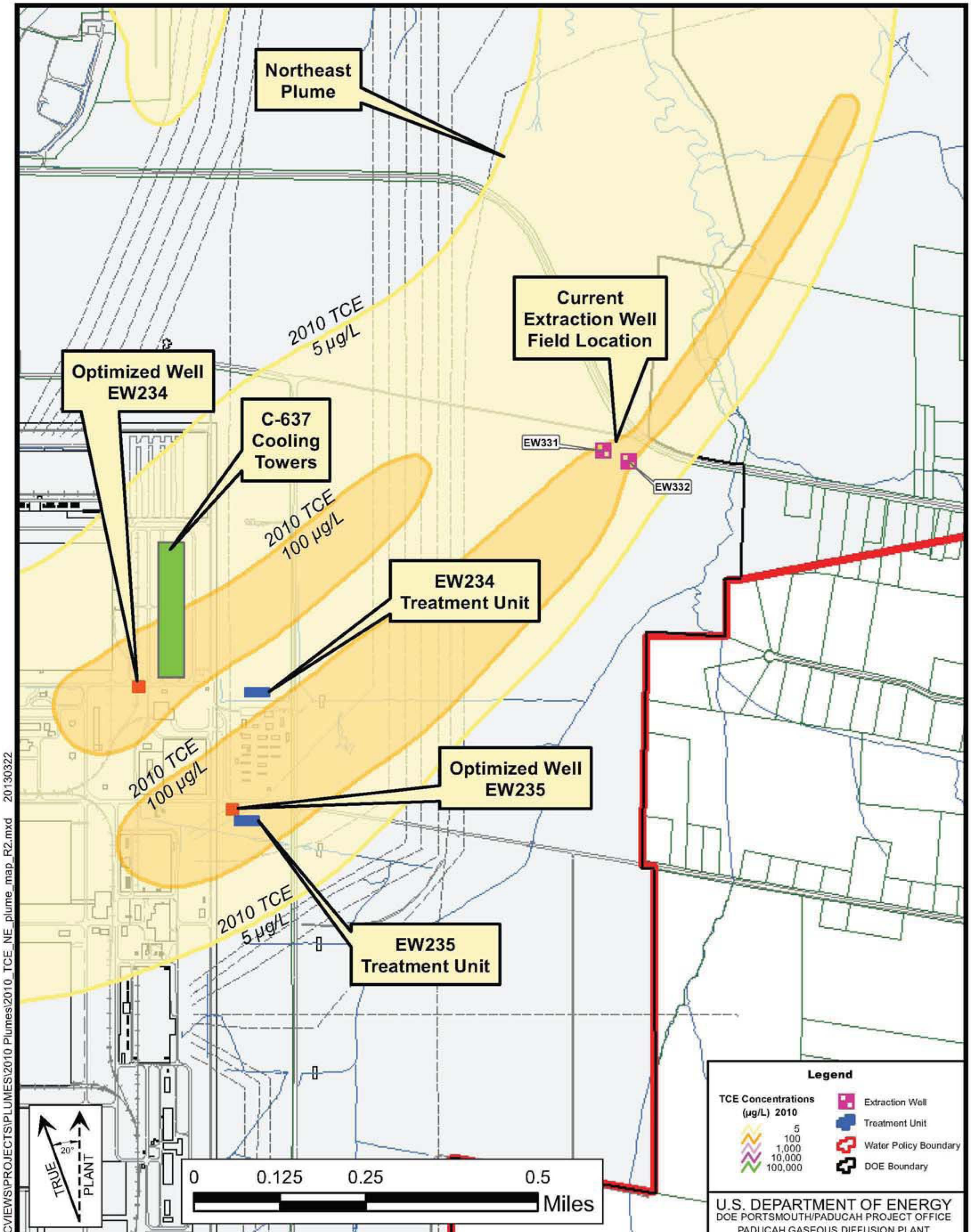

Figure 1. Northeast Plume Extraction Wells

Table 1 is a general list of activities governed by procedures. Procedures referenced in the table are those followed by the current DOE prime contractor. The most current versions of all contractor procedures are to be used. This RAWP, plans referenced by this RAWP, and applicable procedures will be readily available in the field to project personnel, including subcontractors, either in hard copy or electronic format. If electronic files are provided, a computer will be available for assessing the documents.

Table 1. General Activities Governed by Procedures

Activity	Applicable Procedure
Accident/Incident Reporting	PAD-SH-1007, *Initial Incident/Event Reporting*
Analytical Laboratory Interface	PAD-ENM-5004, *Sample Tracking, Lab Coordination, & Sample Handling*
Calibration of Measuring and Test Equipment	PAD-QA-1020, *Control and Calibration of Measuring and Test Equipment*
Chain-of-Custody	PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*
Collection of Samples	PAD-ENM-0018, *Sampling Containerized Waste* PAD-ENM-0023, *Composite Sampling* PAD-ENM-2101, *Groundwater Sampling* PAD-ENM-2300, *Collection of Soil Samples* PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation* PAD-IH-5560, *Workplace Industrial Hygiene Sampling*
Conducting Assessments	PAD-QA-1420, *Conduct of Management Assessments* PAD-REG-0003, *Performing Environmental Compliance Assessments and Identification and Reporting of Environmental Issues*
Control of Sample Temperature	PAD-ENM-0021, *Temperature Control for Sample Storage*
Data Verification and Validation	PAD-ENM-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* PAD-ENM-0811, *Pesticide and PCB Data Verification and Validation* PAD-ENM-5102, *Radiochemical Data Verification and Validation* PAD-ENM-5103, *Polychlorinated Dibenzodioxins/Polychlorinated Dibenzofurans Verification and Validation* PAD-ENM-5105, *Volatile and Semivolatile Data Verification and Validation* PAD-ENM-5107, *Inorganic Data Verification and Validation*
Decontamination of Sampling Equipment	PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices* PAD-DD-2701, *Large Equipment Decontamination*
Document Control	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents*
Documenting and Controlling Field Changes to Approved Plans	PRS-WC-0021, *Work Release and Field Execution*
Evaluations for Suspect/Counterfeit Items	PAD-QA-1009, *Identification, Control, and Disposition of Suspect/Counterfeit Items*
Fall Prevention	PAD-SH-2004, *Fall Prevention and Protection*
Field Logbooks	PAD-ENM-2700, *Logbooks and Data Forms*
Graded Approach	PAD-QA-1650, *Graded Approach*
Handling, Transporting, and Relocating Waste Containers	PAD-WD-0661, *Transportation Safety Document for On-site Transport within the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Hoisting and Rigging Operations	PAD-ENG-0012, *Hoisting and Rigging Operations*
Vendor/Supplier QA Program	PAD-QA-1208, *Approved Supplier Selection and Evaluation*
Issue Management (includes corrective action)	PAD-QA-1210, *Issues Management*
Lithologic Logging	PAD-ENM-2303, *Borehole Logging*

Activity	Applicable Procedure
Nonconforming Items and Services	PAD-QA-1440, *Control of Nonconforming Item, Services, Procedures, Processes* PAD-SH-2001, *Identifying Defective Equipment*
Powered Industrial Trucks	PAD-SH-2007, *Powered Industrial Trucks*
Quality Assured Data	PAD-ENM-5003, *Quality Assured Data*
Quality Assurance Program	PAD-PLA-QM-001, *Quality Assurance Program and Implementation Plan for the Paducah Environmental Remediation Project*
Radiation Protection	PAD-PLA-HS-002, *LATA Environmental Services of Kentucky, LLC., Radiation Protection Program at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Records Management	PAD-RM-1009, *Records Management, Administrative Record, and Document Control*
Revisions to Procedures or Work Packages	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents* PAD-WC-0018, *Work Planning and Control Program for the Paducah Environmental Remediation Project, Paducah, Kentucky* PAD-WC-0021, *Work Release and Field Execution*
Shipping Samples	PAD-WD-3028, *Off-Site Shipping*
Subcontract Management	PAD-CP-0008, *Receipt and Evaluation of Proposals*
Suspend/Stop Work	PAD-SH-2018, *Stop/Suspend Work (Safety Related)*
Temperature Extremes	PAD-IH-5134, *Temperature Extremes*
Training	PAD-PROG-0016, *Project Training Program Description for the Paducah Environmental Remediation Project, Paducah, Kentucky* PAD-TR-0702, *Conduct of Training* PAD-TR-0710, *Assignment of Training* PAD-TR-0750, *Required Reading*
Transmission of Data	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*
Vendor/supplier evaluations	PAD-QA-1208, Approved *Supplier Selection and Evaluation*
Waste Management and Disposition	PAD-WD-0016, *Waste Handling and Storage in DOE Waste Storage Facilities* PAD-WD-0437, *Waste Characterization and Profiling* PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Staging of Waste Materials at Paducah*

2.1 WELLFIELD OPTIMIZATION MODELING

The wellfield optimization effort was undertaken using the 2008 updated PGDP groundwater flow model (DOE 2008a). The 2008 updated PGDP groundwater flow model was developed through group consensus and accepted for use by the Groundwater Modeling Discussion Group. The Groundwater Modeling Discussion Group included representation of the FFA parties and supporting subcontractors. The 2008 updated groundwater flow model is coupled with Brute Force, a particle tracking optimization code based on sequential MODFLOW2000 (Harbaugh et al. 2000) and MODPATH (Pollack 1994) modeling software. The updated model initially was recalibrated taking into account present and historical locations of the both the Northwest and Northeast Plumes, which provided three specific model variations. The 3 models then were recalibrated to 17 different historical time periods back to 1995. The time periods each had specific measured plume conditions/characteristics to which the model was calibrated against. Seven of the time periods were used to calculate specific anthropogenic recharge to the RGA system from PGDP industrial operations for the model calibration. Of the 3 variations, the model variation with the best contaminant particle flow paths was selected for further use in selecting extraction well locations.

Specific constraints were placed on the analysis for determining optimized extraction well locations. Those constraints included these:

- Minimize contaminant migration to Northeast Plume from C-400 source area,
- Balance Northeast Plume extraction with extraction from Northwest Plume,
- Avoid major infrastructure such as major building locations and potential future location of CERCLA cell landfill, and
- Design well locations for both continued anthropogenic and no anthropogenic recharge conditions (uncertainty of PGDP continued operations versus PGDP discontinuing operations).

Utilizing these constraints, 18 potential new EW locations were loaded into the model and were provided minimum, maximum, and initial testing extraction rates. The Brute Force particle tracking optimization algorithm was utilized with the pumping rates to determine the optimal wellfield configuration based on which well location(s) captures the most dissolved-phase contaminant particles (representing dissolved contaminant mass only, not nonaqueous-phase liquid or sorbed-phase mass). The well location and extract rates resulted in numerous combinations of systems to evaluate. A number of additional issues and challenges were identified from the initial modeling and they are as follows:

- Need prevent change in Northwest Plume migration pathway,
- Need to minimize number of EWs,
- Need to minimize extraction rates of wells, and
- Need prevent dissolved-phase contamination from migrating into now uncontaminated areas.

In order to minimize these additional issues and challenges to the Northeast Plume, an evaluation was performed to determine the effect of the EW(s) at C-400. The results indicated maximum effectiveness was encountered at extraction rates nearing 50 gpm from a C-400 EW. Simulation runs for multiple well scenarios were executed for one NW Plume well, two for typical, minimal, and maximum recharge conditions (with and without anthropogenic recharge) to determine the dissolved mass capture efficiency of contaminants migrating in both the Northeast and Northwest Plumes. Groundwater modeling predicts that mass capture will be in excess of 90% using existing Northwest Plume EW, EW232, pumping at 220 gpm; an extraction well located in the vicinity of C-400 pumping at 80 gpm; and the two Northeast Plume EWs located in the high-concentration portion of the Northeast Plume along the eastern edge of the PGDP industrial facility with a minimal combined extraction rate of 300 gpm (150 gpm each). (Note: The production goal for each new EW will be 150 gpm, for a total production of 300 gpm for the optimized IRA.)

The flow model recalibration and the process and results of the modeling to select the optimized extraction well locations were reviewed with remedial project managers for EPA and KY, as well as subject matter experts from EPA, KY, and DOE via Web-assisted teleconference meeting held July 26, 2012. The presentation information package for the work was provided at that time. EPA provided comments on the presentation and the presentation information package October 22, 2012. A comment response summary for the comments received on that modeling was developed and submitted to EPA and provided to Kentucky on December 12, 2012. Further discussions on the modeling were held among the FFA parties at the December 17, 2012, monthly meeting. No additional comments have been received on the modeling work.

2.2 WELLFIELD AND SYSTEM DESIGN

2.2.1 Key Design Changes

The Northeast Plume IRA optimization will implement the following design changes:

- The EW234 area TU will be used temporarily for treating groundwater from EW331 and EW332 due to the cessation of uranium enrichment operations at PGDP, making the C-637 Cooling Towers unavailable.

- The new EW, EW234, will utilize the treatment capacity of the TU.

- The current EWs, EW331 and EW332, will be shut down and taken out of service.

- The current EWs, existing associated tanks, pipelines, electronic controls, and power distribution system will not be abandoned at this time, but will be placed in a standby mode.

- The new EW, EW235, will utilize a similar skid-mounted treatment system, like the TU.

- Treated VOC-contaminated groundwater discharge will be through a maximum of two CERCLA designated outfalls. The receiving water body is Little Bayou Creek, which carries a Kentucky use classification of Recreational.

- New electrical power connections will be installed for the treatment units and EWs (EW234 and EW235).

2.2.2 Key Design Assumptions

The Northeast Plume IRA optimization will be designed based on the following key assumptions.

- The EW field volumetric flow rate is not limited by the treatment plant capacity but will be limited by the EW well yield. The optimized design will include an air stripping capability to remove the necessary volatile contaminant mass from the planned extraction volume.

- The number of new EWs to be installed during the optimization process is two wells identified as EW234 and EW235.

- EW235 and EW234 will be located near the eastern edge of the PGDP industrial facility and in the high-concentration TCE lobes of the Northeast Plume (see Figure 1), which have monitoring wells MW256 and MW260, respectively, nearby with RGA TCE contaminant average concentrations since 2000 of 450 µg/L and 517 µg/L, respectively. Maximum TCE contamination levels experienced in these monitoring wells since 2000 are 870 µg/L (2/2009) and 680 µg/L (11/2005) for MW256 and MW260, respectively.

- The design parameters of both treatment systems will be an extracted groundwater flow rate of 200 gpm and capable of reducing an influent TCE concentration of 1,000 ppb to meet an effluent discharge. The treatment systems will include, but not be limited to, a skid mounted treatment system consisting of a high efficiency air stripper, air blower, effluent pump, influent bag filters, and control system all enclosed in a heated weather proof enclosure.

The planned treatment process accommodates the treatment of volatile organic compounds (primarily TCE and associated breakdown products) using air stripping, which essentially mimics the process provided by the C-637 Cooling Towers. Both treatment systems will contain contingency process treatment capacity in the unlikely event that concentrations of Tc-99 exceed release criteria. (Tc-99, although not a contaminant of concern in the ROD, is the other contaminant present in groundwater at PGDP that is mapped as a plume. Tc-99 currently requires treatment as part of the Northwest Plume treatment system.) Contingency capacity will consist of equipment footprint capacity, interface connections such as piping connections, utilities capacity and connection, logic control interface connections, and other connections. No additional treatment equipment is included in the planned TUs beyond what currently is required to replace the current air stripping capacity mechanism.

- The groundwater effluent from EW234 and EW235 following treatment will be released into tributaries to Little Bayou Creek through CERCLA outfalls.

- New electrical power lines, pipelines, treatment equipment, and process controls will be constructed in support of the new EW fields.

- Wellfield design will be based on modeling results and on geotechnical data (grain size analyses and lithologic logs) gathered from boreholes installed in close proximity to the proposed well locations.

- Pumping tests will not be performed as a basis for design of the new EWs. Pumping test data from historical tests performed at PGDP in the RGA and existing operational monitoring of the Northwest Plume Groundwater System and the Northeast Plume Containment System are available and have been used for groundwater flow model design and used for EW field placement.

- Electrical power will be provided from Kentucky Utilities, a public utility, from existing feeder lines supplying power in the area with additional lines and poles added as needed. No backup generator will be included since power interruptions are expected to be reasonable in frequency and duration such that contaminant mass not captured during the interruption will be minimal.

- No wetlands will be permanently impacted as a result of proposed locations for new extractions wells.

- The Northeast Plume IRA optimization activities will be constructed and performed in accordance with Northeast Plume IRA ROD applicable or relevant and appropriate requirements (ARARs) as modified and contained in the ESD.

2.2.3 Wellfield Design

Wellfield optimization modeling indicates that a two well configuration is optimal. The new wells, EW234 and EW235, will be located near the eastern edge of the PGDP industrial facility. Refer to Appendix A, Figure A.1, for the overall site plan and proposed well locations. EWs 234 and 235 will have a design capacity each of 200 gpm and will have treatment units capable of reducing an influent TCE concentration of 1,000 ppb to meet an effluent discharge requirement. The planned treatment process accommodates the treatment of volatile organic compounds (primarily TCE and associated breakdown products) using air stripping, which essentially mimics the process provided by the C-637 Cooling Towers. Both treatment systems will contain contingency process treatment capacity in the unlikely event that concentrations of Tc-99 exceed release criteria.[Tc-99, although not a contaminant of concern in the ROD, is the other contaminant present in groundwater at PGDP that is mapped as a plume. Tc-99 currently requires treatment as part of the Northwest Plume treatment system (see Figure 2).]

Contingency capacity will consist of equipment footprint capacity, interface connections such as piping connections, utilities capacity and connection, logic control interface connections, and other connections.

No additional treatment equipment is included in the planned TUs beyond what is currently require to replace the current air stripping capacity mechanism (see Appendix B, Air Dispersion Modeling). Refer to Appendix A, Figure A.2, for the treatment systems general arrangement drawing. Appendix C, Northeast Plume Extraction System Design and Evaluation, provides additional detail on the groundwater modeling process used to determine the optimum locations for the new EWs.

Each of the EWs will be designed similar to the northwest EWs. The EWs will penetrate fully the RGA and will be screened across an RGA thickness (estimated at 60%) necessary to capture the full thickness of the plume at 150 gpm. Appendix A contains general engineering drawings that contain design details for the EW construction. Specific details such as the depths for screen locations, bentonite seals, pump depths, etc., will be determined following the drilling and lithologic logging of the wellbore.

Boreholes will be installed at designated distances from each of the EWs to further characterize the geologic settings. These boreholes will be converted to monitoring wells to support the performance monitoring of the IRA and chemical monitoring of the EW field. Detailed lithologic logs will be generated for these borings to support the geologic understanding of the areas and to complete the required Commonwealth of Kentucky's Uniform Well Construction Record. The well screen and filter pack designs for the EWs and supporting monitoring wells will be based on the existing available grain size results and additional grain size analyses to be obtained from drilling of associated monitoring wells.

2.3 START-UP AND INTEGRATED TESTING

The Northeast Plume IRA System that is currently in place generally will continue to operate during construction of the optimization system components using the TU system that will be associated with EW234. There will be short periods of downtime during tie-in of utilities and operating equipment to the existing system. These short periods of downtime for the existing system will be tracked and reported in the FFA semiannual report. After construction is complete, each equipment unit will be operationally tested, calibrated, and incorporated into the logic control system as part of construction acceptance activities. The C-614 Northeast Pump-and-Treat System and associated EWs that currently are in place will be shut down following this construction acceptance testing to prevent interference with the optimized equipment during the remaining testing. An integrated system test will be performed on the optimized system to test the logic control system interlocks and effectiveness prior to restarting routine operations. The details of the start-up and testing plan will be documented in a revision to the O&M plan. EW235 and the associated treatment system will undergo the same start-up, integrated testing, and construction acceptance testing as the treatment system associated with EW234, and will not cause downtime to the existing Northeast Plume IRA System.

2.4 OPERATIONS AND MAINTENANCE

Upon successful completion of the integrated testing, the new wells are expected to be routinely operated at a combined rate of approximately 300 gpm. Ongoing O&M will be performed in accordance with the revised O&M plan and operating procedures. EPA and KY will have an opportunity to review revisions to the O&M plan prior to start-up of the new wells for routine operations.

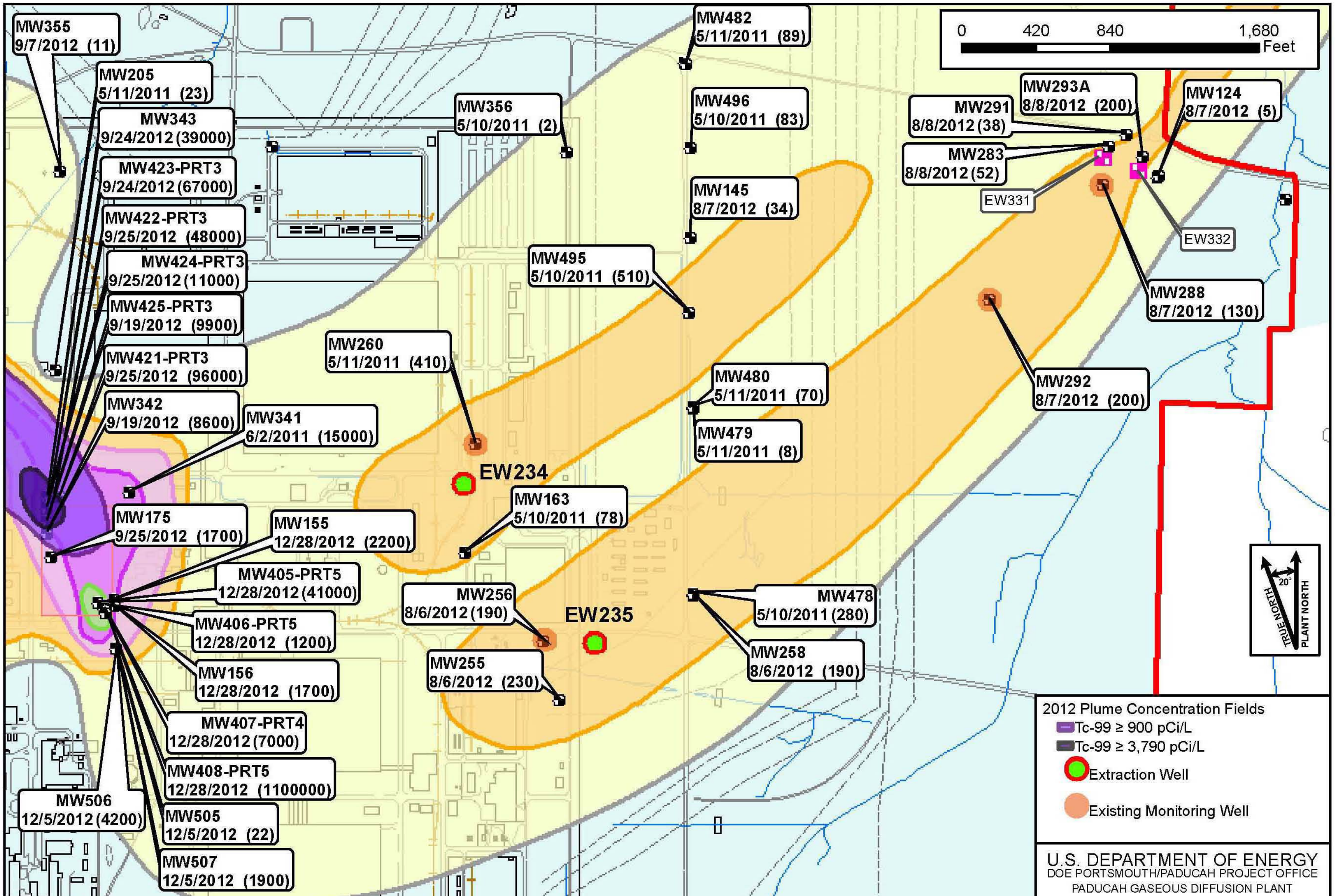

Figure 2. Optimized Extraction Wells Relationship to Tc-99 Contamination

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The optimized Northeast Plume system will continue operating until one the following occurs:

- The FFA parties mutually agree to cease operations,
- A CERCLA Five-Year Review determination supports ceasing operations, or
- The ROD associated with the Dissolved-Phase Plume supports ceasing operations.

2.5 MONITORING

As part of the optimization of the IRA, a groundwater monitoring program will be included. The intent of the program is to provide data to support an ongoing analysis of the contaminant types and levels and operational performance of the treatment unit and associated equipment. This data also will support the development of the regulatorily required five-year reviews.

The MW network is under development and will be presented in the O&M plan for the optimized IRA. It will include new and existing wells. The four existing wells are MW256, MW260, MW288, and MW292. The network of new monitoring wells when combined with existing monitoring wells will provide both hydraulic and chemical performance information such as the following:

- Contaminant concentration gradients within the RGA;

- Potential contaminant migration impacts to the Northwest Plume by the optimized Northeast Plume IRA extraction;

- Early warning of increases or decreases in target contaminants or presence of non-target contaminants such as Tc-99; and

- Effectiveness of capturing Northeast Plume contamination by the optimized EW locations.

The specific activities and parameters for collecting the hydraulic and chemical data will be documented in the revised O&M plan for the optimized system.

2.6 WASTE MANAGEMENT AND DISPOSITION

Waste generated during drilling and construction activities will be managed and dispositioned in accordance with the waste management plan (WMP) and ARARs. Waste characterization will be performed using analytical results from waste sample analysis described in Section 7 and from process knowledge where applicable. Please refer to the WMP for additional detail concerning waste management and disposition.

3. PROJECT ORGANIZATION

The roles and responsibilities of the project team members are described below.

DOE Project Manager—Serves as the point of contact with regulatory agencies, and directs the overall completion of the remedial action in accordance with the approved RAWP.

Prime Contractor Project Manager—Serves as the primary point of contact with DOE to implement the remedial action. Performs work in accordance with the baseline scope and schedule and directs the day-to-day activities of Contractor personnel.

Quality Assurance Manager—Verifies all work is completed in accordance with the Quality Assurance Plan. Supports the development, implementation, and maintenance of the Quality Assurance (QA) Program. Verifies implementation of work is consistent with QA Rule; 10 *CFR* 830, Subpart A; DOE Order 414.1C; and applicable NQA-1 Consensus Standard.

Field Superintendent—Oversees all field activities and verifies field operations follow established plans and procedures.

Health and Safety Representative—Assists in the development of the health and safety (H&S) plan and activity hazard assessment, and verifies implementation of Worker Safety and Health Program and Integrated Safety Management Systems. The H&S specialist provides oversight for safety and health compliance performance.

Environmental Compliance Representative—Oversees implementation of the Environmental Management Systems. The environmental compliance representative provides direct support to the prime contractor project manager.

Waste Management Coordinator—The waste management coordinator (WMC) will manage all waste according to PGDP facility requirements and the WMP. WMC responsibilities include coordinating daily activities with field personnel, overseeing daily waste management operations and maintaining a waste management logbook.

Field Technical Staff—Provides direct support to the field superintendent concerning technical aspects of the project.

Subcontractors—Provide equipment and expertise during drilling, EW installation, treatment facility, and pipeline construction.

Training of project personnel will be in accordance with training matrices developed for this project as part of the PGDP work control process.

4. PROJECT SCHEDULE

A generalized project planning schedule is shown in Table 2.[1]

[1] Projected schedules for completion of activities set forth herein are estimates provided for informational purposes only and are not considered to be enforceable elements of the remedial action or this document. The enforceable milestones for performance of activities included as part of the remedial action are set forth in the FFA (EPA 1998). Any additional milestones, timetables, or deadlines for activities included as part of the remedial action will be identified and established independent of this RAWP, in accordance with existing FFA protocols.

Table 2. Project Planning Schedule

Activity	Date
Regulatory Concurrence of Wellfield Design Model Results	9/19/2013
Final Design Complete	11/6/2013
RAWP	
Submittal of Draft D1 to EPA/KY	3/28/2013
Submittal of D2 RAWP to EPA/KY	8/19/2013
Approval of D2 RAWP	9/19/2013
Explanation of Significant Difference (ESD)[2]	
Submittal of D1 ESD to EPA/KY	6/21/2013
Submittal of D2 ESD	8/2/2013
Regulatory Approval of D2	9/1/2013
Issue Public Notice of Availability	9/11/2013
Construction Mobilization	12/6/2013
Drilling/Construction Start	12/16/2013
Construction Complete	10/29/2014
O&M Plan	
Submittal of the D1 O&M plan to EPA/KY	5/6/2014
Submit D2 O&M plan to EPA/KY	10/3/2014
Approval of D2 O&M plan	11/3/2014
System Start-Up and Testing Complete	12/2/2014
System Turnover to O&M Personnel	12/3/2014
Postconstruction Report	
Submittal of the D1 Postconstruction Report to EPA/KY	2/27/2015
Submittal of the D2 Postconstruction Report to EPA/KY	7/27/2015
Approval of D2 Postconstruction Report	8/25/2015

5. HEALTH AND SAFETY PLAN

The Northeast Plume IRA optimization project will incorporate by reference the H&S plan requirements from the RAWP (DOE 2008b). The C-400 RAWP H&S plan will be applicable, as written, with the following exception: replace references to the C-400 IRA with Northeast Plume IRA optimization project.

6. ENVIRONMENTAL COMPLIANCE PLAN

Environmental regulatory compliance will be facilitated during the implementation of this optimization project by adhering to ARARs. The modified interim remedy, which continues to capture and remove TCE and 1,1-DCE from within the high concentration area of the Northeast Plume, meets the threshold criteria of CERCLA Section 121 and the National Contingency Plan. The remedy continues to be protective of human health and the environment and complies with ARARs. As part of optimization of this IRA, ARARs included in the ROD pertaining to discharge through a KPDES-permitted outfall (i.e., 401 *KAR* 5:005 § 7, 5:029 § 2, 5:029 § 3, 5:031, 5:055, and 5:080 § 1) are being replaced with ARARs to allow the utilization of up to two CERCLA outfalls for treated water discharge, as defined by the approved ESD (DOE 2013). The identified ARARs address requirements necessary to ensure the

[2] An ESD will be used to document that up to two new CERCLA discharge points will be created. See Section 6.3 for additional details.

protection of the waters of the Commonwealth for the discharge of effluent through up to two CERCLA outfalls.

6.1 WITHDRAWAL OF PUBLIC WATERS

In accordance with Section XXI of the FFA, which requires that DOE identify permits that otherwise would have been required in the absence of CERCLA Section 121(e) (1) and the National Contingency Plan, this section identifies the Commonwealth of Kentucky requirement for a permit to withdraw water from a public groundwater source (*KRS* Chapter 151.150 and 401 *KAR* 4:010). Such a permit is not needed for this CERCLA action.

The Northeast Plume IRA optimization project, a CERCLA action, includes the installation of two new EWs for the purpose of extracting contaminated groundwater from the Northeast Plume. The wells will be installed in accordance with ARARs identified in the approved ESD, as well as those identified in the original ROD signed June 15, 1995, for the IRA.

The proposed locations of the new EWs, EW234 and EW235 are shown on Figure 1. Refer to Figure A.3 for design details for the EWs. Installation of the new wells and commencement of water withdrawal will be in accordance with the planning schedule shown in Section 4. Withdrawal rates will be measured by flow meters installed at each well. Combined groundwater extraction from EW234 and EW235 is not expected to exceed 400 gpm (or 576,000 gpd).

6.2 AIR EMISSIONS

Volatile organic compounds (VOC) will be emitted to the atmosphere by the air stripper component of the Northeast Plume Treatment System. The emissions of VOC must comply with identified ARARs in Table 2 of the ESD (DOE 2013). Compliance with these ARARs is demonstrated by air dispersion modeling and by analysis of the groundwater to be treated. Any determination of the volatile organic hazardous air pollutants (VOHAP) concentration of the remediation material can be based on knowledge of the material. Based on existing data, it is expected that the VOHAP concentration of the Northeast Plume groundwater is less than 10 ppmw. Historical data from the locations near the proposed new well locations show the highest anticipated concentration of TCE in the groundwater is less than 1 ppmw.

Air dispersion modeling was performed for the modular TUs that are to receive influent groundwater from the new EWs. The expected contaminant concentrations resulting from treatment of the influent groundwater were estimated based upon maximum equipment process treatment capacity. The results of these air dispersion modeling analyses show the estimated maximum annual average concentration for both modeling scenarios will be below the corresponding maximum allowable off-site concentrations of respective pollutants. Additionally, the allowable off-site concentration limit for TCE was developed using a lifetime (i.e., 70-year exposure period) per EPA’s Regional Screening Level User’s Guide. The duration of potential exposure associated with the operation of the associated TUs will be less than 70 years; therefore, emissions associated with this project are not expected to be harmful to the health and welfare of humans, animals, or plants. The results of the air dispersion modeling are contained in Appendix B.

As discussed in Section B.1.4., the removal efficiency of the air stripping units, as provided by the manufacturer, is 99% for VOCs. Additionally, nearby existing monitoring wells provide an estimate of the VOC concentration expected in the extracted groundwater that is below the maximum design loading of 1,000 ppb TCE. Once operations of the optimized system are initiated, the extracted groundwater will be sampled periodically and analyzed to provide the contaminant concentration to be stripped and released to the atmosphere. The specifics associated with the extraction water sampling will be included in the revised operations and maintenance plan for the optimized system. The combination of the periodic water sampling (pre- and post-air stripping) and the 99% removal efficiency provides the information on the contaminants released to the atmosphere. Based on the information above, there is no need for air emissions testing of the optimized IRA system at this time.

6.3 POST-RECORD OF DECISION DOCUMENTATION

The treated groundwater will be discharged through a newly created CERCLA discharge point(s). Therefore, an ESD will serve as the appropriate post-ROD documentation.

6.3.1 Explanation of Significant Differences

The treated groundwater will be discharged through a new CERCLA discharge point, and new ARARs will be required. Consequently, an ESD will be required. Preparation and finalization of the ESD will be undertaken in parallel with design and construction of the optimization project TUs. Groundwater discharges to a new CERCLA discharge point will not occur until the ESD has been approved.

6.3.2 Interim Remedial Action Metrics and Performance Monitoring

The Declaration of the ROD for the IRA for the Northeast Plume states the following as the primary objective:

> …to implement a first phase remedial action as an interim action to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the plant security fence.

In Section 2.6 of the ROD (Summary of Site Risks), the principal goal is stated as follows:

> The principal goal of this remedial action is to implement control measures which will mitigate migration of the contaminants.

Plume mapping performed subsequent to expansion of the sitewide groundwater environmental monitoring system in 2009 and 2010, resulted in the identification of two sublobes of TCE that exceed 100 µg/L of TCE, which are migrating beyond the eastern plant security fence. Optimization of the Northeast Plume extraction system addresses the objective and goal, as stated above, by refocusing extraction at locations within a few hundred feet of the eastern plant security fence and within sublobes of the Northeast Plume that exceed 100 µg/L of TCE.

In addition to the goal and objective provided in the ROD, the design of the optimized extraction system for the Northeast Plume identified the following design objectives.

- **Minimize impacts to groundwater flow trajectory and associated dissolved-phase mass in the C-400 area.** To meet this objective the wellfield design process evaluated extraction well locations and pumping rate impacts to dissolved-phase mass in the RGA emanating from the C-400 source area. Dissolved-phase mass emanating from the C-400 source area represents the upgradient extent of the Northwest Plume and imposing extraction based gradients that alter the trajectory of this mass by pulling it to the east is undesirable. The design process determined that pumping at the proposed extraction wells near the eastern security fence at the design rates would, over time, potentially redirect the trajectory of dissolved phase mass at C-400. To mitigate potential trajectory impacts in the C-400 area placement of an extraction well north of the C-400 Building (pumping at approximately 80 gpm) within three to four years of initiation of pumping of the optimized Northeast Plume extraction wells was determined to offset mass trajectory impacts.

- **Complement Northwest Plume extraction well capture zones.** This objective was met by assessing the balance between extraction rate, the number of extraction wells, and extraction well locations. The proposed configuration was found to attain the best balance of mass removal, extraction well configuration, and overall pumping rate.

- **Avoid locations potentially under consideration for waste disposal alternative evaluation.** This objective was attained by avoiding locations under consideration as part of waste disposal options evaluation (see slide 21 in Appendix D).

- **Manage anthropogenic recharge variability.** To address this objective model recalibration was performed using multiple steady state and transient stress periods representing a range of anthropogenic recharge conditions. Model predicted capture zone dimensions are less during periods of relatively high anthropogenic recharge. With this in mind, and in an effort to reduce the potential for underestimating capture zone dimensions, post-calibration wellfield design development and testing used the October 2011 stress period to understand how capture zones for design configurations under consideration developed under periods of high anthropogenic recharge. Capture zone development under periods of comparatively lower anthropogenic recharge are predicted to be larger, encompassing a larger portion of the plume volume.

- **Develop a design that is effective to the extent practicable under conditions where PGDP operations are active (high anthropogenic recharge) and conditions reflective of a post-PGDP status (reduced anthropogenic recharge).** Wellfield design modeling tested conditions that were considered to be reflective of both active PGDP and post-PGDP status. Post-PGDP conditions are expected to include a substantial reduction in anthropogenic recharge, potential trends in plume trajectory, and a corresponding increase in capture zone dimension, as the hydraulic flux from the site decreases. Plume trajectory monitoring will be required to assess potential changes in groundwater flow direction as anthropogenic recharge is reduced; however, under this scenario the combined pumping of the Northwest and Northeast Plumes extraction systems are expected to continue to effectively address the objectives of the interim remedial action.

Metrics for the optimized extraction system will be detailed in the optimization O&M Plan and summarized in the ESD. Performance assessment metrics will be evaluated through the collection of key system performance data and will focus on determining if the extraction system is functioning as intended and is effective in addressing the goals and objectives of the interim remedial action. Performance assessment data collection will be used to (1) determine if the system is meeting the design objective and to identify if operational improvements are needed; (2) monitor changes in plume chemistry to determine if design objectives are being met with respect to plume capture, and avoidance of impacts to dissolved phase mass associated with the C-400 source area; and (3) assess extraction system hydraulic performance and potential changes in ambient hydrologic conditions that may influence system hydraulic performance.

The general approach to wellfield performance monitoring will utilize a combination of contaminant and hydraulic monitoring to assess system performance.

Contaminant monitoring will be performed by sampling a defined array of monitoring wells prior to system start-up to assess baseline conditions and subsequent monitoring at regular intervals during system operations. It is anticipated that the array of contaminant monitoring locations will include the following:

- Upgradient locations to assess contaminant concentrations east of the C-400 source area and associated dissolved phase mass in the RGA;

- Crossgradient locations to assess contaminant concentrations at locations potentially outside the lateral extent of the EW capture zones; and

- Downgradient monitoring wells located outside the downgradient extent of the EW capture zones to assess changes in contaminant concentrations as a result of groundwater extraction.

Hydraulic monitoring will be conducted to determine if the EW system is performing as designed relative to capture zone development. Hydraulic monitoring will include the following:

- Baseline sitewide synoptic groundwater elevation surveys to assess conditions prior to extraction operations at the new optimized extraction well locations;

- System shutdown and restart testing to evaluate how capture zone development compares with model predicted capture zone dimensions; and

- Periodic sitewide synoptic groundwater elevation surveys to assess potential trends in ambient groundwater flow conditions due to changes in PGDP operations, optimization, or hydrologic trends.

Additionally, the O&M plan and ESD will address trigger criteria with regard to the potential need for process treatment upgrades to address Tc-99. Tc-99, a component of the Northwest Plume, is treated at C-612; however, Tc-99 is not a contaminant of concern of the Northeast Plume. While it is not anticipated that activities of Tc-99 in the Northeast Plume will increase to levels in excess of 900 pCi/L (MCL, 4 mrem beta activity), the modular treatment system general arrangement provides floor space and appurtenances that are compatible with potential process system upgrades for treatment of inorganic constituents (such as Tc-99) using ion exchange.

7. WASTE MANAGEMENT

This WMP provides information for the management and final disposition of waste material that will be generated as a result of the Northeast Plume IRA optimization project. The project includes the installation of two EWs, construction of a treatment system to remove the TCE contamination, and construction of pipelines to transfer the groundwater to and from associated treatment equipment and to release locations.

This WMP addresses the management of waste from the point of generation through final disposition. The Northeast Plume IRA optimization project is part of the DOE prime contractor’s ER program, and the DOE prime contractor shall be responsible for all waste management activities. Standard practices and procedures outlined in this WMP pertaining to the generation, handling, transportation, and storage of waste will comply with all DOE Orders, Resource Conservation and Recovery Act (RCRA), and Toxic Substance Control Act (TSCA) requirements.

Copies of this WMP will be available during fieldwork. The DOE prime contractor’s ER WMC will be responsible for implementing procedures and requirements of this WMP.

The WMP for the Northeast Plume IRA optimization project underscores the following objectives:

- Management of project waste in a manner that is protective of human health and the environment;
- Minimization of waste generation;
- Compliance with federal, state, and DOE requirements; and
- Selection of storage and disposal alternatives.

Waste generated will be stored in CERCLA on-site waste storage areas (e.g., C-745-C, C-752-C, C-760, C-761, or other CERCLA storage facility) or within the RCRA area of contamination during the characterization period prior to disposal, when practical. CERCLA on-site waste storage areas will be operated in compliance with applicable or relevant and appropriate waste storage requirements. Wastewater will be transferred to storage pending characterization and treatment. All waste management activities must comply with this WMP; applicable procedures; the C-746-U Landfill waste acceptance criteria (WAC) (*Waste Acceptance Criteria for the Department of Energy Treatment, Storage and Disposal Units at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* PAD-WD-0011); *Hazardous Waste Facility Operating Permit*—Permit No. KY8-890-008-982; and the WAC for off-site treatment, storage, and disposal facilities (TSDFs) designated to receive waste. The decision has not been made as to the final TSDF that will be used. Potential off-site TSDFs that may be used include, but are not limited to, Energy*Solutions*, Nevada National Security Site, Perma-Fix, and Waste Control Specialists.

During the course of this optimization project, additional PGDP and DOE waste management requirements may be identified. Necessary revisions to the WMP will ensure the inclusion of these additional requirements into the daily activities of waste management personnel. DOE will inform the FFA parties of any substantive changes to the WMP. The criteria for document changes will be those found in the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (EPA 1998).

7.1 WASTE GENERATION AND PLANNING

7.1.1 Waste Generation

A variety of waste may be generated during this project, including soil cuttings and water from drilling activities in the Upper Continental Recharge System and RGA; dewatered soil and water from waste water filtration activities; personal protective equipment (PPE); sample residual (used sample bottles, etc.); grout; and construction and sanitary trash. The waste generated from field-related activities has the potential to contain contaminants related to known or suspected past operations; therefore, this waste must be stored and disposed of in accordance with ARARs. Waste that is likely to have either hazardous or radiological contamination typically will be stored on-site in containers in CERCLA waste storage areas in accordance with PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Staging of Waste Materials at Paducah*, during the characterization period and prior to treatment/disposal. Consistent with EPA Policy, the generation, storage, and movement of waste during a CERCLA project and storing it on-site does not trigger the administrative RCRA storage or disposal requirements. On-site waste storage areas will be managed in accordance with the substantive RCRA hazardous waste storage standards and in accordance with ARARs. Among the substantive requirements are compatible containers in good condition, regular inspections, containment to control spills or leaks, and characterization of run-on and run-off, either by process knowledge or by sampling. Final disposition of the materials will depend on final characterization. Table 3 summarizes estimated quantities and container types estimated to be generated in performing this project.

Table 3. Estimation of Waste

Waste Stream	Volume	Container Type and Quantity	Disposition Facility	Treatment Required
Soil and Other Solid Media (Cuttings, Drill Tool Decontamination Solids, Lithologic Core, Dewatered Soils)	105 yd^3	6 roll-off/intermodal boxes	C-746-U or off-site facility	None or off-site LDR treatment*
Well Installation Water	26,000 gal	Mobile, Portable Containers	C-612	C-752-C solids removal
Decontamination Water	10,000 gal	Mobile, Portable Containers	C-612	C-752-C solids removal
Well Development Water	100,000 gal	Mobile, Portable Containers	C-612	C-752-C solids removal
Personal Protective Equipment	6 yd	25 1A2X Drums	C-746-U or off-site facility	None or off-site LDR treatment
Grout/Concrete	2 yd	8 1A2X Drums	C-746-U or off-site facility	None or off-site LDR treatment

*Waste not meeting the definition of hazardous waste at the point of generation and meeting the requirements of the WAC may be disposed of in the C-746-U Landfill with no further treatment. Waste meeting the definition of hazardous waste at the point of generation must be treated to LDR standards prior to landfill.

Waste generated during field activities will require a comprehensive waste-tracking system capable of maintaining an accurate inventory of waste. To prevent inappropriate disposal of waste, all generation, storage, and characterization information must be included in the tracking system. Specifically, the waste inventory must include the following information:

- Generation date
- Request for Disposal (RFD) number
- Waste origination location
- Waste matrix (solid, liquid)
- Waste description (soil, PPE, etc.)
- Quantity
- Storage location
- Sampling status
- Sampling results status
- Date of disposal

7.1.2 Soil from Drilling and Construction Activities

Solid waste drilling cuttings and excavated soil will be generated from installation of the new EWs, monitoring wells, and pipeline construction. Drill cuttings from the RGA, drill cuttings from boreholes in the industrial facility of PGDP, and soils excavated in the industrial facility of PGDP will be containerized as they are generated, labeled, and managed on-site according to the substantive requirements of RCRA, until they either are determined not to be RCRA waste, as provided in Section 7.9.1, or dispositioned to an appropriate disposal facility in accordance with ARARs. Waste minimization also will be facilitated by not containerizing material known to originate from clean area (e.g., above the RGA or outside the industrial facility of PGDP). Wastes will be stored at CERCLA storage areas and will be managed according to the substantive requirements of RCRA and in accordance with ARARs. The solid waste will be sampled and analyzed as described in Section 7.9 for proper waste determination.

7.1.3 Personal Protective Equipment

PPE will be worn as specified in the H&S plan by personnel performing the field tasks. While site personnel use procedures and best management practices to minimize opportunities for contacting contaminated media and equipment, it is likely that some PPE or related debris (e.g., plastic sheeting) will come into contact with contaminated materials during the remediation process. Process knowledge, visual inspections, or direct sampling will be used to characterize PPE and any related debris. Based on the results of the characterization, any PPE or the related debris determined by site personnel to be contaminated by a listed waste or exhibiting a RCRA characteristic will be managed as hazardous waste, decontaminated, or a no longer contaminated-with determination will be made pursuant to Section 7.9. In cases where site personnel conclude, based on the above characterization process, that the PPE or related debris has not been contaminated by a listed waste or does not exhibit a characteristic, then the materials will not be considered a RCRA hazardous waste.

7.1.4 Grout

Bentonite grout is used to hold new well casing in place. There is a potential for grout to become waste due to test pours, spillage, or leftover material in a batch following a pour. Grout will be packaged separately from other waste streams and managed as non-hazardous material.

7.1.5 Well Installation/Development/Decontamination/Sample Residual Water

Dual rotary drilling technology will be used to drill the EWs. With dual rotary drilling, the bit is advanced slightly behind the bottom of the outer casing. Compressed air is used to force soil cuttings and groundwater up the annulus between the drill pipe and casing. These cuttings and water are diverted through a discharge swivel and directed via flexible hose to a cyclone separator. Soil cuttings and water fall out of the bottom of the separator into a container while air is released from the top of the separator.

Newly installed EWs will be developed to remove fine material from the formation around the well screen. This process will generate water with high suspended solids content. Additional waste water with suspended solids will be generated as a result of drilling equipment decontamination activities.

Wastewater generated during drilling, well development, and decontamination activities will be processed through particulate filters at the drill site or accumulated and stored on-site until it can be processed for removal of suspended solids, as necessary. The solids will be classified according to the results of water and soil analyses. The filtered water will be pumped to dual wall holding tanks until verification that it meets the appropriate acceptance criteria for suspended solids before transfer to the on-site C-612 Northwest Plume Groundwater System. Potential contaminants of concern in this filtered waste water will be assumed to be consistent with those in the Northeast Plume groundwater. Once treatment of the wastewater is complete, the estimated 136,000 gal of treated drilling, development, and decontamination water to be discharged from C-612 is a small fraction of the approximately 8 million gal released annually from current sources through Outfall 001.

Wastewater generated during drilling, well development, and decontamination activities that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to “no longer contain” listed hazardous waste (e.g., TCE), as discussed in Section 7.9.1. This treated wastewater may be directly discharged to permitted KPDES Outfall 001 or on-site ditches that flow to permitted Outfall 001.

7.1.6 Miscellaneous Noncontaminated/Clean Trash

DOE has implemented waste management activities for the segregation of clean trash (i.e., trash that is not chemically or radiologically contaminated). Examples of clean trash are office paper, aluminum cans, packaging materials, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items. During implementation of this WMP, clean trash will be segregated according to those guidelines and then collected and recycled/disposed of by the WMC when it has been approved for removal.

7.2 WASTE CHARACTERIZATION

Waste characterization will be performed based on sample analyses, evaluation of existing data, or process knowledge. Refer to Section 7.9 of this document for more information on waste characterization sampling.

7.3 CONTAINERS, ABSORBENT, AND DRUM LINERS

WAC approved absorbent will be used if necessary to ensure there are no free liquids in the waste being disposed of in the C-746-U Landfill. Table 3 summarizes container types and estimated quantities of containers.

7.4 WASTE MANAGEMENT ROLES AND RESPONSIBILITIES

7.4.1 Waste Management Tracking Responsibilities

Waste generated during remediation activities at PGDP is tracked using a system capable of maintaining an up-to-date inventory of waste. The inventory database is used to store data that will facilitate determination of management, storage, treatment, and disposal requirements for the waste.

7.4.2 Waste Management Coordinator

The WMC will ensure that all waste activities are conducted in accordance with PGDP facility requirements and this WMP. Responsibilities of the WMC also include coordinating activities with field personnel, overseeing daily waste management operations, and maintaining a waste management logbook that contains a complete history of generated waste and the current status of individual waste containers. Designated waste operators also may complete the waste management logbook.

The WMC will ensure that procurement and inspection of equipment, material, or services critical for shipments of waste to off-site TSDFs are conducted in accordance with appropriate procedures. In addition, the WMC will ensure that wastes are packaged and managed in accordance with applicable requirements (e.g., the WAC for the landfill).

Additional responsibilities of the WMC include the following:

- Maintaining an adequate supply of labels;
- Maintaining drum inventories at sites;
- Interfacing with all necessary personnel;
- Preparing RFDs;

- Tracking generated waste;
- Ensuring that drums are properly labeled;
- Coordinating waste recycling, disposal, or transfers;
- Sampling waste containers to characterize wastes;
- Coordinating pollution prevention and waste minimization activities;
- Transferring characterization data to DOE prime contractor's data manager; and
- Ensuring that temporary project waste storage areas are properly established, maintained, and closed.

Waste item container logs will be used to document each addition of waste to containers.

The WMC and waste operators will perform the majority of waste handling activities. These activities will involve coordination with the DOE prime contractor IRA project manager or designee who will perform periodic inspections to verify that drums are labeled in accordance with the WMP guidelines.

The WMC will be responsible for ensuring characterization sampling of the waste in accordance with the procedures outlined in this plan. When sampling is complete, the WMC will transfer the waste into the waste holding area established for this project, if necessary.

The WMC or designee will complete all chain-of-custody forms relating to the shipment of waste characterization samples. The chain-of-custody forms, along with the associated samples, will be transferred to the personnel responsible for packaging and delivery of the samples.

The WMC or designee will inspect the decontamination facility to ensure that waste generation is minimized to the extent possible and that the transfer of liquids to the waste holding area is arranged such that the work schedule is not delayed. If improper waste-handling activities are observed, the WMC will notify the DOE prime contractor project manager and temporarily stop decontamination activities. All activities not in compliance with the WMP will be identified and corrected before decontamination activities continue.

7.4.3 Coordination with Field Crews

The WMC will be responsible for daily coordination with project field crews involved in activities that generate waste. The WMC will inspect work sites to oversee the waste collection and will verify that procedures used by the field crews comply with the WMP guidelines. Deficiencies will be documented in the waste management logbook, and appropriate direction will be given to the field crews. Site visits will be documented in the field logbook.

7.4.4 Coordination with Treatment, Storage, and Disposal Facilities

The waste streams generated on the Northeast Plume IRA optimization project may be managed and disposed of in a variety of ways depending on characterization and classification. Waste will be temporarily stored on-site as previously discussed. Waste that is to be shipped to an off-site TSDF must be done so in accordance with applicable DOE contractor procedures and U.S. Department of Transportation requirements.

7.4.5 Waste Management Training

The WMC and other project personnel with assigned waste management responsibilities will be trained and qualified in accordance with the approved project training matrix.

7.5 TRANSPORTATION OF WASTE

The areas where the Northeast Plume IRA optimization activities will be conducted are on DOE property. Transportation of waste on DOE property will be conducted in accordance with applicable DOE, PGDP, and DOE Contractor policies and procedures. In the event that it becomes necessary to transport known or suspected hazardous waste over public roads, coordination will be initiated with PGDP Security, as necessary, which may result in the temporary closing of roads. Off-site transportation/disposal of waste will be made in accordance with the substantive and administrative requisites of applicable regulations.

7.6 SAMPLE SCREENING

7.6.1 Screening of Analytical Samples

During the course of the Northeast Plume IRA optimization field activities, screening of waste samples will be performed to protect the health and safety of on-site personnel and to ensure compliance with regulatory requirements.

7.6.2 Field Screening

Field screening for health and safety will be conducted during project field activities and sample collection. The field screening to be performed will incorporate the use of instrumentation to monitor for organic vapors, as well as radiation meters capable of detecting alpha and beta/gamma radioactivity. An elevated reading from field monitoring may be cause for reevaluation of current waste classification, labeling, and handling activities.

7.6.3 On-Site Laboratory Radiation Screening

A fixed-base laboratory will analyze all waste characterization samples. All samples to be shipped off-site for laboratory analysis will be screened for radiation at an on-site laboratory before shipment and will receive approval for off-site shipment.

7.7 WASTE MINIMIZATION

Waste minimization requirements that will be implemented, as appropriate, including those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, 435.1, and 458.1; and requirements specified in the project waste management plan and procedures concerning waste generation, tracking, and reduction techniques will be followed.

To support the DOE contractor’s commitment to waste reduction, an effort will be made during field activities to minimize waste generation, largely through ensuring that potentially contaminated waste material is localized and is not allowed to come into contact with clean material. Such an event could create more contaminated waste. Waste minimization also will be facilitated by not containerizing material known to originate from clean areas, such as above the RGA or outside the industrial facility of PGDP.

Solid wastes such as Tyvek® coveralls and packaging materials will be segregated. An attempt will be made to separate visibly soiled coveralls from clean coveralls. In some instances, partially soiled coveralls can be cut up and segregated. Other solid waste will not be allowed to contact potentially contaminated soil waste. Efforts will be made to keep Tyvek® coveralls clean, reuse clean coveralls, and use coveralls only when necessary. Proper waste handling and spill control techniques will help minimize waste, particularly around decontamination areas where water must be containerized.

7.8 HEALTH AND SAFETY ISSUES RELATED TO WASTE ACTIVITIES

Waste management activities will be conducted in compliance with health and safety procedures documented in the H&S plan.

7.9 WASTE SAMPLING AND ANALYSIS PLAN

This plan describes sampling to support analysis of waste generated from the installation of up to two EWs. Solid waste will be generated from drill cuttings, while aqueous liquids (groundwater, well purge and development water, and sample residuals water) also will be generated during drilling. The project team will perform sampling work in accordance with contractor-approved procedures and work instructions. Procedures related to the sample collection are listed below. Additional procedures are referenced in Section 2, Table 1.

- PAD-ENM-0018, *Sampling Containerized Waste*
- PAD-ENM-0021, *Temperature Control for Sample Storage*
- PAD-ENM-0023, *Composite Sampling*
- PAD-ENM-2101, *Groundwater Sampling*
- PAD-ENM-2300, *Collection of Soil Samples*
- PAD-ENM-2303, *Borehole Logging*
- PAD-ENM-2700, *Logbooks and Data Forms*
- PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*
- PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation*
- PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*
- PAD-ENM-5003, *Quality Assured Data*
- PAD-ENM-5004, *Sample Tracking, Lab Coordination & Sampling Handling*
- PAD-WD-9503, *Shipments by Air Transport*

Wastes generated from sites designated as potentially contaminated will be characterized to classify the waste for proper handling, record keeping, transfer, storage, and disposal. Waste analyses will be performed using the EPA approved procedures, as applicable. Analyses required for hazardous waste classification will reference EPA SW-846 or other EPA-approved methods, as required. Wastewater analyses will reference the applicable analytical requirements in PGDP's KPDES permit, Clean Water Act, or Safe Drinking Water Act. QA/quality control (QC) requirements and data management requirements, as specified in Sections 7.9 and 7.10 of this document, will be followed for waste characterization sampling activities.

Characterization requirements and guidance are provided in the site WAC, PAD-WD-0437, *Waste Characterization and Profiling*, and PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Staging of Waste Materials at Paducah.* Section 7.9.2 lists the analytical testing methods that will be used for analysis. The WMC will coordinate with the DOE contractor Northeast Plume IRA optimization project manager and DOE contractor sample and data management group for required analyses and guidance on collection and transfer of characterization samples to a Sample Management Office-approved fixed-base laboratory that has been audited under DOE Consolidated Audit Program (DOECAP).

7.9.1 Contained-In/Contaminated-With Determinations

The Northeast Plume groundwater is contaminated with certain VOCs that originated from disposal of spent solvents. As a result, the TCE contamination in the Northeast Plume has been declared a RCRA listed hazardous waste (code F001, F002, U228). Additionally, 1,1,1-trichloroethane (1,1,1-TCA), also a RCRA hazardous waste constituent associated with F001 and F002, has been detected at low levels in the Northeast Plume. Under the EPA "contained-in" policy, environmental media, such as groundwater, must be managed as hazardous waste if they "contain" listed hazardous waste. EPA guidance, *Management of Remediation Waste under RCRA*, recommends that "contained-in" determinations use conservative, health-based standards to develop site-specific health-based levels of hazardous constituents below which contaminated environmental media would be considered to no longer contain hazardous waste (EPA 1998). Consequently, per the EPA's contained-in policy, the Northeast Plume groundwater is considered to contain the RCRA listed hazardous waste. Management of such groundwater must comply with the RCRA ARARs for hazardous waste identified in the original ROD (DOE 1995) and the ESD (DOE 2013), unless the groundwater is determined to contain TCE below the health-based levels. The site-specific health-based level for TCE in groundwater at PGDP has been established at 30 ppb, which is based on Kentucky ambient water quality criteria for protection of human health for consumption of fish [401 *KAR* 10:031 § 6(1)]. Groundwater contaminated with TCE generated from the Northeast Plume project at or below 30 ppb will be considered to no longer contain the RCRA listed hazardous waste (F001, F002, U228). Groundwater that meets the health-based level for TCE also shall be deemed to no longer contain 1,1,1-TCA. Degradation products (*cis*-1,2-DCE; *trans*-1,2-DCE; or vinyl chloride) associated with TCE may be present in groundwater, and any treatment process used for the TCE-contaminated groundwater also would be effective in treating/reducing the concentrations of the degradation products.

Most of the contaminated groundwater extracted for treatment exceeds this site-specific health-based level; thus, it must be managed as RCRA listed hazardous waste. Consequently, certain solid wastes generated from treatment units that treat groundwater containing TCE above 30 ppb are considered RCRA hazardous waste due to the derived-from rule at 40 *CFR* § 261.3(c) and (d) (401 *KAR* 31:010 § 3). The treated groundwater that is discharged into the receiving surface water body (e.g., Little Bayou Creek) through the CERCLA outfall will comply with identified Clean Water Act and Kentucky water quality standards identified as ARARs and will be below the 30 ppb TCE. Pursuant to 40 *CFR* § 261.4(a)(2) (401 *KAR* 31:010 § 4), point source discharges are excluded from regulation as a hazardous wastes. The exclusion applies only to the actual point source discharge and does not exclude industrial wastewaters while they are collected, stored, treated before the discharge, nor does it exclude sludge that is generated by industrial wastewater treatment.

Some of the waste debris, other than PPE, and environmental media such as drill cuttings generated during this project will be characterized and the results compared to health-based standards to determine whether or not any concentrations of TCE and 1,1,1-trichloroethane (TCA) are above health-based levels listed in Table 4. If the concentrations are below the levels contained in Table 4, then the waste will be deemed not to contain or not to be contaminated with a (RCRA) listed waste (based on TCE/TCA content) for the purposes of management at the site.

Table 4. Health-Based Levels for TCE and 1,1,1-TCA

Constituent	Concentration in solids (ppm)
TCE	39.2
1,1,1-TCA	2,080

Because data from previous sampling events indicate that conditions for C-746-U Landfill disposal potentially will be met, characterization for C-746-U Landfill disposal will be undertaken. Land disposal restrictions (LDRs) generally apply to media and debris generated from this project that no longer contain or no longer are contaminated with RCRA hazardous waste. The LDR treatment standard for TCE is below the contained-in level; therefore, if a contained in determination is made, the LDR treatment standard also will be satisfied.

Health-based standards of 39.2 ppm TCE and 2,080 ppm 1,1,1-TCA in solids will be used as the criteria for making contained-in/contaminated-with determinations for environmental media and debris designated for disposal at the C-746-U Landfill. Solid waste disposal at landfills other than C-746-U will be subject to a contained-in/contaminated-with determination that will be approved by the Commonwealth of Kentucky and the state in which the receiving landfill is located. The Kentucky Energy and Environment Cabinet (KEEC) has agreed to consult with DOE and the state where the off-site facility is located to reach agreement upon the appropriate health based standard for making such determinations for waste that is be shipped to such a facility.

Aqueous liquids (groundwater, well purge and development water, and sample residuals water) contaminated with TCE will be treated to the wastewater effluent limit of 0.030 mg/L or less in an on-site permitted wastewater treatment facility. Treated effluent meeting the discharge limit of 0.030 mg/L also shall be below the health-based level and considered to “no longer contain” listed hazardous water (i.e., TCE). Based on the process knowledge of the C-612 treatment facility’s performance in achieving effluent levels for TCE that are significantly below health-based levels, this treated wastewater may be directly discharged to KPDES Outfall 001 or to on-site ditches that flow to KPDES Outfall 001 without providing KEEC supporting analytical data or contained-in/contaminated-with determinations.

Soil and debris wastes shall be sampled and analyzed in accordance with Section 7.9.2. For soil and debris waste meeting the health-based standards above, DOE shall submit its contained-in determinations and supporting analytical data to the KEEC. The KEEC will review DOE’s determination and supporting analytical data and provide DOE with notification of any concerns the Cabinet has within 30 days. After 30 days, if the Cabinet has not notified DOE of any concerns, DOE may dispose of soil and debris waste at the C-746-U Landfill if it meets WAC. Soil and debris wastes from this project not meeting the WAC for the C-746-U Landfill will be shipped off-site for disposal at an appropriate facility meeting the necessary regulatory criteria.

7.9.2 Waste Characterization

Waste characterization sampling will be performed in accordance with procedure PAD-WD-0437, *Waste Characterization and Profiling*. Based on sample analyses, existing data, or process knowledge, the waste may be classified into one of the following categories:

- RCRA-listed hazardous waste
- RCRA characteristic hazardous waste
- Polychlorinated biphenyl (PCB) waste
- Transuranic waste (TRU)
- Low-level waste (LLW)
- Mixed waste or
- Nonhazardous solid waste

Tables 5, 6, 7, and 8 list the analytical testing methods that will be used for analysis.

Table 5. TCLP Parameters for Analysis of Solid Waste

Constituent	Method	TCLP Regulatory Limit (mg/L)	20 Times TCLP Regulatory Limit (mg/kg)
1,1-Dichloroethene	8260	0.7	14
1,2-Dichloroethane	8260	0.5	10
Arsenic	6010/6020	5.0	100
Barium	6010/6020	100.0	2,000
Benzene	8260	0.5	10
Cadmium	6010/6020	1.0	20
Carbon tetrachloride	8260	0.5	10
Chlordane	8081	0.03	0.6
Chlorobenzene	8260	100.0	2,000
Chloroform	8260	6.0	120
Chromium	6010/6020	5.0	100
Lead	6010/6020	5.0	100
Mercury	7470	0.2	4
Methylethylketone	8260	200.0	4,000
Selenium	6010/6020	1.0	20
Silver	6010/6020	5.0	100
Tetrachloroethene	8260	0.7	14
Trichloroethene	8260	0.5	10
Vinyl chloride	8260	0.2	4

Table 6. Analytical Parameters for Radiological and PCB Characterization

Constituent	Method
Total uranium	Mass Spec
Neptunium-237	Alpha Spec
Plutonium-239/240	Alpha Spec
Plutonium-238	Alpha Spec
Thorium-230/232	Alpha Spec
Technetium-99	Liquid Scintillation
Cesium-137	Gamma Spec
PCB	8082

Table 7. Waste Characterization Requirements for Solid Waste

Constituent	Method
TCLP VOCs	SW-846 1311, 8260
TCLP metals	SW-846 1311, 6010/6020/7470
Acetone	8260
Toluene	8260

Table 8. Waste Characterization Requirements for Decontamination, Development, and Purge Water

Parameter	Method	Detection Limit
TCE	EPA 624	0.001 mg/L
1,1,1-TCA	EPA 624	0.001 mg/L
PCBs	EPA 608	varies by Aroclor
Total recoverable metals*	EPA 200.8/245.2	varies by metal
Total suspended solids	EPA 160.2	30 mg/L

*Total recoverable metals: antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, nickel, calcium, silver, tantalum, uranium, zinc, and mercury.

Wastes generated from sites designated as potentially contaminated will be characterized to classify the waste for proper handling, record keeping, transfer, storage, and disposal. Waste analyses will be performed using the EPA approved procedures, as applicable. Analyses required for hazardous waste classification will reference EPA SW-846 or other EPA-approved methods, as required. Wastewater analyses will reference the applicable analytical requirements in the PGDP KPDES permit, the Clean Water Act, or Safe Drinking Water Act. QA/QC requirements and data management requirements will be followed for waste characterization sampling activities. Characterization requirements and guidance are provided in the site WAC and PAD-WD-0437, *Waste Characterization and Profiling*. The WMC will coordinate with the DOE contractor project manager and DOE contractor sample and data management group for required analyses and guidance on collection and transfer of characterization samples to a Sample Management Office-approved fixed-base laboratory that has been audited under DOECAP.

7.9.2.1 RCRA-listed hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA-listed hazardous waste is expected on this project. The waste is listed-hazardous due to the presence of TCE in the RGA underlying the majority of the area in which the soil borings, EWs and monitoring wells are to be installed. Waste generated during soil borings (i.e., drilling cuttings, purge water, sample residuals) will be classified as RCRA-listed hazardous wastes with waste codes F001, F002, and U228 if the boring locations are inside the PGDP industrial facility or from the RGA and if analytical results for the associated soil samples and water samples are above the health-based levels discussed in Table 4. If the concentrations are below the levels contained in Table 4, then the waste will be deemed not to contain or not to be contaminated-with a RCRA listed waste (based on TCE/TCA content) for the purposes of on-site management. If the WAC is met, the waste will be properly disposed of in the C-746-U Landfill.

Aqueous liquids that have undergone wastewater treatment and meet the KPDES discharge limits shall be considered to “no longer contain” listed hazardous waste (i.e., TCE). This treated wastewater may be discharged directly to permitted KPDES Outfall 001 or on-site ditches that flow to permitted KPDES Outfall 001.

7.9.2.2 RCRA-characteristic hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA characteristic-hazardous waste is possible during this action. Any waste determined to be RCRA characteristic-hazardous waste will be treated in the same manner as RCRA listed-hazardous waste for handling, storage, and disposal requirements.

7.9.2.3 PCB wastes

Based on process knowledge and existing historical sample data, the generation of PCB-contaminated waste is not expected to be generated on this project.

7.9.2.4 TRU wastes

TRU wastes are those that are contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium that are in concentrations greater than 100 nCi/g. Although it is possible that TRU elements may be detected in characterization samples collected on this project, it is unlikely that any of the waste generated will be at or above the TRU threshold limit. If TRU waste is generated in performing the optimization work, the waste will be managed as specified in DOE Orders 435.1, 458.1 and 40 *CFR* Part 191.

7.9.2.5 Low-level waste

LLWs are described as any nonhazardous, non-PCB, or non-TRU waste containing radioactivity or other radionuclides in a concentration greater than authorized limits or the latest off-site release criteria and are not classified as high-level waste, TRU waste, spent nuclear fuel, or by-product material. LLW may be generated from materials removed from the radiological areas. All wastes from this project have the potential to be classified as LLW. The potential radiological contaminant of concern is Tc-99. Due to varying levels of Tc-99, some work may be performed under a radiological work permit (RWP).

7.9.2.6 Mixed wastes

Mixed waste contains both hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954. The generation of mixed waste is possible on this project.

7.9.2.7 Nonhazardous wastes

Waste that does not meet the classification requirements of RCRA hazardous wastes, PCB wastes, LLW, TRU waste, or mixed wastes will be classified as nonhazardous solid waste. Nonhazardous waste will be generated as part of this project. The types of materials expected to be nonhazardous wastes are construction debris, waste concrete, grout, shipping materials, and containers (e.g., boxes, bags).

7.10 SAMPLING AND ANALYSIS OF WASTE

The WMC will be responsible for coordinating the sampling of solid and liquid waste in accordance with this section. During sampling, all appropriate health and safety concerns will be addressed in accordance with Section 5. All samples will be screened for radioactivity based on the RWP and appropriate actions taken to prevent the spread of contamination. Sample materials from different containers will not be mixed unless they are from the same waste stream, and only containers requiring further characterization will be sampled. Samples will be assigned a unique identifier. The following text summarizes the waste characterization requirements and describes the sampling procedures.

7.10.1 Solid Waste

For solid wastes, the “20 times” rule will be used to determine if the waste is characteristically hazardous. That is, if the total concentrations of RCRA constituents are less than 20 times Toxicity Characteristic Leaching Procedure (TCLP) limits in 40 *CFR* § 261.24, then the waste will be considered not to be characteristically hazardous. Where the total concentrations of RCRA constituents are greater than 20 times the TCLP limits, TCLP analyses will be performed to confirm the result.

For listed waste determinations for media or debris, the total concentrations of TCE and 1,1,1-TCA will be compared to the approved health-based levels of 39.2 ppm for TCE and 2,080 ppm for 1,1,1-TCA. If total concentrations are detected, but less than 39.2 ppm TCE and 2,080 ppm 1,1,1-TCA, the waste will be determined to "no longer contain" listed constituents. (The detection limit for TCE and 1,1,1-TCA is 5 ppb.) If the results exceed the health-based levels, the waste will be considered a RCRA-listed hazardous waste and must be managed and disposed of as such.

Solid waste may be containerized in drums, ST-90 boxes, intermodals, or 25-yd^3 roll-off containers during generation. Specific sampling event plans (including parameters, required detection limits, and QC requirements) will be identified when the proposed final waste containers have been presented to the waste characterization organization. Physical sampling will be performed in accordance with approved standard operating procedures.

Additional analyses to meet off-site disposal WAC also may be required and will be specified upon selection of the disposal site.

7.10.2 Aqueous Liquids

Liquid waste generated during drilling, well development, and decontamination activities will be characterized using process knowledge and/or sampling data as appropriate. These liquid wastes will be managed in accordance with ARARs prior to being processed through particulate filters at the drill site or accumulated and stored on-site until they can be processed at C-752-C for separation of groundwater and soils, as necessary. If filtered, the filtered water will be pumped to dual-wall holding tanks until it is verified that the filtered water meets the appropriate acceptance criteria for suspended solids and then is transferred to the on-site C-612 Northwest Plume Groundwater System. Potential contaminants of concern in this filtered waste water will be assumed to be consistent with those in the Northeast Plume groundwater currently treated at C-637 Cooling Towers, and no additional sampling and analysis is planned prior to treatment by the C-612 Northwest Plume Groundwater System.

Groundwater generated during drilling, well development, and decontamination activities that has undergone wastewater treatment, and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste. This treated wastewater may be discharged directly to permitted KPDES Outfall 001 or on-site ditches that flow to permitted Outfall 001, or an authorized CERCLA outfall, as appropriate.

Debris (e.g., particulate filters) and media (e.g.,soils) separated from the groundwater will be managed as outlined in Section 7.10.1. Any carbon media or other wastewater treatment sludge will be managed based upon the process knowledge and/or analytical data for the influent waste stream in accordance with ARARs.

8. QUALITY ASSURANCE AND CONSTRUCTION QUALITY CONTROL PLAN

The Northeast Plume IRA optimization will not perform the collection and laboratory chemical analyses of soil or water for environmental analysis in the course of the optimization project work. As such, a Quality Assurance Project Plan for the optimization activities is not required. Since the optimization efforts are aligned with construction activities, the following construction quality control plan (CQCP) will be used for ensuring a quality implementation.

8.1 INTRODUCTION

The CQCP which is presented in the following subsections provides a means to maintain effective quality control (QC) of the construction activities associated with the optimization of the IRA. The quality control measures as presented herein include quality control organization; methods of performing, documenting, and enforcing QC operations of both the primary contractor and its subcontractors (including inspection and testing); inspections to be performed; and protocol describing corrective actions.

Overall management of the CQCP will be the responsibility of the DOE prime contractor project manager. The project manager will have the authority to act in all construction quality control matters and will be responsible for ensuring that all materials and work comply with the contract specifications. All inspection and testing will be at the disposal of the project manager and his/her representatives to ensure that all aspects of work are compliant with the work control and design documentation. The project manager will report any deviations from the CQCP independently to the manager or projects.

8.2 SITE DESCRIPTION

The description of the PGDP facility in which the Northeast Plume IRA optimization project will be performed is contained in Section 1.

8.3 PROJECT ORGANIZATION

The prime contractor's key personnel assigned to this project will possess a broad range of remedial action experience and skills and PGDP site knowledge. All will have had experience dealing with the handling of contaminated waste and should be familiar with requirements of day-to-day work at PGDP.

The project organization for this optimization project, along with project roles and responsibilities, is provided in Section 3, Project Organization.

8.4 QUALITY ASSURANCE METHODS

This CQCP will be implemented in order to ensure compliance with the specifications for remedial action construction as detailed in specifications and drawings located in other applicable section of this RAWP. The basis of the CQCP is nationally recognized codes and standards included in the certified for construction package and procedures as followed by the DOE prime contractor as discussed in Section 2.

QA measures will extend to staffing; types of construction materials and construction equipment to be used; and methods of performing, documenting, and enforcing quality operations of the DOE prime contractor and subcontractors (including inspection and testing).

8.4.1 Implementation

As previously stated, maintenance of the CQCP will be the responsibility of the project manager. The project manager or assigned representatives will be responsible for ensuring that all materials and work comply with the governing documents, specifications and drawings. The project manager will have the field superintendent, QA manager, and the field technical staff available to assist in performing on-site inspections and testing of the materials and equipment used in implementing the optimization of the IRA.

The field superintendent or the project manager designee will report directly to the project manager and will complete site inspections to ensure compliance with the QC specifications. The field superintendent also may delegate the responsibility of performing and inspection on an as-needed basis.

8.4.2 Documenting

The inspection reports will be completed listing all field testing and material sampling activities. The reports will be submitted to the project manager. The project manager or designee will be responsible for resolving issues identified in the quality inspection and testing reports and for ensuring that all materials and work comply with the work control, specification and drawings, and that all performance standards are met. The field superintendent will record project activities in a daily log for the optimization project that will be maintained on-site at all times. All site activities, site inspections, and field testing of materials will be recorded in the log, along with any unacceptable site occurrences or deficiencies and their associated corrective actions. Each entry into the log will be signed by the field superintendent.

8.5 INSPECTIONS

To ensure that all construction and remedial activities comply with the project specifications, the project manager or designee will complete, in conjunction with the Field Technical Staff, three phases of site inspections for each feature of work. The following are the types of inspections to be used.

Phase I—Preparatory Inspection

Preparatory inspections will be performed prior to beginning work on any definable feature of the project and will include these:

- Review submittal requirements for the performance of the work;
- Check to assure that provisions have been made to provide required field QC testing;
- Examine the work area to ascertain that all preliminary work has been completed;
- Verify all field dimensions and advise project manager of any discrepancies;
- Perform a physical examination of materials and equipment to assure that they conform to approved drawings, specification, or approved submittal data.

Phase II—Initial Inspections

Initial phase inspections will be performed as soon as a representative portion of the particular feature of the optimization work has been accomplished. Initial inspections include, but are not limited to, examination of the quality of workmanship; review of control testing for compliance with control requirements; and identification of defective or damaged materials, omissions, and dimensional requirements.

Phase III—Follow-Up Inspections

Follow-up inspections will be performed daily as work progresses to ensure continuing compliance with construction requirements, including control testing, until completion of the particular feature of work. The follow-up inspections also will evaluate the repair or corrective measures taken to correct previously identified issues. Final follow-up inspections will be conducted and deficiencies corrected prior to beginning new work.

8.6 FIELD TESTING PROCEDURES

The contractor will conduct field-testing to verify that control measures are adequate to provide a product that conforms to the construction requirements.

Field testing will be conducted under the auspices of the field superintendent or designee who will complete the following tasks:

- Arrange for or conduct field testing in accordance with applicable test codes and standards parameters (American Society for Testing and Materials, etc.).

- Verify that facilities and testing equipment are available and comply with testing standards and ensure that testing facilities are LATA Environmental Services of Kentucky, LLC, approved suppliers or part of the Sample Management Office Contract Laboratory Program.

- Check test equipment calibration data against certified standards.

- Verify that all tests are documented and submitted as part of QC system reporting.

- Review all test documentation prior to submittal.

8.7 SUBMITTALS

The subcontractors responsible for providing the materials, equipment, and performing the construction will follow standard procedures concerning submittals. Each submittal form may contain more than one submittal specific to that specification section. A submittal register listing major submittals will be prepared by the field superintendent or designee from the field technical staff. The field superintendent will be responsible for the review and approval of submittals prior to the use of the subject materials or equipment. This includes reviews of materials and suppliers' catalog cuts, and subcontractor submittals. The field superintendent or designee will review the submittal for completeness and compliance with the construction specifications.

8.8 DOCUMENTATION

All testing results will be recorded in the field superintendent's daily log. Any concerns or deviations from the required material specifications and the actions taken to correct the problems will be noted in the log and will be reported back to the appropriate subcontractor. Information recorded from the testing and reported back to the subcontractor by the field superintendent or designee may include any of the following:

- Definable features of work that was addressed
- Description of trades working on the project
- Numbers of personnel
- Weather conditions
- Construction requirements reference numbers and sections

- Types and numbers of tests performed
- Results of testing
- Nature of defects or cause for rejection
- Suggested corrective action(s)

8.9 REVISIONS TO WORK

Revisions/corrections/repairs resulting from the inspections and testing under this CQCP for work associated with implementing this optimization to the Northeast Plume IRA may require corrective actions to be implemented by subcontractor or the DOE prime contractor. The DOE prime contractor may be required to revise the construction specifications to allow subcontractor work to be completed. The subcontractor shall submit a corrective action plan. The plan should contain information similar to the following:

- Deficiency identified
- Corrective action to be taken and date
- Schedule delays encountered
- Information and/or directions received from the DOE prime contractor staff
- Health and safety issues or deficiencies and how they were resolved
- Expected cost impacts

The DOE prime contractor project manager will be responsible for ensuring total compliance of fieldwork to the project specifications. Should modifications or revisions to the specifications become necessary, the DOE prime contractor will make the request, in writing, to the subcontractor contract representative.

8.10 DEFINABLE FEATURES OF WORK

Listed below are the general categories and types of work that will be performed as part of this optimization project. These items, known as Definable Features of Work, have been grouped into the various categories in which work will be performed. Suitable QC methods and procedures will be used in order to ensure that all work is performed to the standards and quality required by the construction specifications. The following are the definable features of work that will be performed under this contract:

- Preconstruction preparation activities
- Mobilization
- Site preparation
- Drilling
- EW and monitoring well installation
- Electrical service construction
- Pipeline construction
- Mechanical system construction and piping
- Electrical system wiring
- Programmable logic controller programming
- Demobilization

9. DATA MANAGEMENT AND IMPLEMENTATION PLAN

The Northeast Plume IRA optimization project will incorporate by reference the data management and implementation plan (DMIP) requirements from the C-400 RAWP. The C-400 RAWP DMIP, Sections 10.2 through 10.8, (http://www.paducaheic.com/media/34134/I-04616-0089a-PDI05.pdf) will be implemented as written for scope elements associated with the Northeast Plume IRA optimization project. References to the C-400 IRA project should be replaced with Northeast Plume IRA optimization project.

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APPENDIX A

CONSTRUCTION FIGURES

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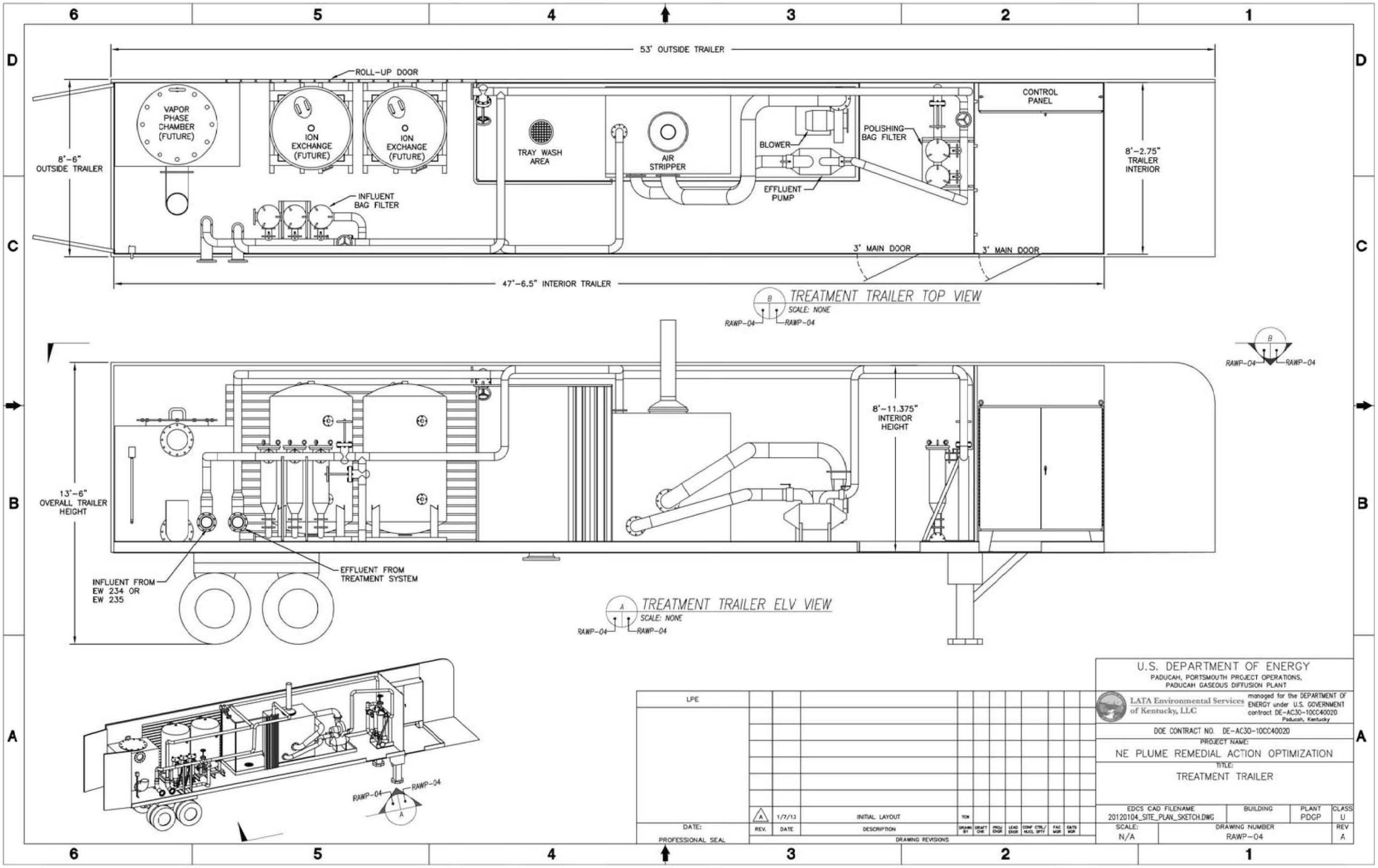

Figure A.1. Treatment Systems General Arrangement Drawing

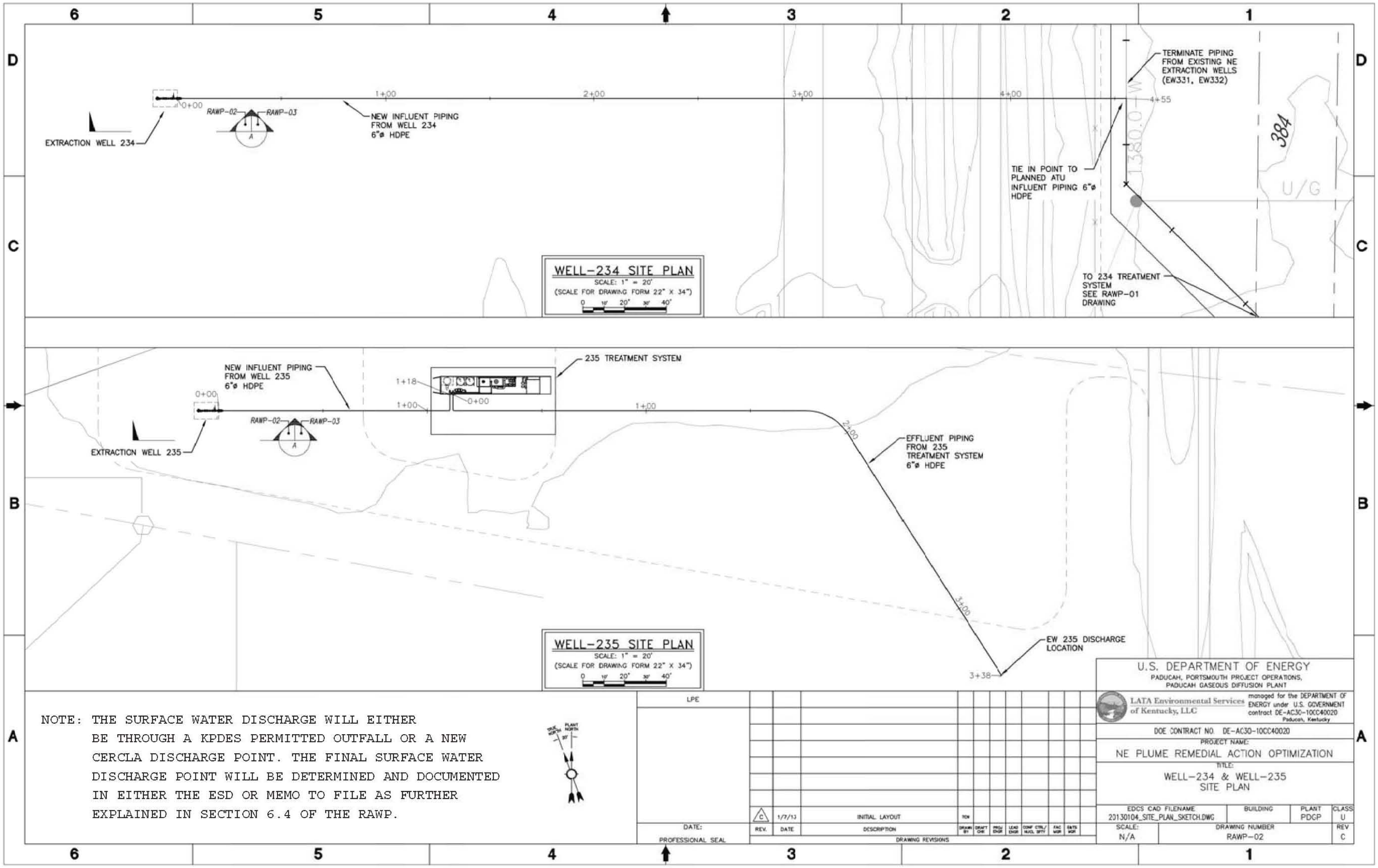

Figure A.2. EW234 and EW235 Plan View

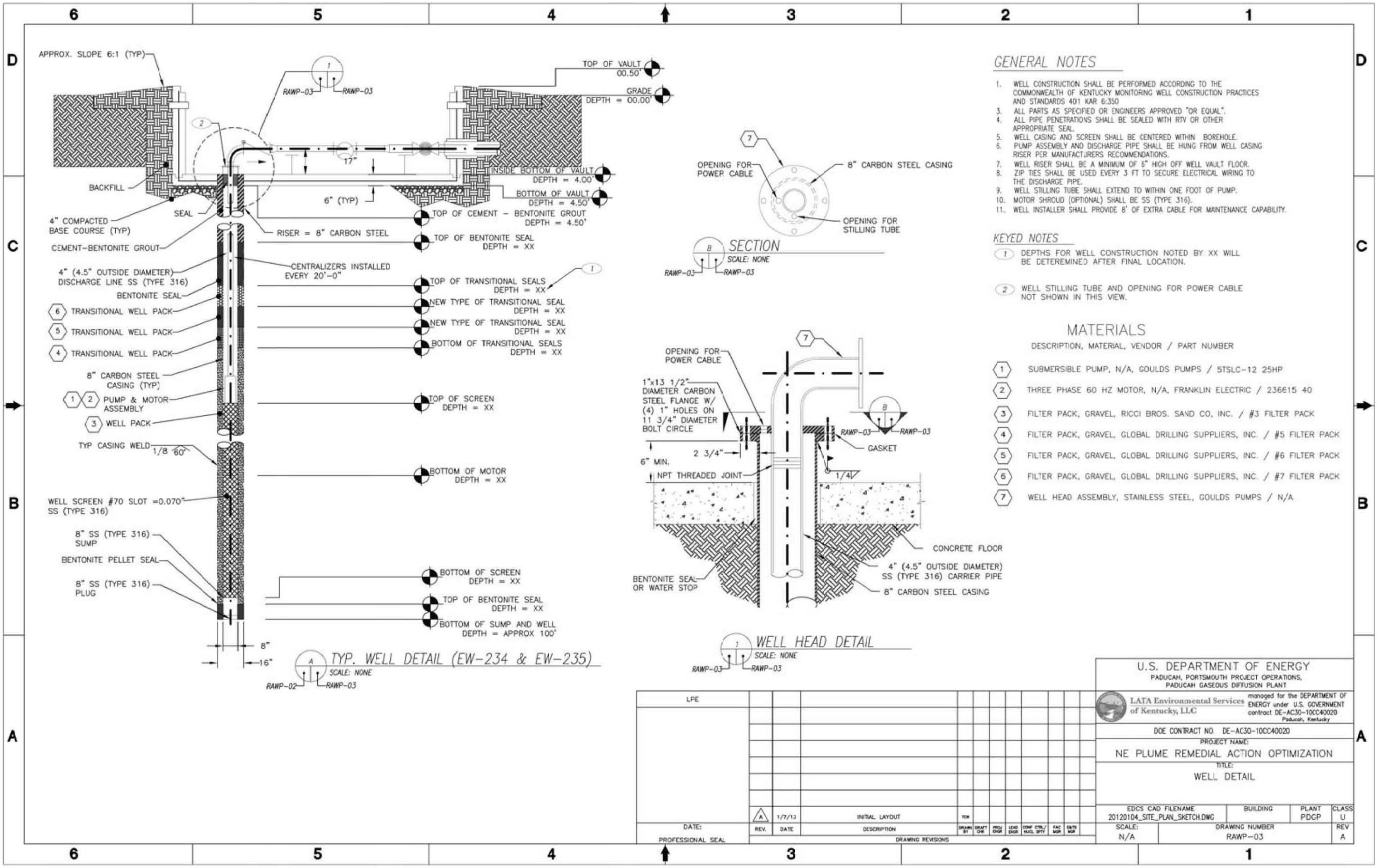

Figure A.3. EW234 and EW235 Well Details

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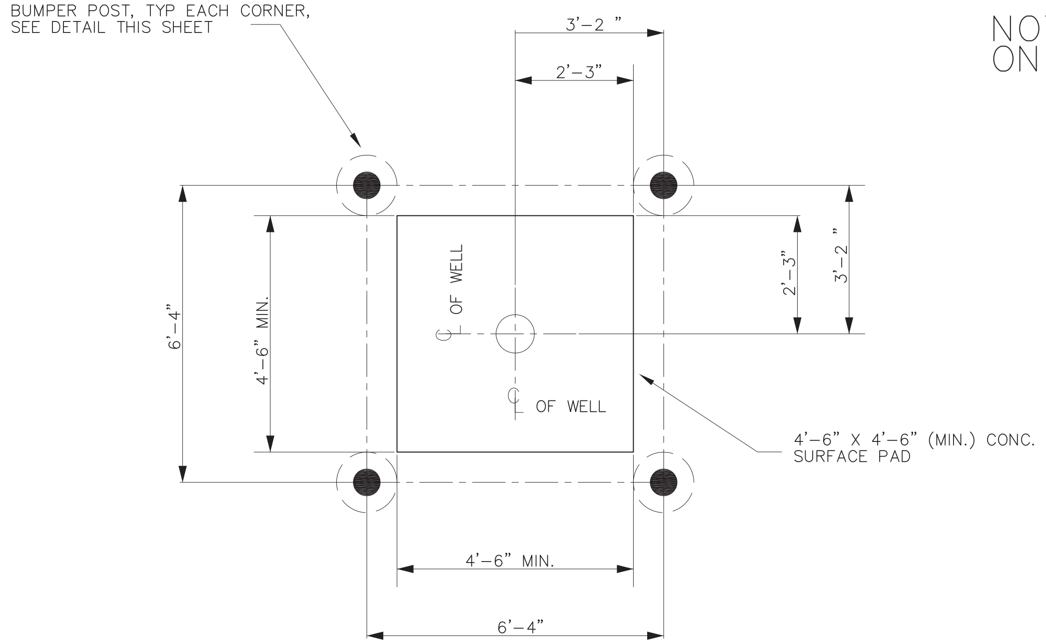
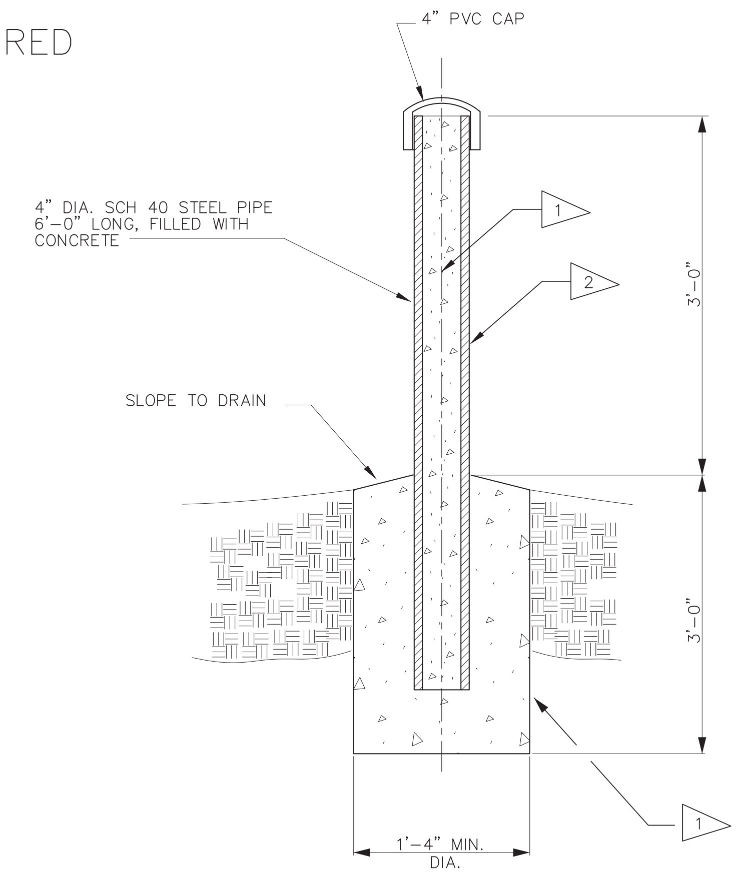
NOTE: PAD AND BOLLARDS ARE NOT REQUIRED ON TEMPORARY PIEZOMETERS



CONCRETE PAD AND BOLLARD LOCATION PLAN

NOT TO SCALE



TYPICAL BOLLARD DETAIL

NOT TO SCALE

GENERAL NOTES:

1. CONCRETE FOR BOLLARDS SHALL BE CLASS "A" IN ACCORDANCE WITH KDH STANDARD SPECIFICATION SECTION 601.
2. BOLLARD SHALL BE CLEANED ACCORDING TO SSPC-SP6 AND PRIMED WITH TNEMEC SERIES 37-77W @ 3-5 MILS AND FINISHED WITH TNEMEC SERIES 82-BW56 @ 2-3 MILS, OR CONTRACTOR ACCEPTED EQUAL.

REFERENCE DRAWINGS	DRAWING NO.
GROUND WATER MONITORING WELLS INSTALLATION DETAILS	C7DCWELLSA003

SECTION AND DETAIL KEY: SECTION NUMBER OR DETAIL LETTER; DRAWING ON WHICH SECTION OR DETAIL IS TAKEN; DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

LPE

ORIGINAL PE STAMP ON FILE

PAUL A. CRABTREE 18316

6/28/13

DATE

PROFESSIONAL SEAL

REV.	DATE	DESCRIPTION	DRAWN BY	DRAFT CHK	PROJ ENGR	LEAD ENGR	CONF CTRL/ NUCL SFTY	FAC MGR	E&TS MGR
1	6/28/13	GENERAL REVISIONS	KTW	PAC	KRD	PAC	N/A	CTD	PAC

DRAWING REVISIONS

U.S. DEPARTMENT OF ENERGY
PADUCAH, PORTSMOUTH PROJECT OPERATIONS, PADUCAH GASEOUS DIFFUSION PLANT

LATA Environmental Services of Kentucky, LLC — managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC30-10CC40020, Paducah, Kentucky

DOE CONTRACT NO. DE-AC30-10CC40020

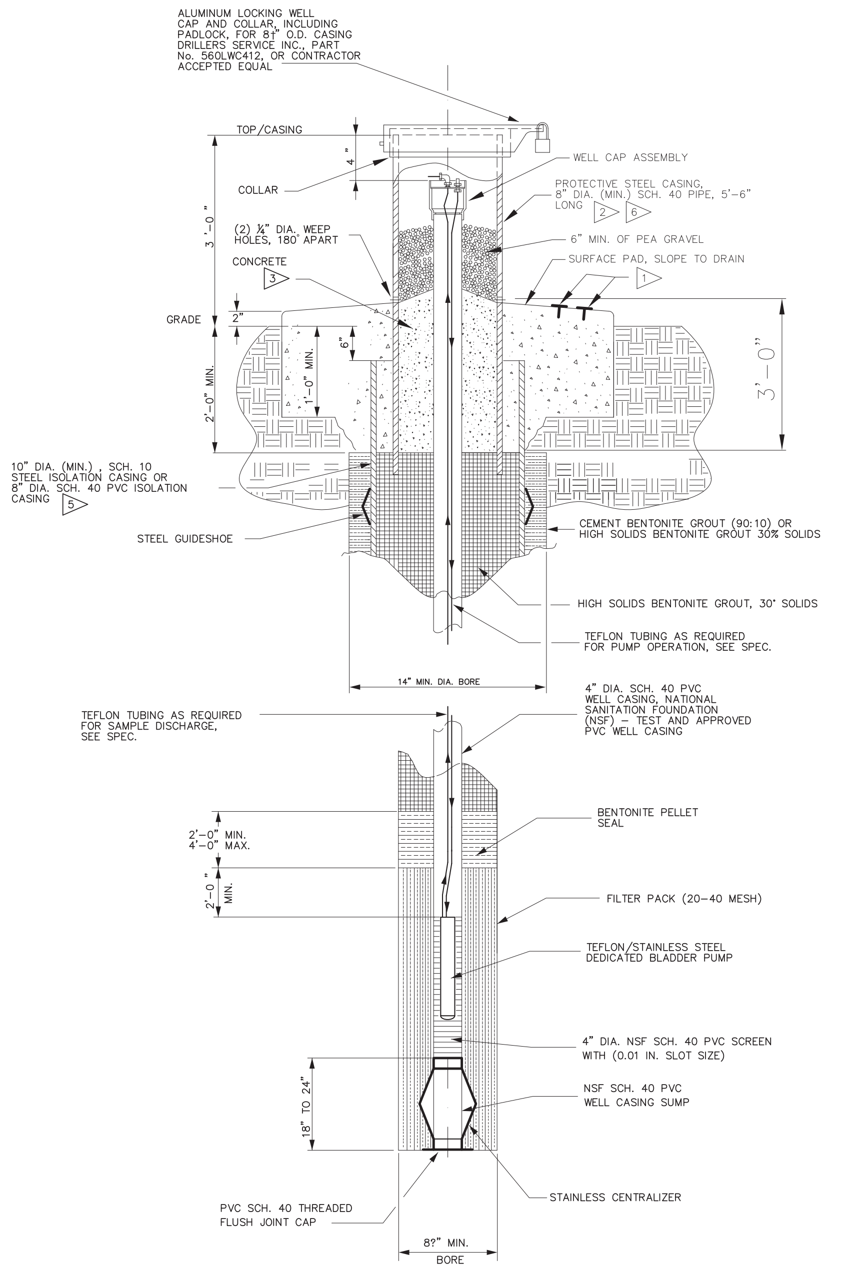
PROJECT NAME: ENVIRONMENTAL MONITORING UPGRADE

TITLE: GROUND WATER MONITORING WELLS TYPICAL WELL DETAILS

EDCS CAD FILENAME	BUILDING	PLANT	CLASS
C7DCWELLSA002 rev1.dwg	CWELLS	PGDP	U

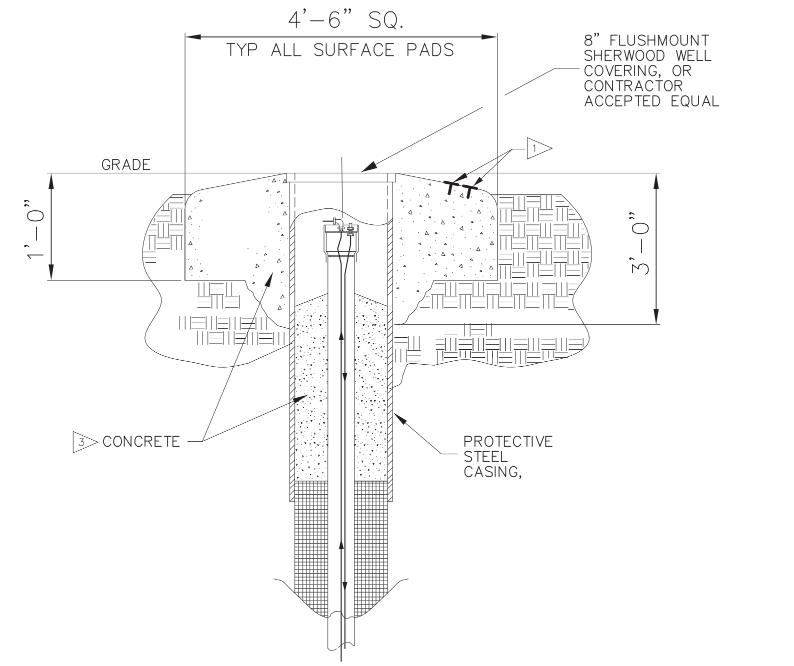
SCALE:	TYPE	DRAWING NUMBER	REV
NOTED		C7DCWELLSA002	1

Figure A.4. Groundwater Monitoring Wells Typical Well Details



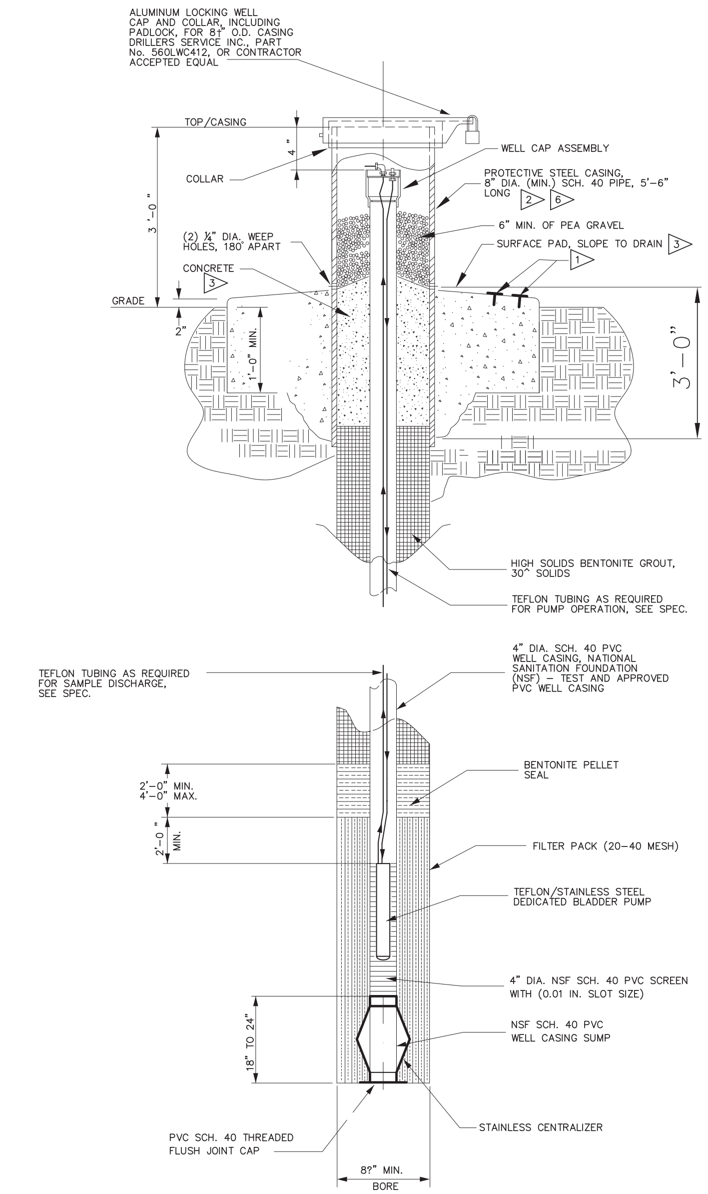
MONITORING WELL WITH ISOLATION CASING

NOT TO SCALE



FLUSH MOUNT SURFACE PAD ARRANGEMENT

NOT TO SCALE



MONITORING WELL WITHOUT ISOLATION CASING

NOT TO SCALE

GENERAL NOTES:

1. INSTALL TWO BRASS PLATE MONUMENTS. SUB-CONTRACTOR SHALL STAMP WELL NUMBER (MIN. OF ½" SIZE LETTERS) IN BRASS PLATE. BRASS PLATE SHALL BE DOMED SURVEY MARKER 3" DIA. LIETZNUMBER 8134-18 OR CONTRACTOR ACCEPTED EQUAL.
2. PROTECTIVE CASING SHALL BE CLEANED ACCORDING TO SSPC-SP6 AND PRIMED WITH TNEMEC SERIES 37-77W @ 3-5 MILS AND FINISHED WITH TNEMEC SERIES 82-BW56 @ 2-3 MILS, OR CONTRACTOR ACCEPTED EQUAL.
3. CONCRETE FOR PAD AND PROTECTIVE WELL CASING SHALL BE CLASS "A" IN ACCORDANCE WITH KDH STANDARD SPECIFICATION SECTION 601
4. OMIT
5. ISOLATION CASING TO BE INSTALLED IN CONFINING LAYER ABOVE RGA.
6. EACH PROTECTIVE CASING SHALL BE LABELED WITH BLACK LETTERS. LABEL SHALL INCLUDE THE PREFIX MW FOR MONITORING WELLS, THE PREFIX PZ FOR PIEZOMETERS AND THE NUMBER ASSIGNED BY THE CONTRACTOR. LETTERS SHALL BE A MINIMUM OF 2 INCHES HIGH.

REFERENCE DRAWINGS	DRAWING NO.
GROUND WATER MONITORING WELLS TYPICAL WELL DETAILS	C7DCWELLSA002

SECTION AND DETAIL KEY: SECTION NUMBER OR DETAIL LETTER; DRAWING ON WHICH SECTION OR DETAIL IS TAKEN; DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

LPE — ORIGINAL PE STAMP ON FILE — PAUL A. CRABTREE 18316 — 10/25/12 — DATE — PROFESSIONAL SEAL

REV.	DATE	DESCRIPTION	DRAWN BY	DRAFT CHK	PROJ ENGR	LEAD ENGR	CONF CTRL/ NUCL SFTY	FAC MGR	E&TS MGR
1	6/28/13	GENERAL REVISIONS	KTW	PAC	KRD	PAC	N/A	CTD	PAC

DRAWING REVISIONS

U.S. DEPARTMENT OF ENERGY
PADUCAH, PORTSMOUTH PROJECT OPERATIONS, PADUCAH GASEOUS DIFFUSION PLANT

LATA Environmental Services of Kentucky, LLC — managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC30-10CC40020 Paducah, Kentucky

DOE CONTRACT NO. DE-AC30-10CC40020

PROJECT NAME: ENVIRONMENTAL MONITORING UPGRADE

TITLE: GROUND WATER MONITORING WELLS INSTALLATION DETAILS

EDCS CAD FILENAME	BUILDING	PLANT	CLASS
C7DCWELLSA003 rev1.dwg	CWELLS	PGDP	U

SCALE:	TYPE	DRAWING NUMBER	REV
NOTED		C7DCWELLSA003	1

Figure A.5. Groundwater Monitoring Wells Installation Details

APPENDIX B

AIR DISPERSION ANALYSIS

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B.1. AIR DISPERSION ANALYSIS

B.1.1 INTRODUCTION

As a result of the expected cessation of uranium enrichment operations at PGDP, the use of the C-637 Cooling Towers as an air stripper facility for trichloroethene (TCE)-contaminated groundwater will be discontinued for this Interim Remedial Action (IRA). After PGDP ceases operations and prior to completion of the Northeast Plume IRA Optimization project, one (1) Northeast Plume treatment unit (TU), located near EW234 will be used temporarily to continue treatment of groundwater from the two existing Northeast Plume extraction wells (EW331 and EW332) until EW234 and EW235 begin operation. The TU systems will include, at minimum, a skid-mounted treatment system consisting of a high efficiency air stripper, air blower, effluent pump, influent bag filters, and process control system all enclosed in a heated weatherproof enclosure. In addition, the EW234 TU will include a tie-in point to the existing Northeast Plume IRA EWs. Two (2) separate TUs will be used to treat extracted water from each new EW; one (1) TU for EW234 and one (1) TU for EW235, and will be located in the same general area as the new extraction wells.

This appendix describes the air dispersion analysis of potential hazardous air pollutant (HAP) and/or toxic air pollutant (TAP) emissions after implementation of the Northeast Plume IRA Optimization project is complete, and EW234 and EW235 have begun operation. The property boundary concentrations for potential HAP/TAP emissions were estimated using BREEZE AERMOD Version 7.7.1. Report printouts and electronic model-ready input files are included in the attachment to this appendix. The results of the dispersion analysis are summarized herein.

Air Dispersion Model Selection

The BREEZE AERMOD Version 7.7.1 program was used to conduct air dispersion modeling using the latest version (12345) of the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) to estimate maximum ground-level concentrations. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

Modeling Receptor Grids

Ground-level concentrations were calculated within one Cartesian receptor grid and at receptors placed along the property line (property line). The property line grid receptors were spaced at a maximum of approximately 50 m apart. The Cartesian receptor grid extending out a minimum of 600 m beyond the property line was spaced at 200-m intervals in all directions. The Cartesian receptor grid was generated to ensure concentrations were decreasing away from the property line. All resultant maximum concentrations occur well within this distance.

Terrain

AERMOD uses advanced terrain characterization to account for the effects of terrain features on plume dispersion and travel. AERMOD's terrain pre-processor, AERMAP (latest version 11103), imports digital terrain data and computes a height scale for each receptor from National Elevation Dataset (NED) data files. A height scale is assigned to each individual receptor and is used by AERMOD to determine whether the plume will go over or around a hill.

The modeled receptor terrain elevations input into AERMAP are the highest elevations extracted from United States Geological Survey (USGS) 1:24,000 scale (7.5-minute series) NED data for the area surrounding PGDP. For each modeled receptor, the maximum possible elevation within a box centered on the receptor of concern and extending halfway to each adjacent modeled receptor was chosen. This is a conservative technique for estimating terrain elevations by ensuring that the highest terrain elevations are accounted for in the analysis. HAP/TAP emission concentrations were calculated at all receptors.

Building Downwash Analysis

The emission units were evaluated in terms of their proximity to nearby structures.[1] The purpose of this evaluation was to determine if stack discharge might become caught in the turbulent wakes of these structures leading to downwash of the plume. Wind blowing around a building creates zones of turbulence that are greater than if the building were absent. The current version of the AERMOD dispersion model treats building wake effects following the algorithms developed by Schulman and Scire.[2] This approach requires the use of wind direction-specific building dimensions for structures located within 5L of a stack, where L is the lesser of the height or projected width of a nearby structure. Stacks taller than the structure height plus 1.5L are not subject to the effects of downwash in the AERMOD model.

The current version of the AERMOD dispersion model considers the trajectory of the plume near a building and uses the position of the plume relative to the building to calculate interaction with the building wake. The direction-specific building dimensions used as inputs to the AERMOD model were calculated using the **B**uilding **P**rofile **I**nput **P**rogram **P**lume **Ri**se **M**odel **E**nhancement (BPIP PRIME), version 04274.[3] BPIP PRIME calculates fields of turbulence intensity, wind speed, and the slopes of the mean streamlines as a function of the projected building dimensions. BPIP PRIME is authorized by EPA and is designed to incorporate the concepts and procedures expressed in the GEP Technical Support document,[4] the Building Downwash Guidance document, and other related documents.

BPIP PRIME results indicate the stack height of each emission unit is greater than the GEP stack height; therefore, building downwash is not a concern. The input and output files used in the BPIP PRIME downwash analysis are included in the attachment to this appendix. The output file lists: the names and dimensions of the structures considered; the emissions unit locations and heights; a summary of the dominant structure for each emissions unit (considering all wind directions); and the actual building height and projected widths for all wind directions. Each building processed using BPIP PRIME was assigned a unique numerical identification, which correspond to BPIP PRIME files, and are illustrated in Figure B.1.

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[1] Buildings located farther than 800 m or 2,625 ft of a stack were not considered in the building downwash analysis. http://www.epa.state.oh.us/portals/27/aqmp/eiu/attach2.pdf

[2] Earth Tech, Inc., *Addendum to the ISC3 User's Guide, The PRIME Plume Rise and Building Downwash Model*, Concord, MA.

[3] U.S. EPA, User's Guide to the Building Profile Input Program, (Research Triangle Park, NC: U.S. EPA), EPA-454/R-93-038.

[4] U.S. EPA, Office of Air Quality Planning and Standards, *Guidelines for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised)*, (Research Triangle Park, NC: U.S. EPA), EPA 450/4-80-023R, June 1985.

Figure B.1. Buildings Processed using BPIP PRIME

B.1.2 IDENTIFICATION OF AIR POLLUTANTS

The potential HAPs/TAPs that could be emitted by the Northeast Plume IRA Optimization project have been identified based on groundwater characterization. The potential HAPs/TAPs that could be emitted are trichloroethene (TCE) and 1,1-dichloroethene (1,1-DCE).

B.1.3. ALLOWABLE OFF-SITE CONCENTRATIONS CALCULATIONS

The emitted vapor/gases must comply with the contaminant concentration requirements of 401 *KAR* 63:020. This states that no owner or operator shall allow any affected facility to emit potentially hazardous matter or toxic substances in such quantities or duration as to be harmful to the health and welfare of humans, animals, and plants.

B.1.3.1 TCE Allowable Off-site Concentrations

The maximum allowable air concentration for TCE was estimated using the EPA Region 9 Regional Screening Levels (RSLs), formerly referred to as Preliminary Remediation Goals, which are available from the EPA's Web site at: http://www.epa.gov/region9/superfund//prg/index.html. The TCE value is based on the carcinogenic risk posed by lifetime[5] exposure to TCE. The health effects of exposure to TCE are measured by a target risk of one in one million (1×10^{-6}). The residential RSL was used to develop an allowable off-site concentration limit.

The ambient air allowable off-site concentration for TCE is 0.43 $\mu g/m^3$. The allowable off-site concentration for TCE was selected from the most recent EPA publication of RSLs, which occurred in May 2013.

B.1.3.2 1,1-DCE Allowable Off-site Concentrations

The maximum allowable air concentration for 1,1-DCE also was estimated using the EPA RSL. The 1,1-DCE value is based on the noncancer risks posed by long-term exposure to 1,1-DCE. The health effects of exposure to 1,1-DCE are measured by a hazardous index, with a hazard index of 1 being an indication of the nearest off-site receptor having detrimental health effects from exposure to 1,1-DCE. The residential RSL was used to develop an allowable off-site concentration limit.

The ambient air allowable off-site concentration for 1,1-DCE is 210 $\mu g/m^3$. The allowable off-site concentration for 1,1-DCE was selected from the most recent EPA publication of RSLs, which occurred in May 2013.

The allowable off-site concentrations for TCE and 1,1-DCE are shown in Table B.1.

---

[5] Lifetime exposure is assumed to be 70 years by convention for this air toxics risk assessment. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm. In such assessments, if exposure duration is less than 70 years, inhalation exposure estimates and/or allowable off-site concentrations limits may be adjusted accordingly. http://epa.gov/ttn/fera/risk_atra_vol2.html. For simplicity in this report, allowable off-site concentration limits were not adjusted although exposure duration is expected to be less than 70 years for this project.

Table B.1. Allowable Off-site Concentration Limits

Pollutant	Allowable Off-site Concentration (μg/m^3)	Reference Source
TCE	0.43	Regional Screening Levels, last updated May 2013
1,1-DCE	210	

B.1.4 ESTIMATED EMISSION RATES

B.1.4.1 Emissions

During operation of the project, hazardous constituents in extracted groundwater will be volatilized using two identical TUs including, but limited to, a skid-mounted treatment system consisting of a high efficiency 4-tray air stripper (QED EZ-Tray P/N EZ-24.4SS),[6] air blower, effluent pump, influent bag filters, and process control system all enclosed in a heated weatherproof enclosure. The current design criteria for the TUs are for each air stripper to have a removal efficiency of up to 99% for volatile organic compounds.[7]

The following preliminary design parameters[8] for the stack were used in the model to estimate the dispersion of the hazardous constituents:

- 8-inch diameter
- 19.5-ft high (approximate)
- 1,300 standard cubic feet per minute (scfm) flow rate (approximate)
- 55°F exhaust gas temperature
- The stack will not be equipped with a raincap

In order to assess the potential impacts on ambient TCE and 1,1-DCE concentrations from the project, modeling was performed using estimated maximum potential emissions based on the system's maximum TCE input of 1,000 parts per billion (ppb); information was provided from the manufacturer.

The average expected TCE concentrations in groundwater prior to treatment are 517 parts per billion (ppb) and 450 ppb for ATU 234 and ATU 235, respectively. Based on average expected TCE concentration in untreated groundwater, the TCE emissions to air are estimated as 5.167×10^{-2} pound per hour (lb/hr) and 4.498×10^{-2} lb/hr for ATU 234 and ATU 235, respectively. The maximum observed TCE mass concentration based on sampling data from existing extraction wells was 870 ppb.[9] As such, 9.994×10^{-2} lb/hr based on 1,000 ppb provides a conservative basis for modeling potential emissions.

The maximum emission rates during operation for each model scenario are listed in Table B.2 in both lb/hr and g/s.

[6] Air stripper model information based on as-built equipment.
[7] http://www.qedenv.com/products/air_s.html
[8] Design parameters received in e-mail to Geosyntec on January 24, 2013, and January 28, 2013.
[9] Sampling data received in e-mail to Geosyntec on January 24, 2013. See May 8, 2013, e-mail to Todd Mullins, Kentucky Department for Environmental Protection, from Stan Knaus, LATA Environmental Services of Kentucky, LLC.

Table B.2. Estimated Emission Rates

Model ID	Scenario Description	TU 234 Mass Emissions (lb/hr)	TU 234 Mass Emissions (g/s)	Untreated Water Concentration (ppb)	TU 235 Mass Emissions (lb/hr)	TU 235 Mass Emissions (g/s)	Untreated Water Concentration (ppb)
Max_TCE	Maximum TCE	9.994×10^{-2}	1.259×10^{-2}	1,000	9.994×10^{-2}	1.259×10^{-2}	1,000
Max_11DCE	Maximum 1,1-DCE[10]	9.994×10^{-2}	1.259×10^{-2}	1,000	9.994×10^{-2}	1.259×10^{-2}	1,000

B.1.4.2 Maximum Off-Site Concentrations

The property boundary ambient concentration for each HAP/TAP was estimated using the air dispersion model BREEZE AERMOD Version 7.7.1.

Surface meteorology data from station number 3816 (Paducah, KY) and the nearest available upper air meteorology data from station 00013897 (Nashville, TN) were used. Dispersion analysis was performed using meteorological data from these stations for calendar years 2008, 2009, 2010, 2011, and 2012 (January 1, 2008, through December 31, 2012). The AERMOD-ready meteorological files were purchased from Trinity Consultants, Inc.

The air dispersion modeling analysis was performed using the pollutant-specific controlled emission rates discussed in Section B.1.4.1 to estimate the off-site concentration for each pollutant.

The results of the air dispersion modeling analysis suggest that the maximum annual concentration occurs at a receptor (341114.10, 4109112.90) along the property boundary northeast of the proposed stack locations, illustrated in Figure B.2.

[10] 1,1-DCE is a volatile similar to TCE; therefore, mass emission rates of 1,1-DCE were conservatively assumed to equal TCE.

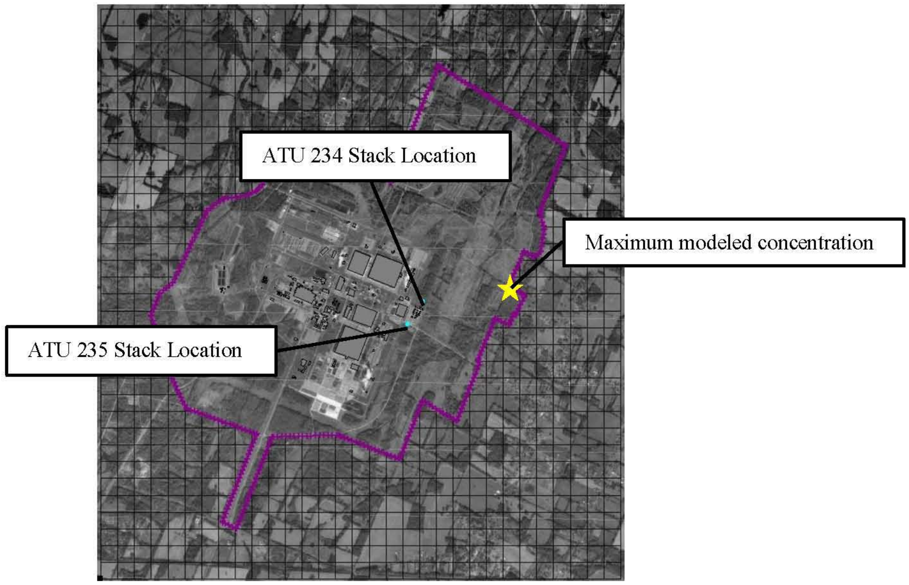

Figure B.2. Modeling Results

The estimated off-site pollutant concentrations for each modeling scenario are shown in Table B.3.

Table B.3. Estimated Off-site Concentrations

Model ID	Off-Site Concentration Limit (µg/m3)	Annual Off-site Concentration (µg/m3)	Below Limit? (Yes/No)
Max_TCE	0.43	0.084	Yes
Max_11DCE	210	0.084	Yes

The results of these air dispersion modeling analyses show the estimated maximum annual average concentration for both modeling scenarios will be below the corresponding maximum allowable off-site concentrations of respective pollutants. Additionally, the allowable off-site concentration limit for TCE was developed using a lifetime (i.e., 70-year exposure period) per EPA's RSL User's Guide.[11] The duration of potential exposure associated with the operation of the TUs will be less than 70 years. Therefore, emissions associated with this project are not expected to be harmful to the health and welfare of humans, animals, or plants.

[11] http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

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AIR DISPERSION ANALYSIS

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APPENDIX C

NORTHEAST PLUME EXTRACTION SYSTEM DESIGN AND EVALUATION

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NE Plume Extraction System Design and Evaluation

July 26, 2012

Outline

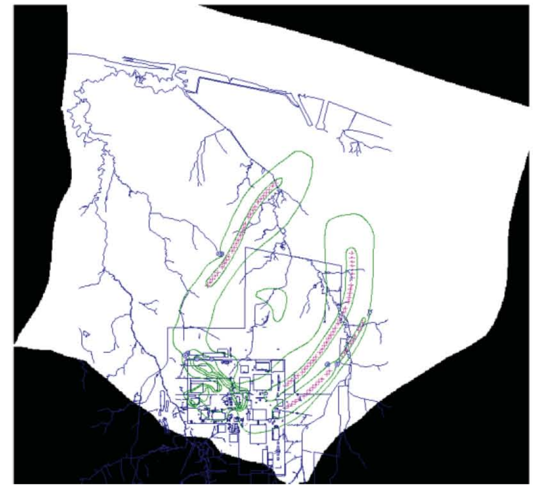
- Model Re-Calibration
- Evaluation of NW Plume Extraction System Using Updated Model
- Design and Evaluation of NE Plume Extraction System

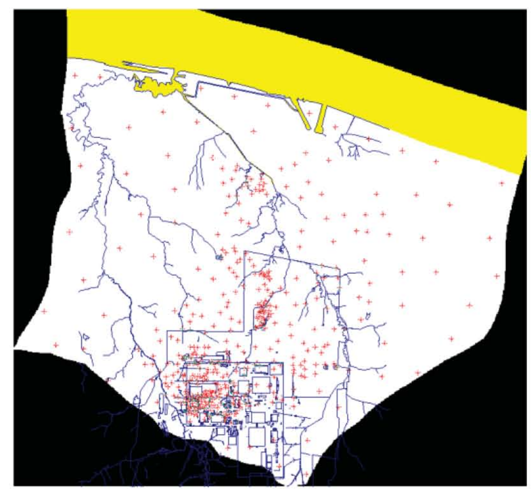
Model-Recalibration

C-5

Recalibration

- Calibrated 3 model variants
  - NW Plume centroid migrated eastward with time, KRCEE lithologic pilot point constraints
  - NW Plume centroid remained constant, KRCEE lithologic pilot point constraints
  - NW Plume centroid remained constant, didn't use KRCEE lithologic pilot point constraints
- Model consists of 7 steady-state stress periods and 10 transient stress periods





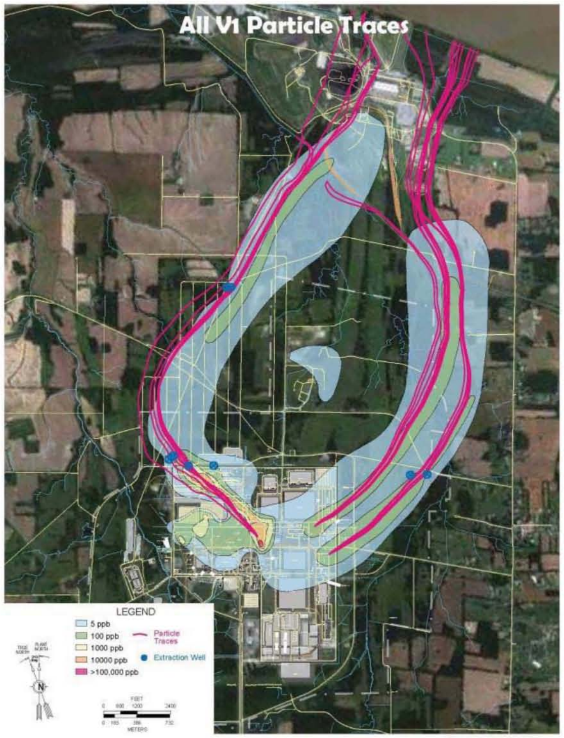
Stress Period Setup

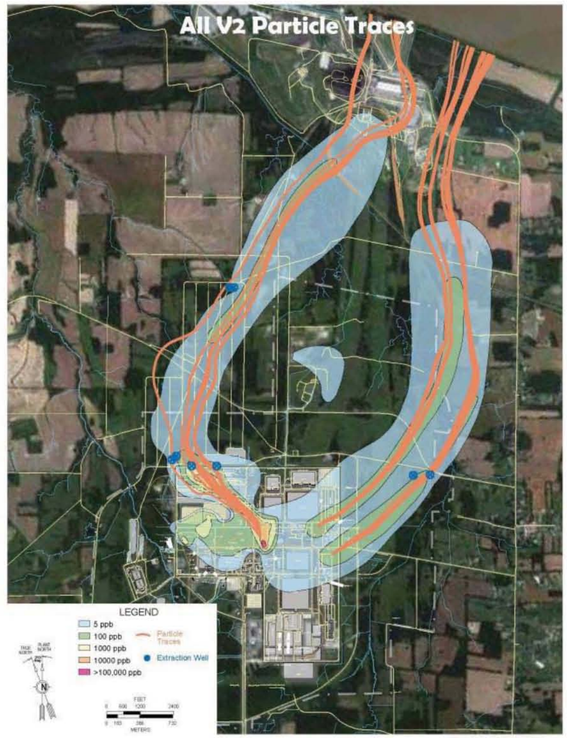
Collection Period	Stress Period Number	Stress Period Type	Stress Period Length, days	Cumulative Time, days	Number of Targets	Target Type	Ohio River Stage, ft msl
February 1995	1	Steady-State	1	1	76	Head, Trajectory, Flux	297.4
3rd Quarter 2005	2	Steady-State	1	2	110	Head, Trajectory, Flux	301.3
1st Quarter 2007	3	Steady-State	1	3	110	Head, Trajectory, Flux	313.0
April 2010	4	Steady-State	1	4	38	Head, Trajectory, Flux	327.2
October 11, 2010	5	Steady-State	1	5	13	Head, Trajectory, Flux	294.8
October 12, 2010	6	Transient	1	6	13	Drawdown, Flux	295.5
October 13, 2010	7	Transient	1	7	13	Drawdown, Flux	295.5
October 14, 2010	8	Transient	1	8	13	Drawdown, Flux	294.9
October 15, 2010	9	Transient	1	9	13	Drawdown, Flux	294.5
October 16, 2010	10	Transient	1	10	13	Drawdown, Flux	294.3
October 17, 2010	11	Transient	1	11	13	Drawdown, Flux	293.8
October 18, 2010	12	Transient	1	12	13	Drawdown, Flux	293.5
October 19, 2010	13	Transient	1	13	13	Drawdown, Flux	293.1
October 20, 2010	14	Transient	1	14	13	Drawdown, Flux	292.8
October 21, 2010	15	Transient	1	15	13	Drawdown, Flux	292.7
April 2011	16	Steady-State	1	16	212	Head, Trajectory, Flux	320.6
October 2011	17	Steady-State	1	17	202	Head, Trajectory, Flux	292.5

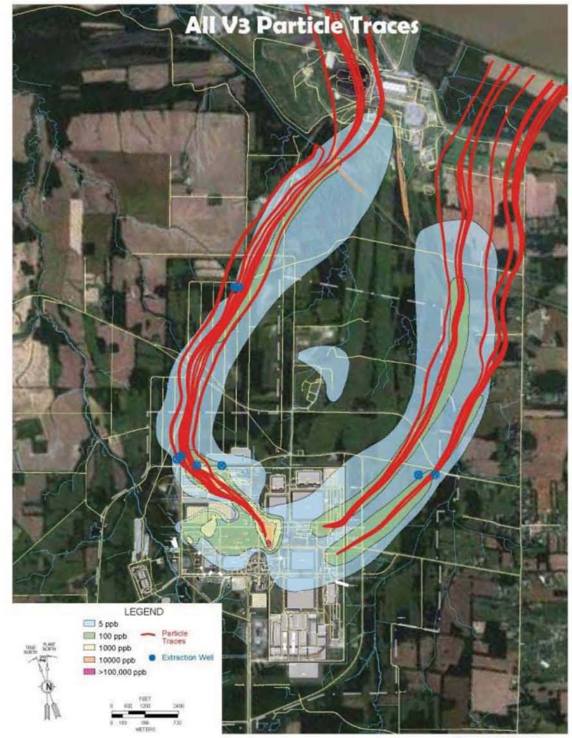
Recalibration

- Outcome
  - Hydraulic conductivity field that is **”best”** for the 7 stead-state and 10 transient stress periods
  - **7 unique recharge regimes** corresponding to the 7 steady-state stress periods
  - The 10 transient stress periods use the same recharge distribution as stress period 5

Model-Predicted Ambient Particle Traces

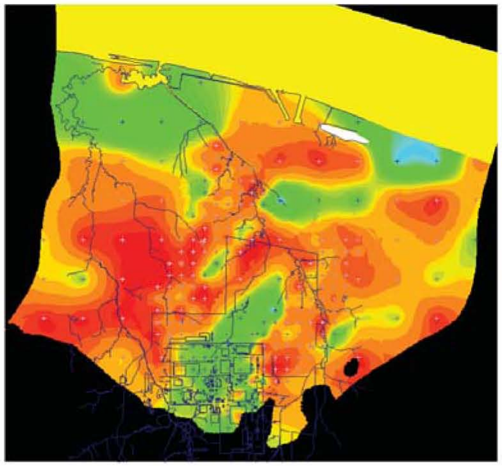






"Best"

Calibration Results – Layer 1 Hydraulic Conductivity



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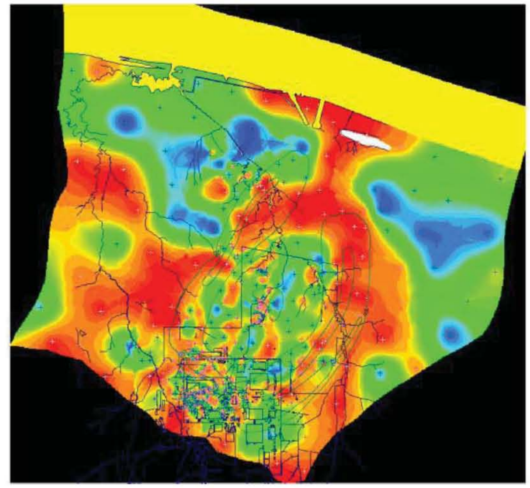
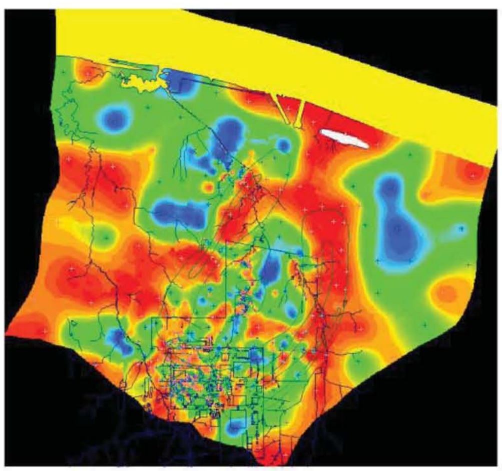


V1



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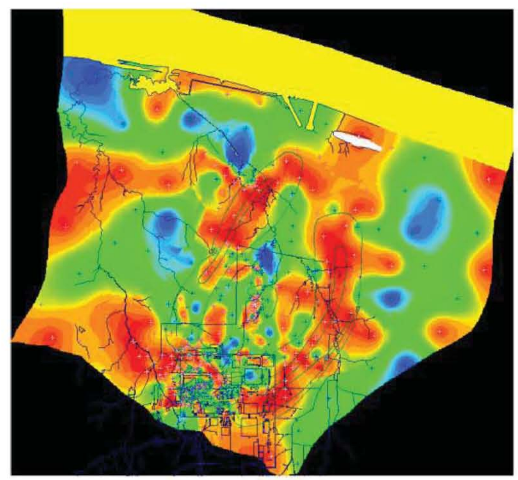
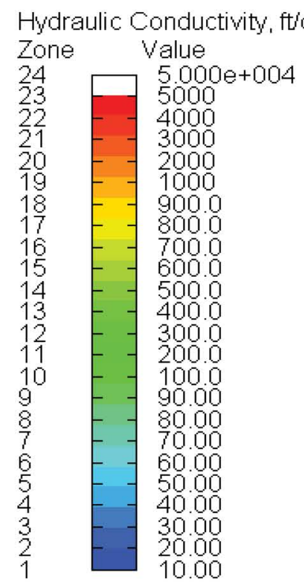
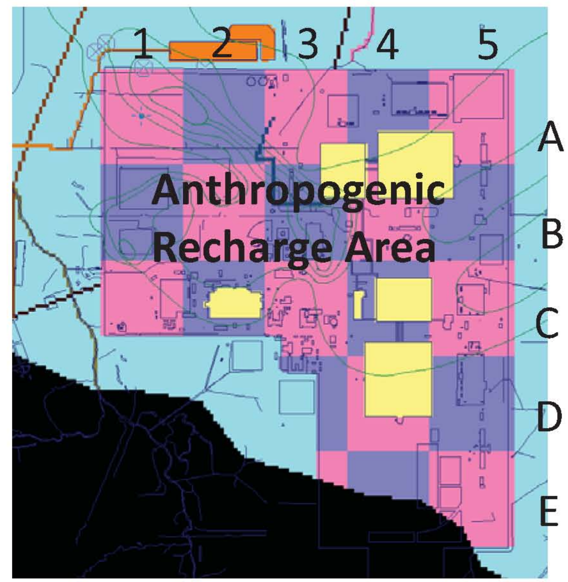


V3



Model Predicted Anthropogenic Recharge

Date	Anthropogenic Recharge, gpm		
	V1	V2	V3
Feb 1995	884	1,152	1,442
3Q 2005	1,204	1,337	1,525
1Q 2007	931	1,042	1,048
April 2010	1,065	678	978
Oct 2010	977	1,317	1,725
April 2011	831	599	491
Oct 2011	1,148	1,420	1,758
Mean	1,006	1,078	1,281
Median	977	1,152	1,442

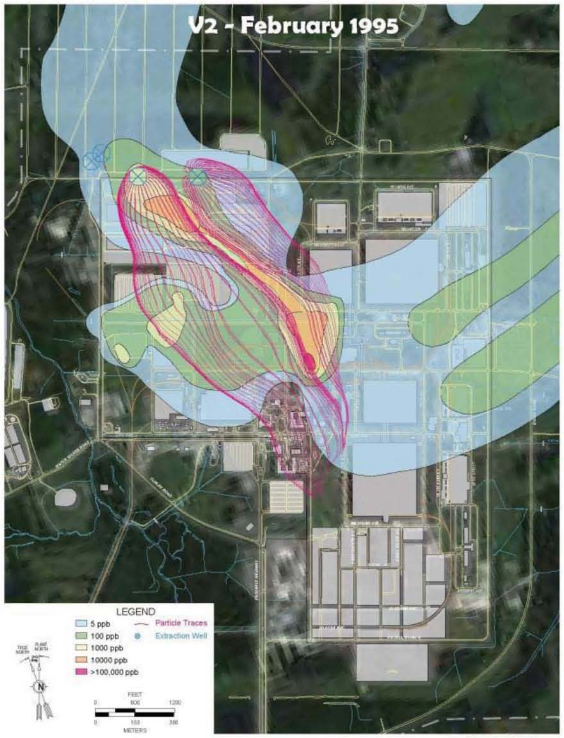


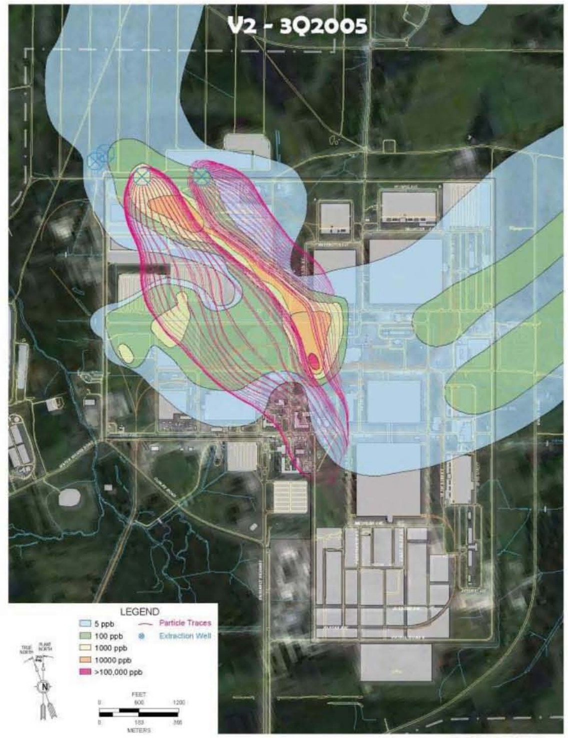
Evaluation of NW Plume Extraction System Using Updated Model

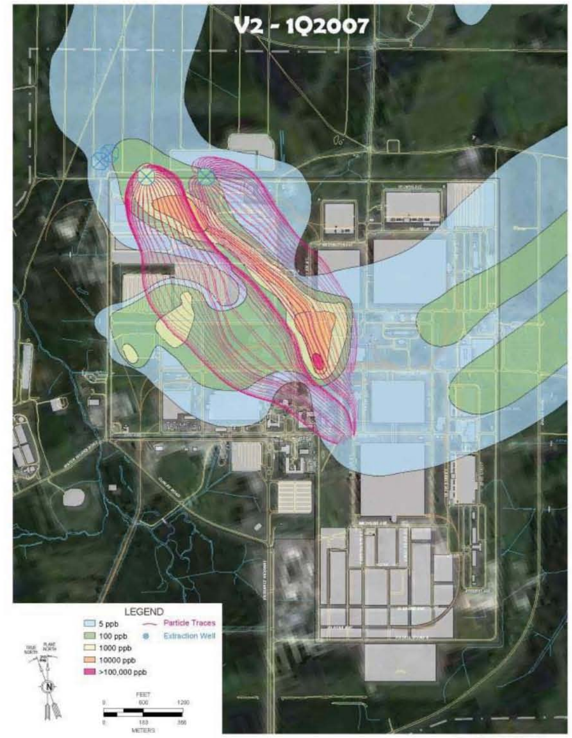
Evaluation of NW Plume Extraction System Using Updated Model

- Perform evaluation to characterize performance of the system under "new" model recharge and hydraulic conductivity regimes
- Are system adjustments required?

Model Variant 2 NW Plume Extraction System Capture Zone Evaluation







Date	Anthropogenic Recharge, gpm		
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Median	977	1,152	1,442

Model Variant 2 NW Plume Extraction System Capture Zone Evaluation

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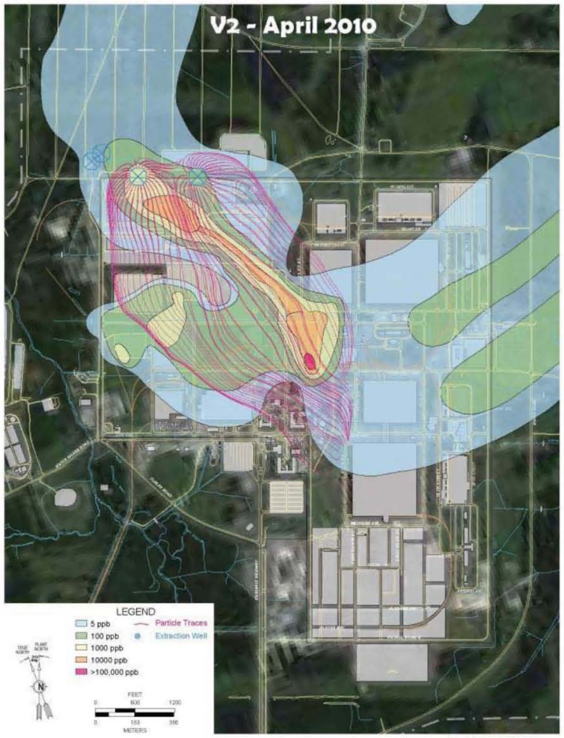

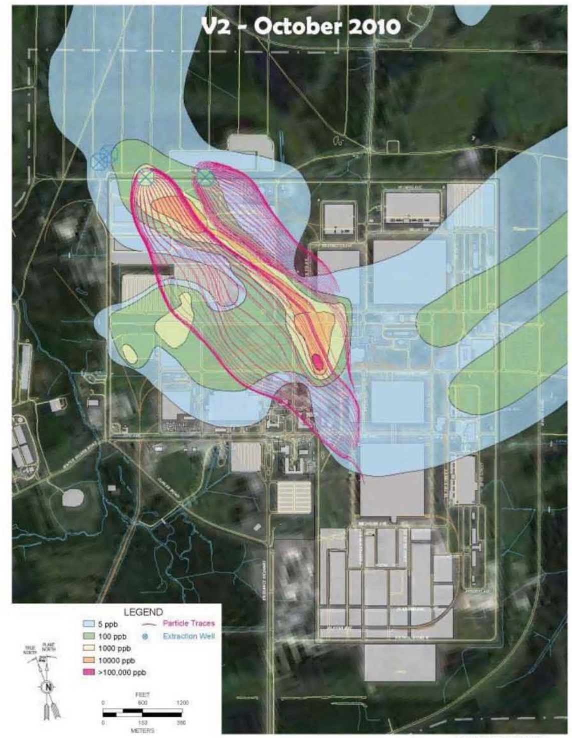

Date	Anthropogenic Recharge, gpm		
	V1	V2	V3
Feb 1995	884	1,152	1,442
3Q 2005	1,204	1,337	1,525
1Q 2007	931	1,042	1,048
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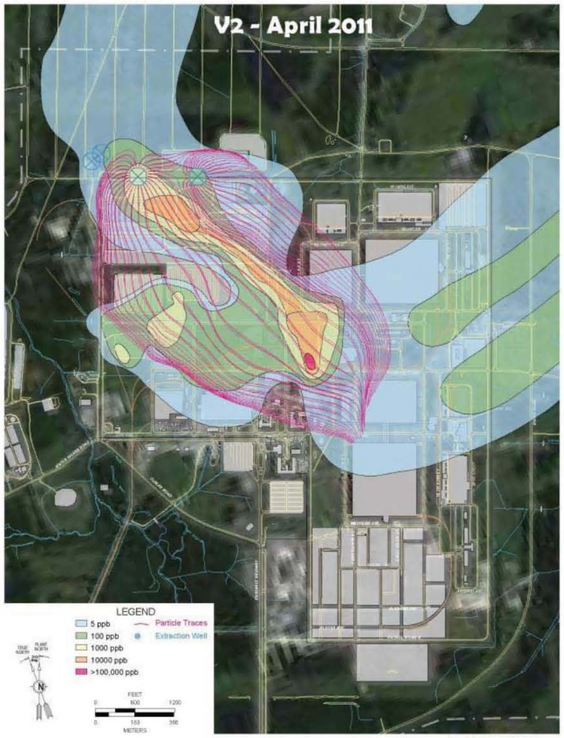
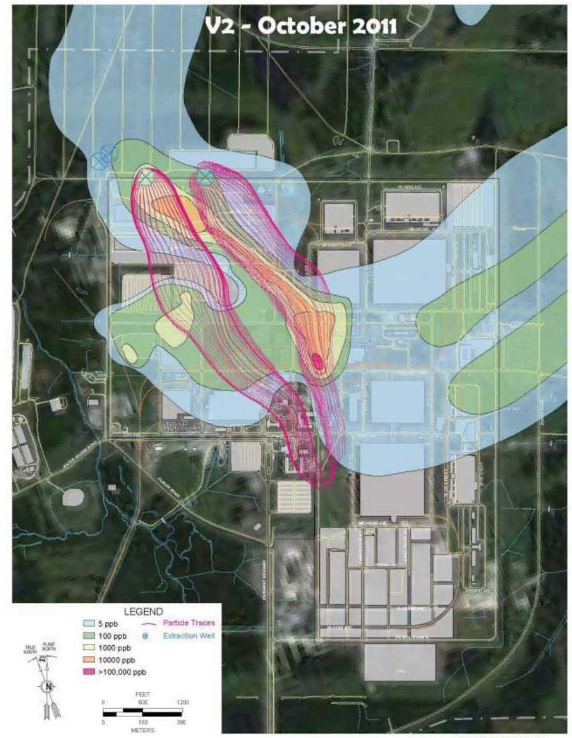
Oct 2011	1,148	1,420	1,758
Mean	1,006	1,078	1,281
Median	977	1,152	1,442

Model Variant 2 NW Plume Extraction System Capture Zone Evaluation





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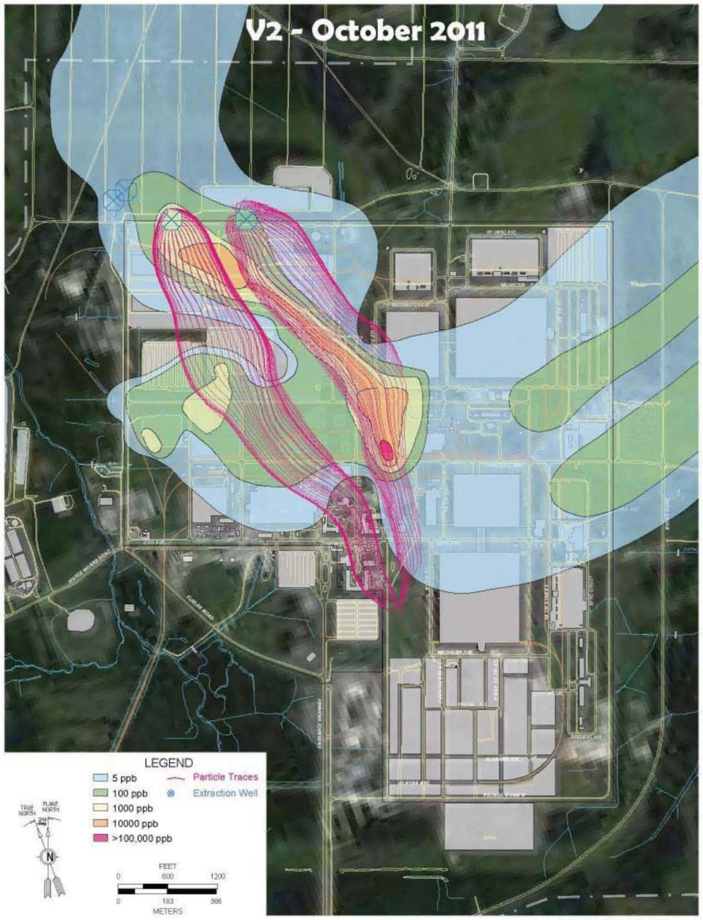
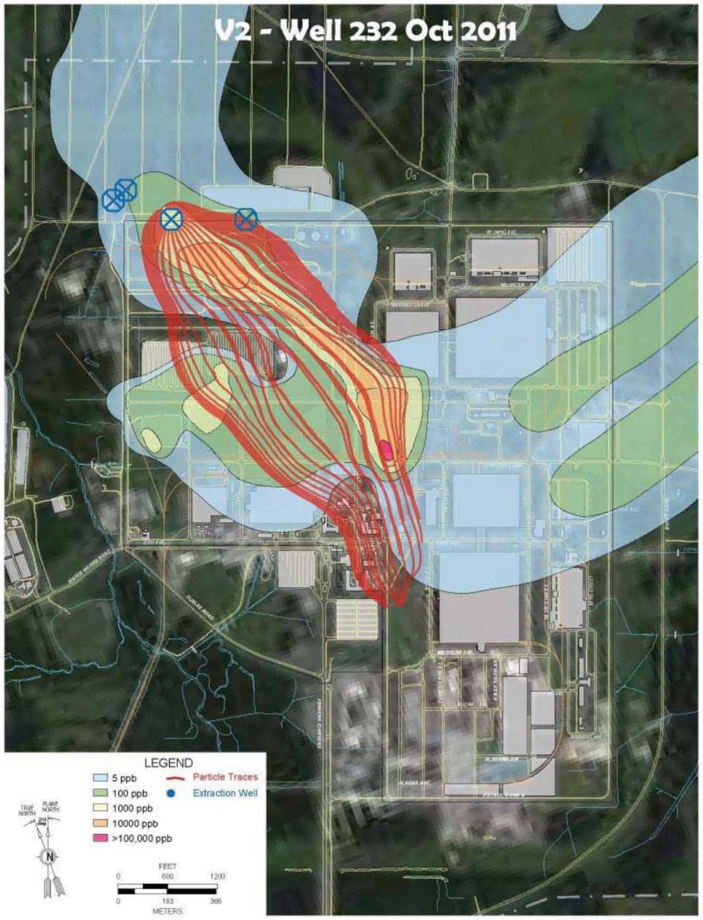
	V1	V2	V3
Feb 1995	884	1,152	1,442
3Q 2005	1,204	1,337	1,525
1Q 2007	931	1,042	1,048
April 2010	1,065	678	978
Oct 2010	977	1,317	1,725
April 2011	831	599	491
Oct 2011	1,148	1,420	1,758
Mean	1,006	1,078	1,281
Median	977	1,152	1,442

New NW Plume Extraction Well Capture Zone Evaluation Summary

- Capture zone width and orientation is a function of the volume and location of anthropogenic recharge
- Each of the 7 modeled periods represents a snap shot in time of anthropogenic recharge conditions
- Reality is anthropogenic recharge is constantly changing between these realizations and possibly beyond the simulated values
- There is no way to know which of the anthropogenic recharge scenarios is dominant
- **The challenge is to design a robust extraction system that accounts for anthropogenic recharge variability**

EW 232 Capture at 220 gpm





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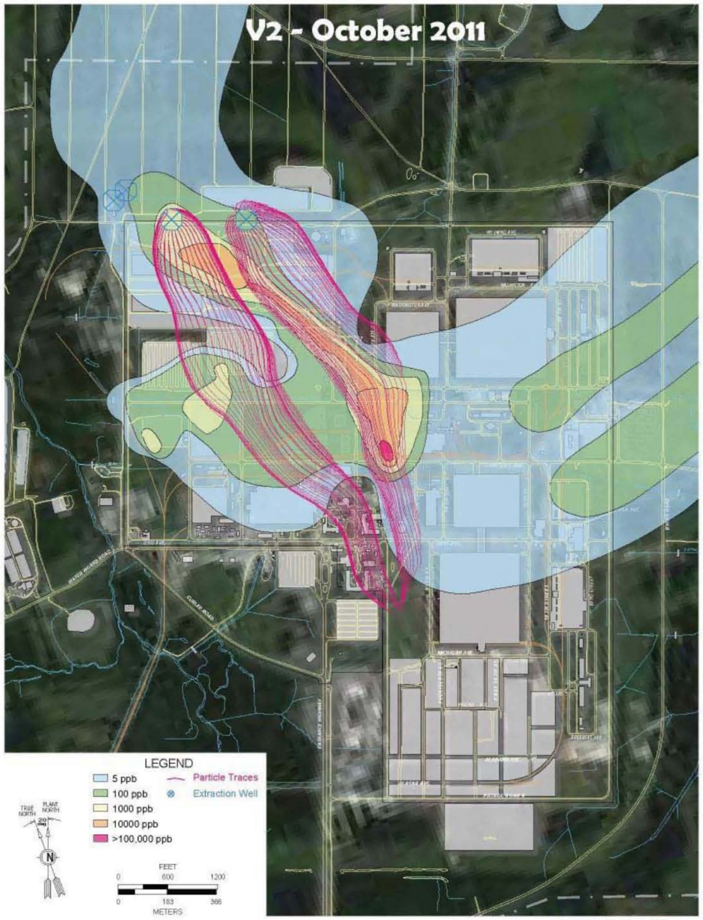
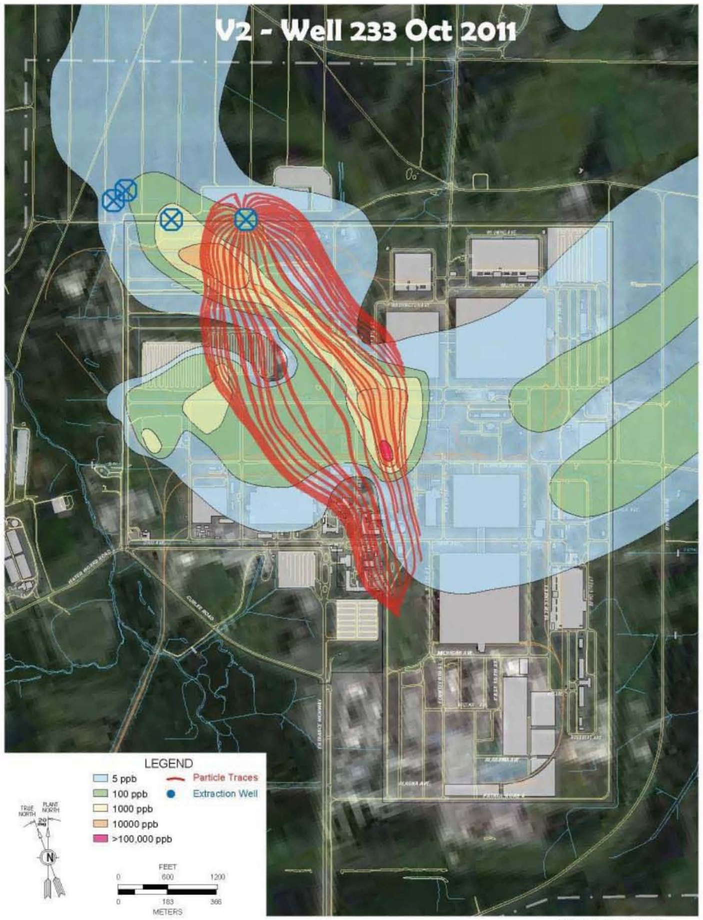
EW 233 Capture at 220 gpm





Model Variant 2 NW Plume Extraction System Capture Zone Evaluation

- Operate individually either EW232 or EW233 at 220 gpm
- Individual capture zones envelope C400, the primary source of NW Plume dissolved contamination
- NE Plume designs will assume either EW232 or EW233 will be operational, but not both
- 220 gpm is the Current Treatment Capacity

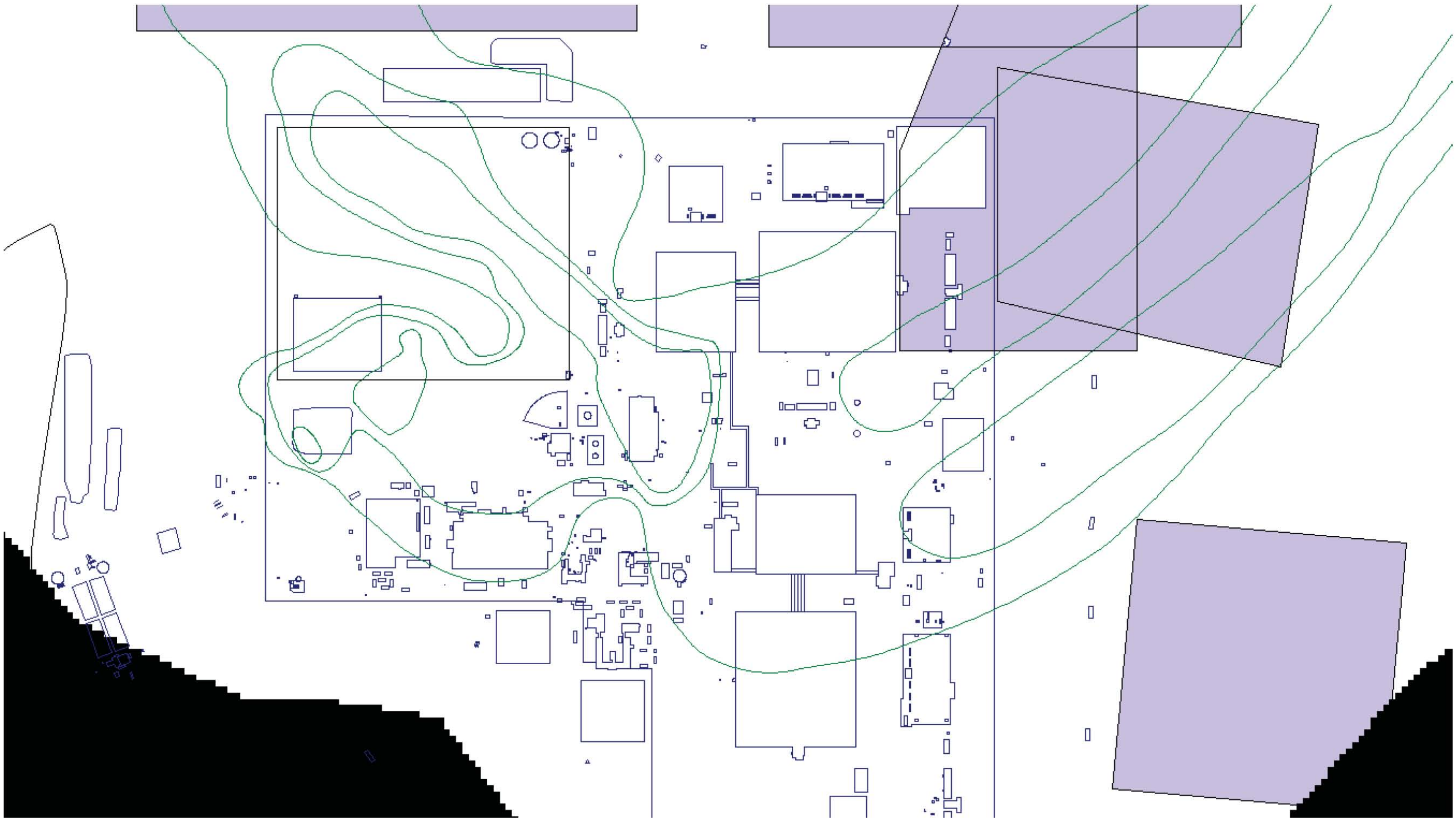
Design and Evaluation of NE Plume Extraction System

NE Plume Extraction System Design Constraints

- Minimize trajectory impacts at C400
- Complement NW Extraction Well capture zones
- Avoid potential CERCLA Cell locations
- Manage anthropogenic recharge variability
- Design for both anthropogenic and no anthropogenic recharge conditions to the extent possible (PGDP vs Post-PGDP)

NOTE: There is uncertainty associated with Post-PGDP conditions

Potential CERCLA Cell Locations

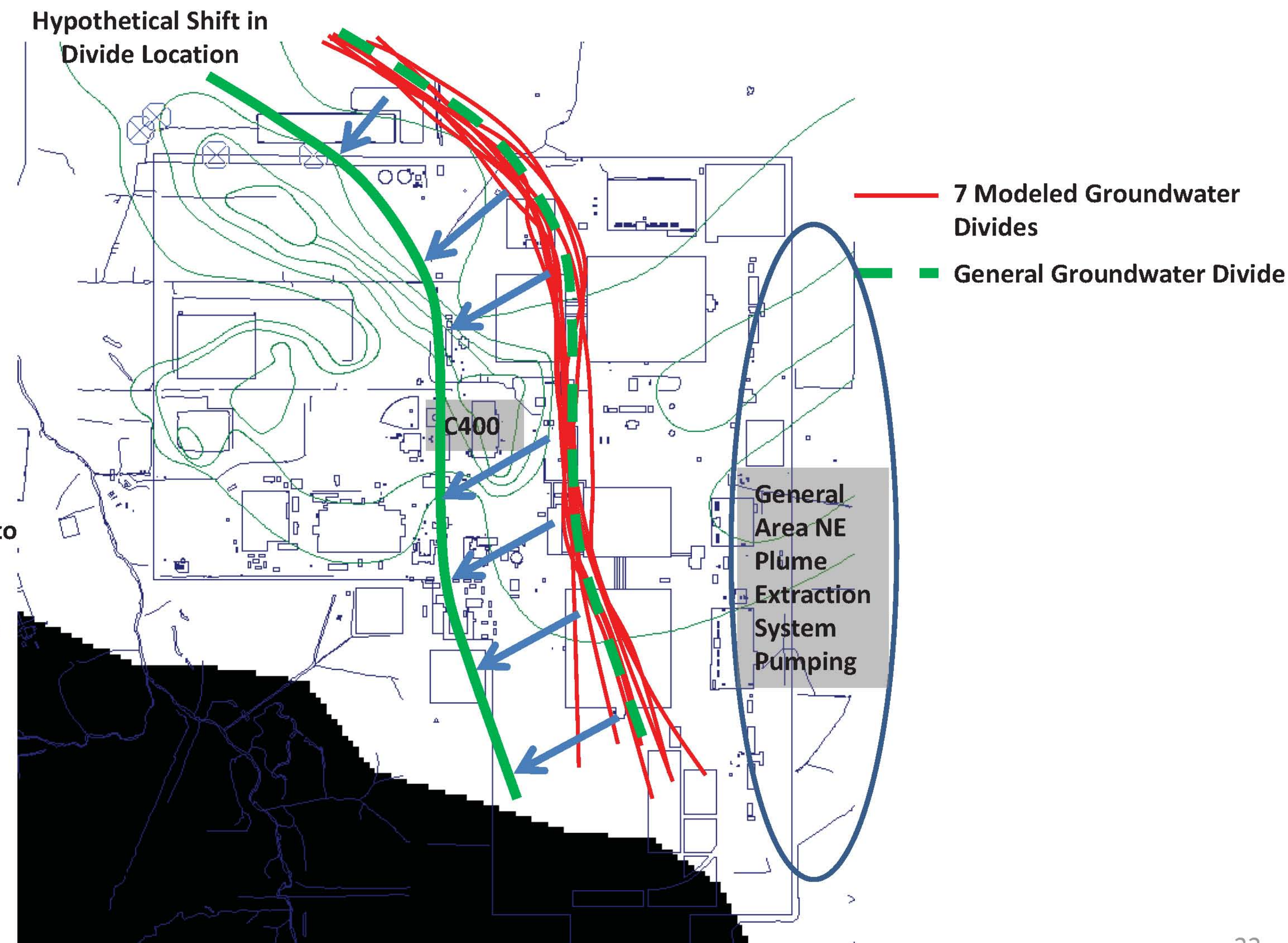


Potential CERCLA Cell Locations

Maintain NW Plume Trajectory

Do not want to shift the divide location westward in response to pumping

Doing so will cause higher concentration portions of the plume to flow eastward and contaminate lower concentration portions of the RGA



C-24

Design and Evaluation of NE Plume Extraction System

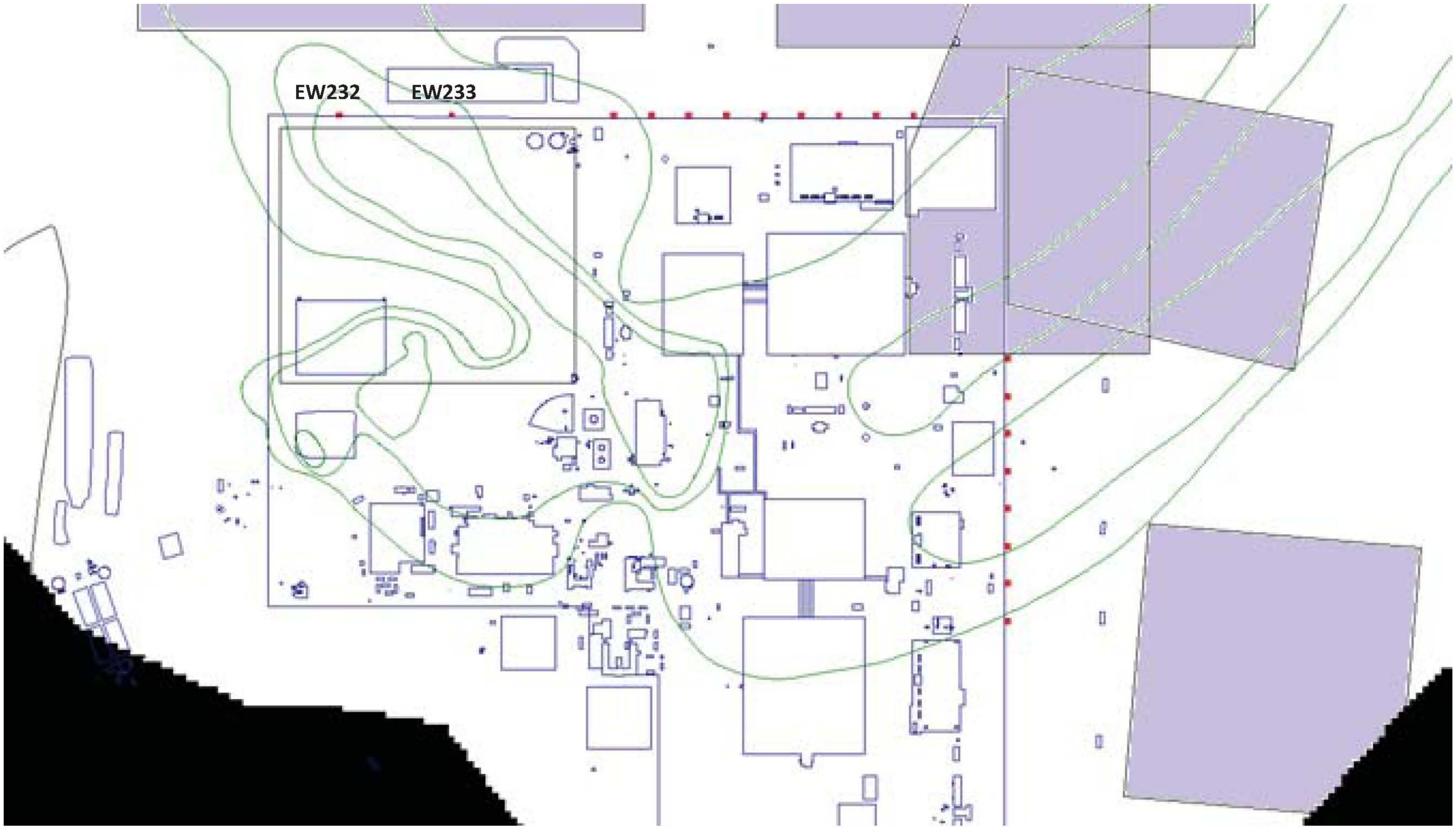
- Use Version 2 Calibrated Model, October 2011 Recharge Regime for Design and Evaluation
- October 2011 Represents Maximum Anthropogenic Recharge
- Use *Brute Force* Particle Tracking Optimization Algorithm, Same as was Used for NW Plume Extraction System Design

Design and Evaluation of NE Plume Extraction System

- After Developing a NE Plume Well Field Configuration and Pumping Schedule Using Maximum Anthropogenic Recharge Conditions, Evaluate the Design using Minimum and Average Anthropogenic Recharge Regimes and Post-PGDP Recharge Regimes
- **NOTE:** Dozens of Extraction Well Configurations Were Evaluated, Only a Few Relevant Designs Will Be Presented Today

NE Extraction Wells Along Fence Line

Candidate Well Locations



Proposed CERCLA Cell Locations   Candidate Well Locations

Particles Representing Dissolved Mass

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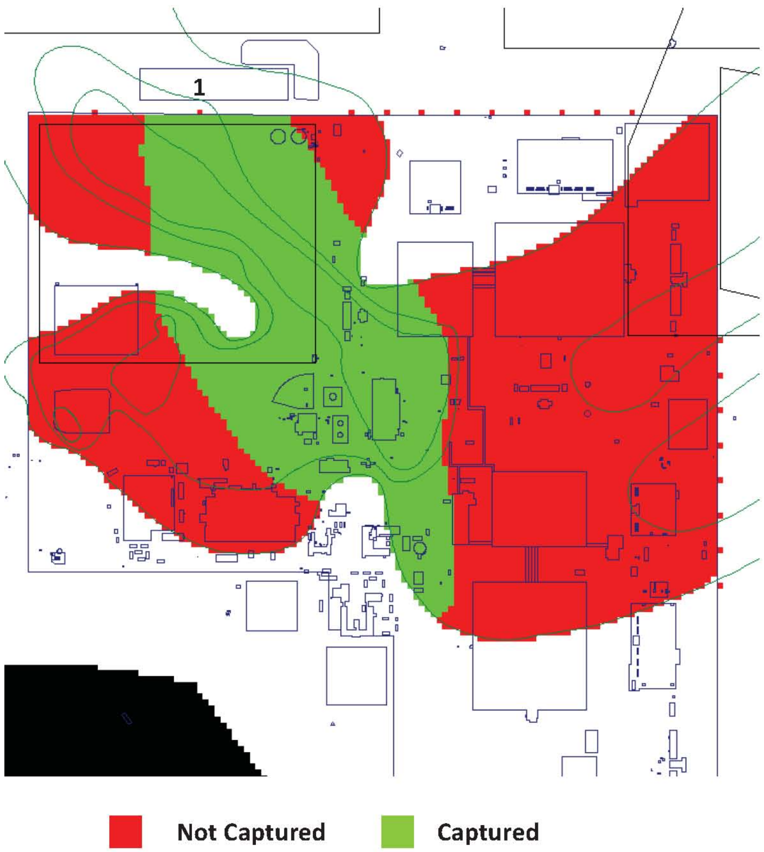
NE Extraction System Design and Evaluation



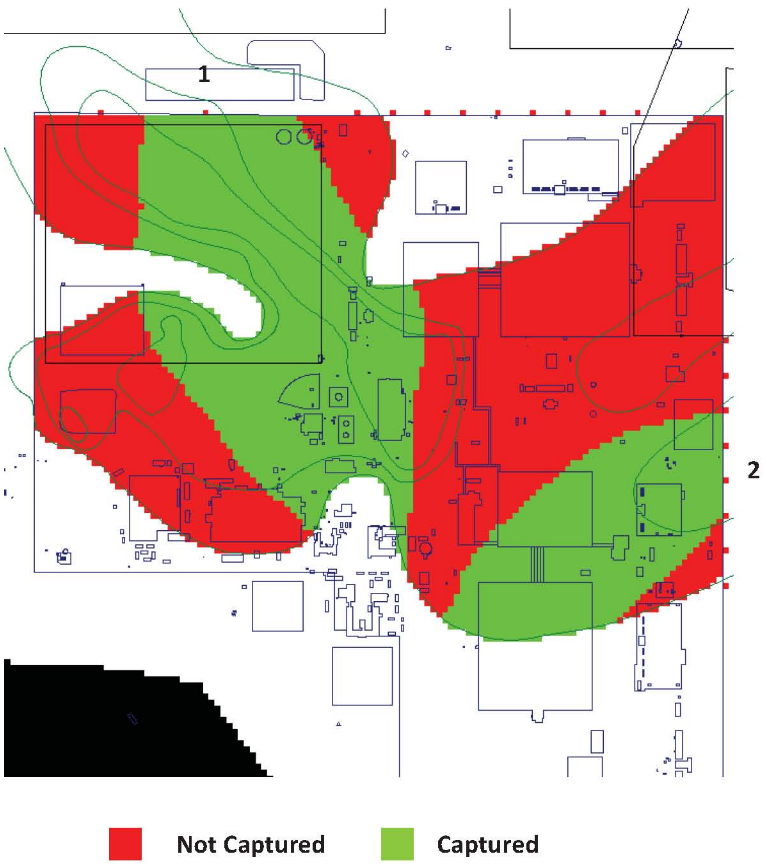
Pumping Rate, gpm

Well	Iteration						
	1	2	3	4	5	6	7
1	**220**	220	220	220	220	220	220
2		250	250	250	250	250	250
3			250	250	250	250	250
4				250	250	250	250
5					250	250	250
6						250	250
7							250
TOTAL	**220**	470	720	970	1,220	1,470	1,720

Mass Captured

Well	Iteration						
	1	2	3	4	5	6	7
1	**88.2%**	83.4%	51.4%	32.4%	29.0%	27.3%	24.6%
2		0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
3			42.2%	5.9%	0.9%	0.5%	0.5%
4				44.9%	42.3%	32.9%	30.1%
5					20.7%	0.3%	0.5%
6						37.9%	43.7%
7							0.2%
TOTAL	**88.2%**	83.8%	94.0%	83.6%	93.3%	99.3%	99.9%

NE Extraction System Design and Evaluation



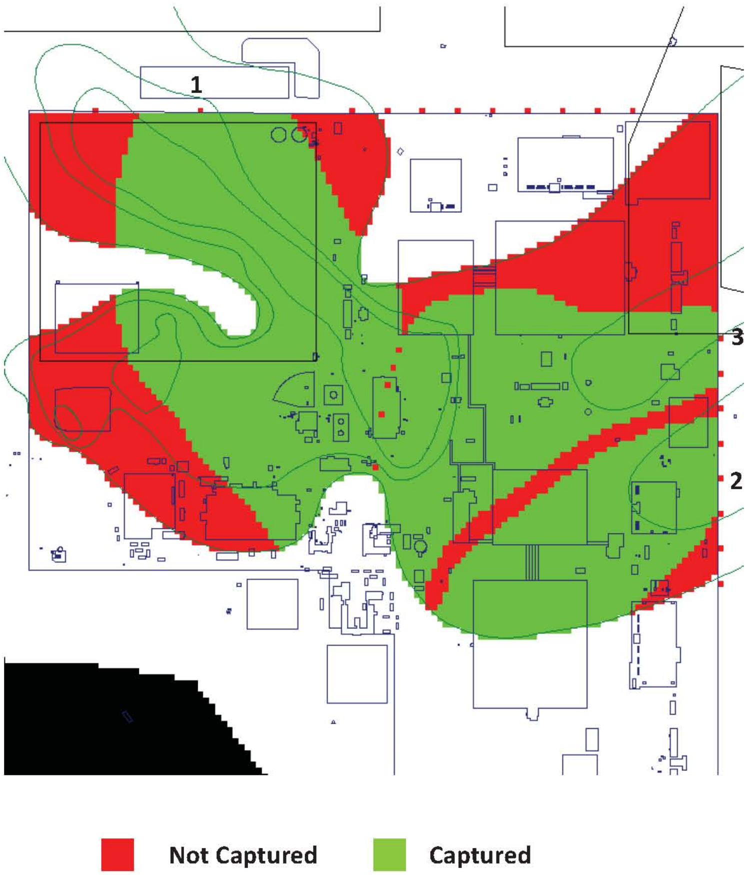
Pumping Rate, gpm

Well	Iteration 1	2	3	4	5	6	7
1	220	**220**	220	220	220	220	220
2		**250**	250	250	250	250	250
3			250	250	250	250	250
4				250	250	250	250
5					250	250	250
6						250	250
7							250
TOTAL	220	**470**	720	970	1,220	1,470	1,720

Mass Captured

Well	Iteration 1	2	3	4	5	6	7
1	88.2%	**83.4%**	51.4%	32.4%	29.0%	27.3%	24.6%
2		**0.4%**	0.4%	0.4%	0.4%	0.4%	0.4%
3			42.2%	5.9%	0.9%	0.5%	0.5%
4				44.9%	42.3%	32.9%	30.1%
5					20.7%	0.3%	0.5%
6						37.9%	43.7%
7							0.2%
TOTAL	88.2%	**83.8%**	94.0%	83.6%	93.3%	99.3%	99.9%

NE Extraction System Design and Evaluation



Pumping Rate, gpm

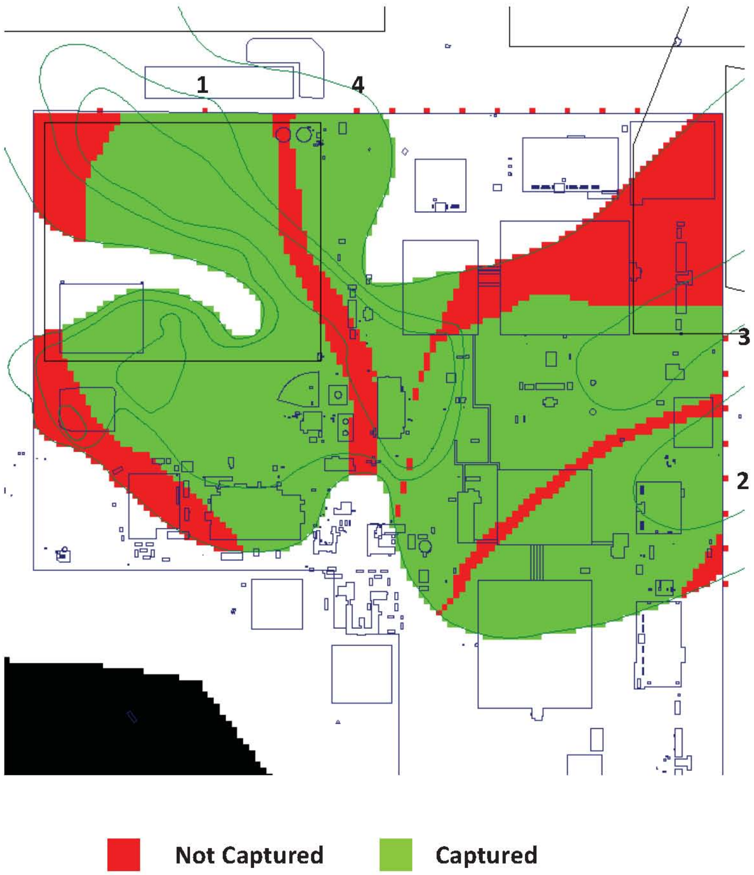
Well	Iteration 1	2	3	4	5	6	7
1	220	220	**220**	220	220	220	220
2		250	**250**	250	250	250	250
3			**250**	250	250	250	250
4				250	250	250	250
5					250	250	250
6						250	250
7							250
TOTAL	220	470	**720**	970	1,220	1,470	1,720

Mass Captured

Well	Iteration 1	2	3	4	5	6	7
1	88.2%	83.4%	**51.4%**	32.4%	29.0%	27.3%	24.6%
2		0.4%	**0.4%**	0.4%	0.4%	0.4%	0.4%
3			**42.2%**	5.9%	0.9%	0.5%	0.5%
4				44.9%	42.3%	32.9%	30.1%
5					20.7%	0.3%	0.5%
6						37.9%	43.7%
7							0.2%
TOTAL	88.2%	83.8%	**94.0%**	83.6%	93.3%	99.3%	99.9%

Violated Design Tenant: Maintain NW Plume Trajectory

NE Extraction System Design and Evaluation



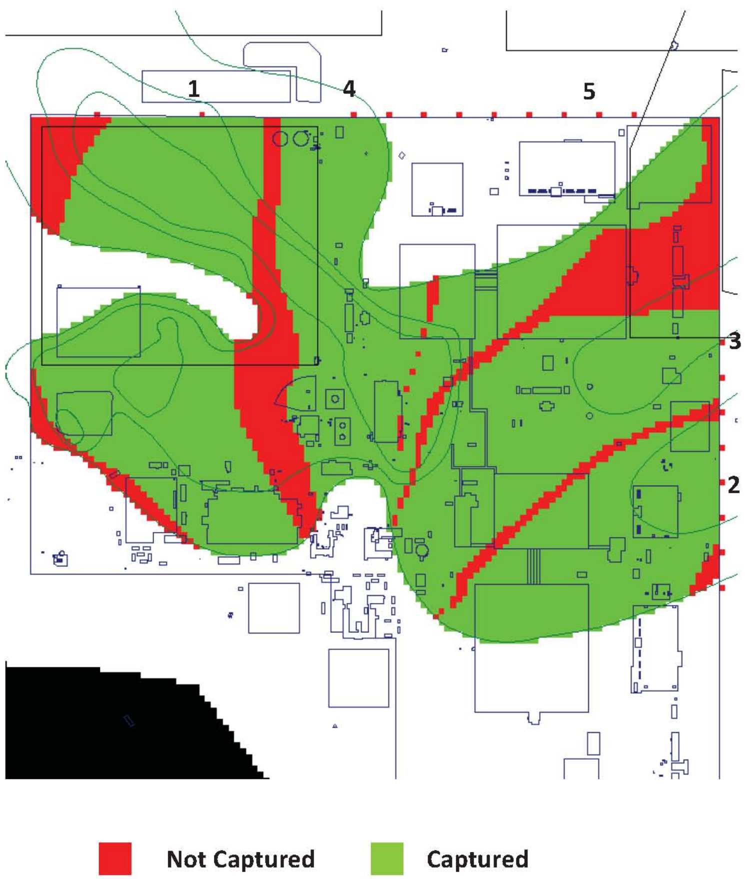
Pumping Rate, gpm

Well	Iteration						
	1	2	3	**4**	5	6	7
1	220	220	220	**220**	220	220	220
2		250	250	**250**	250	250	250
3			250	**250**	250	250	250
4				**250**	250	250	250
5					250	250	250
6						250	250
7							250
TOTAL	220	470	720	**970**	1,220	1,470	1,720

Mass Captured

Well	Iteration						
	1	2	3	**4**	5	6	7
1	88.2%	83.4%	51.4%	**32.4%**	29.0%	27.3%	24.6%
2		0.4%	0.4%	**0.4%**	0.4%	0.4%	0.4%
3			42.2%	**5.9%**	0.9%	0.5%	0.5%
4				**44.9%**	42.3%	32.9%	30.1%
5					20.7%	0.3%	0.5%
6						37.9%	43.7%
7							0.2%
TOTAL	88.2%	83.8%	94.0%	**83.6%**	93.3%	99.3%	99.9%

NE Extraction System Design and Evaluation



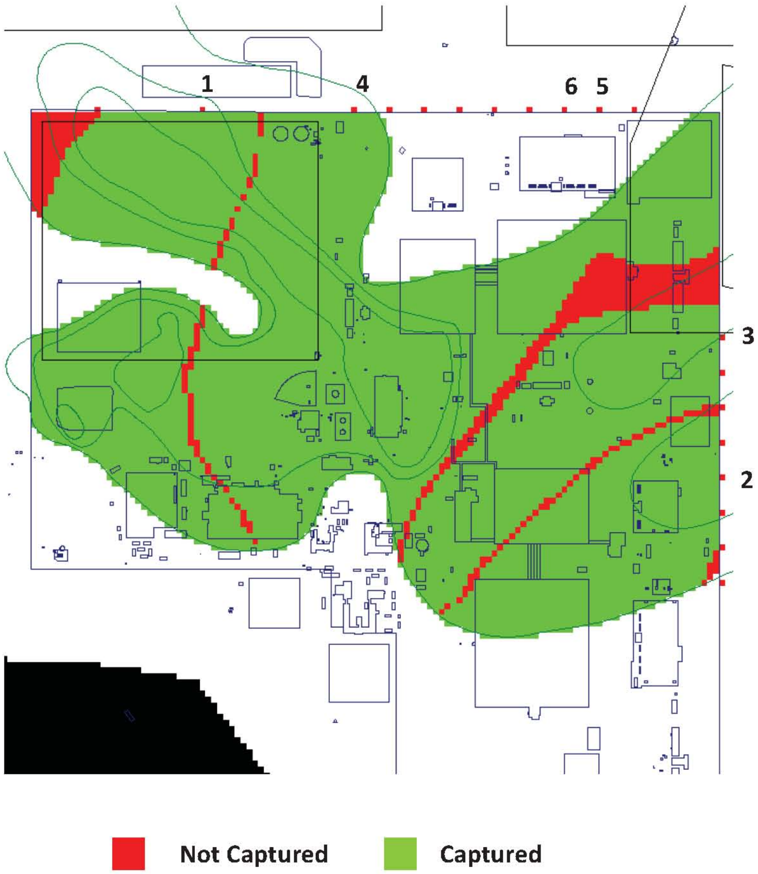
Pumping Rate, gpm

Well	Iteration 1	2	3	4	5	6	7
1	220	220	220	220	**220**	220	220
2		250	250	250	**250**	250	250
3			250	250	**250**	250	250
4				250	**250**	250	250
5					**250**	250	250
6						250	250
7							250
TOTAL	220	470	720	970	**1,220**	1,470	1,720

Mass Captured

Well	Iteration 1	2	3	4	5	6	7
1	88.2%	83.4%	51.4%	32.4%	**29.0%**	27.3%	24.6%
2		0.4%	0.4%	0.4%	**0.4%**	0.4%	0.4%
3			42.2%	5.9%	**0.9%**	0.5%	0.5%
4				44.9%	**42.3%**	32.9%	30.1%
5					**20.7%**	0.3%	0.5%
6						37.9%	43.7%
7							0.2%
TOTAL	88.2%	83.8%	94.0%	83.6%	**93.3%**	99.3%	99.9%

NE Extraction System Design and Evaluation



Pumping Rate, gpm

Well	Iteration 1	2	3	4	5	6	7
1	220	220	220	220	220	**220**	220
2		250	250	250	250	**250**	250
3			250	250	250	**250**	250
4				250	250	**250**	250
5					250	**250**	250
6						**250**	250
7							250
TOTAL	220	470	720	970	1,220	**1,470**	1,720

Mass Captured

Well	Iteration 1	2	3	4	5	6	7
1	88.2%	83.4%	51.4%	32.4%	29.0%	**27.3%**	24.6%
2		0.4%	0.4%	0.4%	0.4%	**0.4%**	0.4%
3			42.2%	5.9%	0.9%	**0.5%**	0.5%
4				44.9%	42.3%	**32.9%**	30.1%
5					20.7%	**0.3%**	0.5%
6						**37.9%**	43.7%
7							0.2%
TOTAL	88.2%	83.8%	94.0%	83.6%	93.3%	**99.3%**	99.9%

NE Extraction System Design and Evaluation

Pumping Rate, gpm

Well	Iteration 1	2	3	4	5	6	7
1	220	220	220	220	220	220	**220**
2		250	250	250	250	250	**250**
3			250	250	250	250	**250**
4				250	250	250	**250**
5					250	250	**250**
6						250	**250**
7							**250**
TOTAL	220	470	720	970	1,220	1,470	**1,720**

Mass Captured

Well	Iteration 1	2	3	4	5	6	7
1	88.2%	83.4%	51.4%	32.4%	29.0%	27.3%	**24.6%**
2		0.4%	0.4%	0.4%	0.4%	0.4%	**0.4%**
3			42.2%	5.9%	0.9%	0.5%	**0.5%**
4				44.9%	42.3%	32.9%	**30.1%**
5					20.7%	0.3%	**0.5%**
6						37.9%	**43.7%**
7							**0.2%**
TOTAL	88.2%	83.8%	94.0%	83.6%	93.3%	99.3%	**99.9%**

Summary NE Extraction Wells Along Fence Line

- Issues:
  - **Change NW Plume Trajectory**
  - Lots of Wells
  - High Extraction Rates
- Challenges:
  - How to keep from spreading dissolved contamination?

C400 Extraction Well Coupled with NE Extraction Wells Along Fence Line

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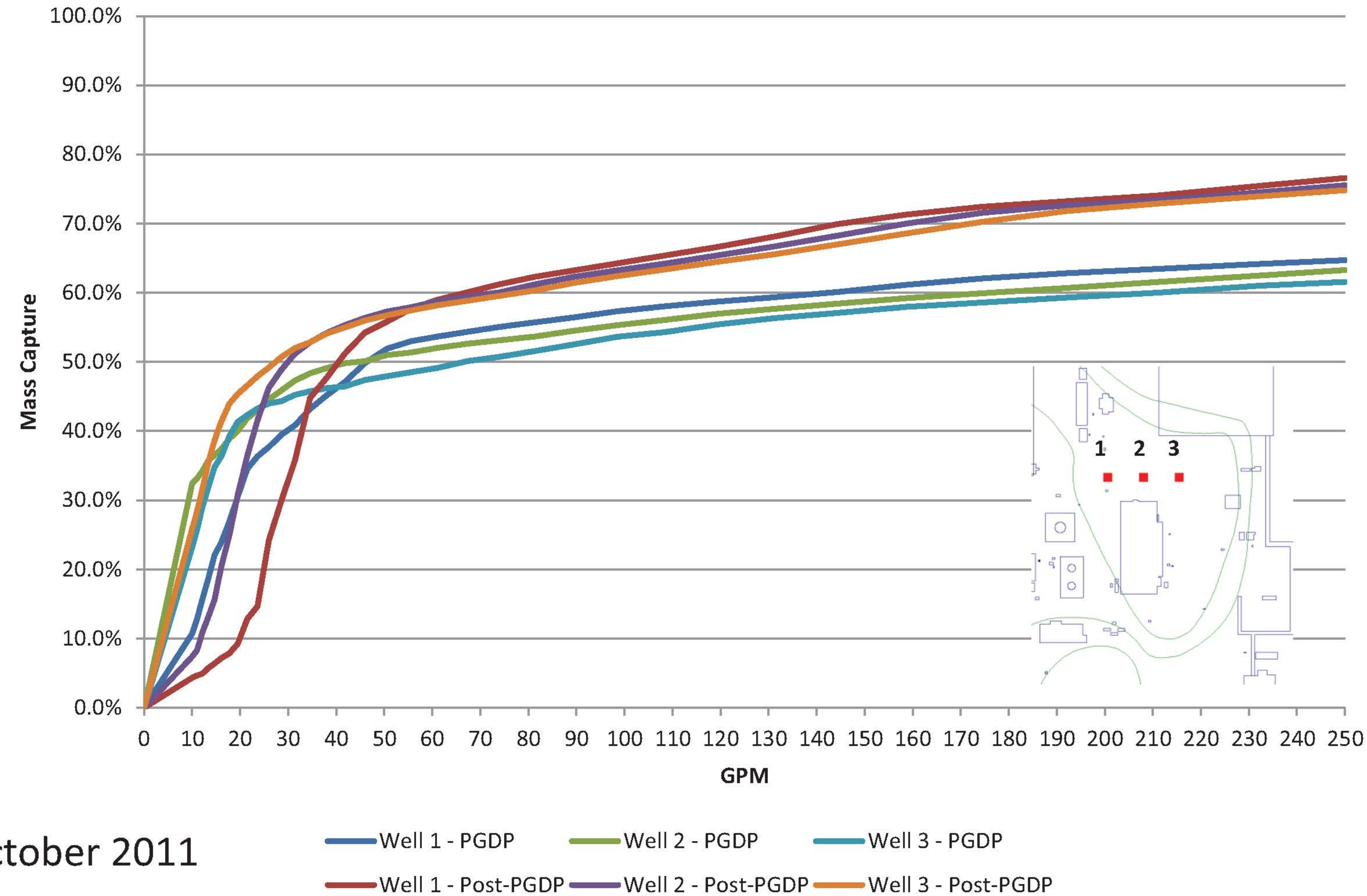
NE Extraction System Design and Evaluation

- Is an Extraction Well Located at C400 Capable of “Pinning” Contamination at That Location?
- In Other Words, Will Use of a C400 Extraction Well Halt Unintended Spreading of Dissolved Contamination?
- How Much Should the Extraction Well be Pumped And Where Should It be Located?

C400 Mass Capture Performance



October 2011

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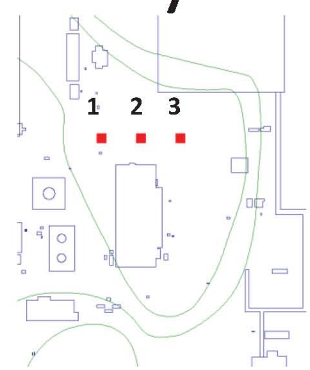
NE Extraction System Design and Evaluation

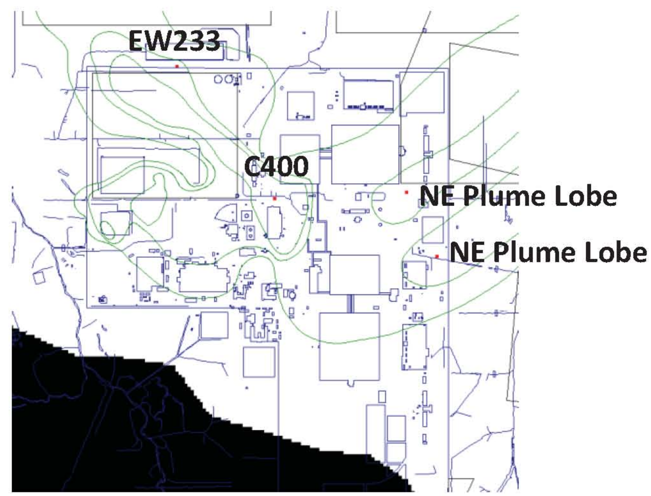
- After 60 gpm There isn't Much Difference in Mass Capture Performance Between the Three C400 Extraction Well Locations
- Evaluate Designs Which Have the C400 Extraction Well Operating at 80 gpm Because That is the Existing Treatment Capability



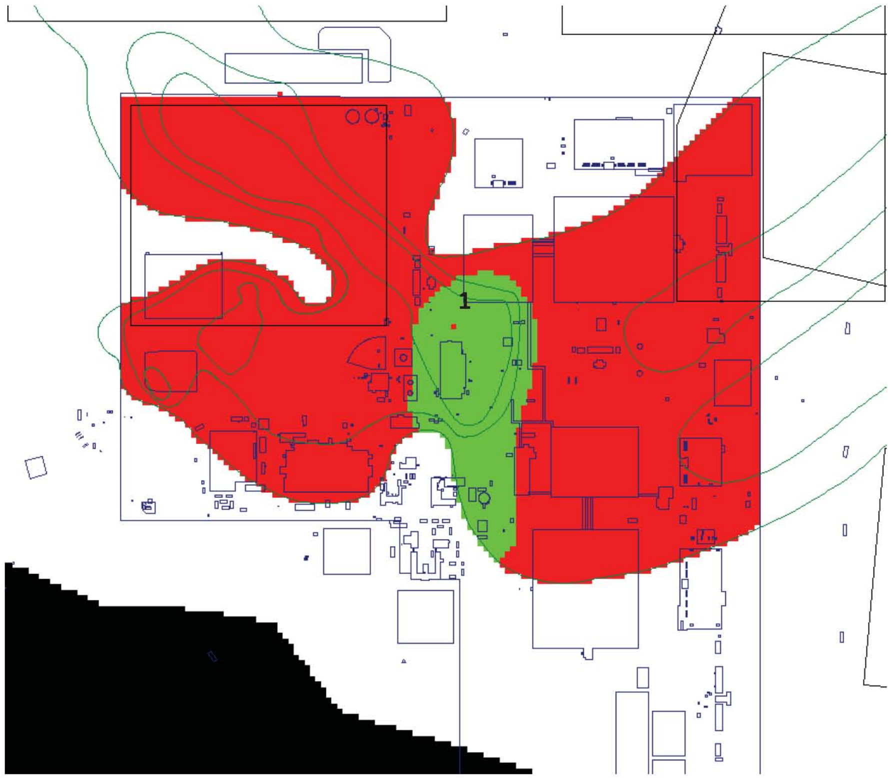
PGDP
Four Extraction Wells
EW233, C400 and 2 NE Extraction Wells at NE Plume Lobes

NE Extraction System Design and Evaluation

- Locate NE Plume Extraction Wells Immediately Down Gradient of the Higher Concentration Lobes
- Evaluate Mass Capture Performance for 50, 100, 150, 200 and 250 gpm/Well Rates



C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

October 2011 – Maximum Anthropogenic Recharge

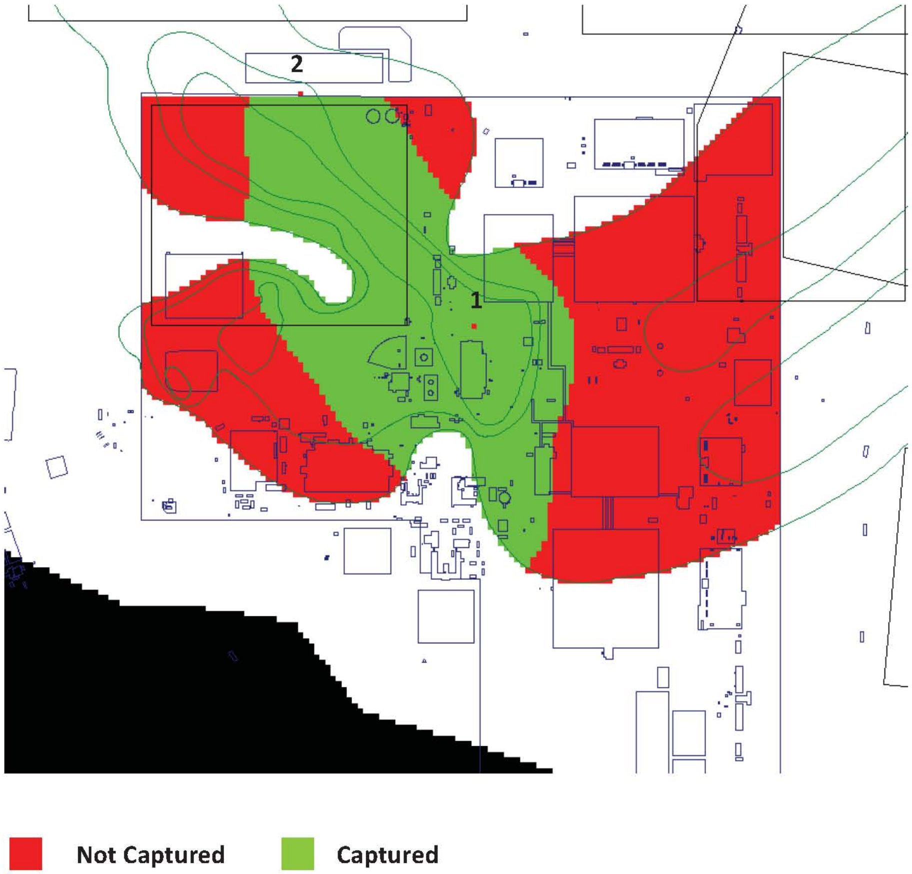
GPM

Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	80	80	80	80
2		220	220	220
3			50	50
4				50
Total	80	300	350	400
Mass Capture				
Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	53.58%	51.68%	51.90%	52.24%
2		37.82%	38.11%	38.67%
3			0.13%	0.13%
4				0.12%
Total	53.58%	89.50%	90.14%	91.17%

It is possible to pin C400 dissolved contamination

50 GPM

C400 Extraction Well Evaluation : PGDP



October 2011 – Maximum Anthropogenic Recharge

GPM

Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			50	50
4				50
Total	80	300	350	400

Mass Capture

Well	Iteration			
	1	2	3	4
1	53.58%	51.68%	51.90%	52.24%
2		37.82%	38.11%	38.67%
3			0.13%	0.13%
4				0.12%
Total	53.58%	89.50%	90.14%	91.17%

50 GPM

C400 Extraction Well Evaluation : PGDP

GPM

Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			50	50
4				50
Total	80	300	350	400

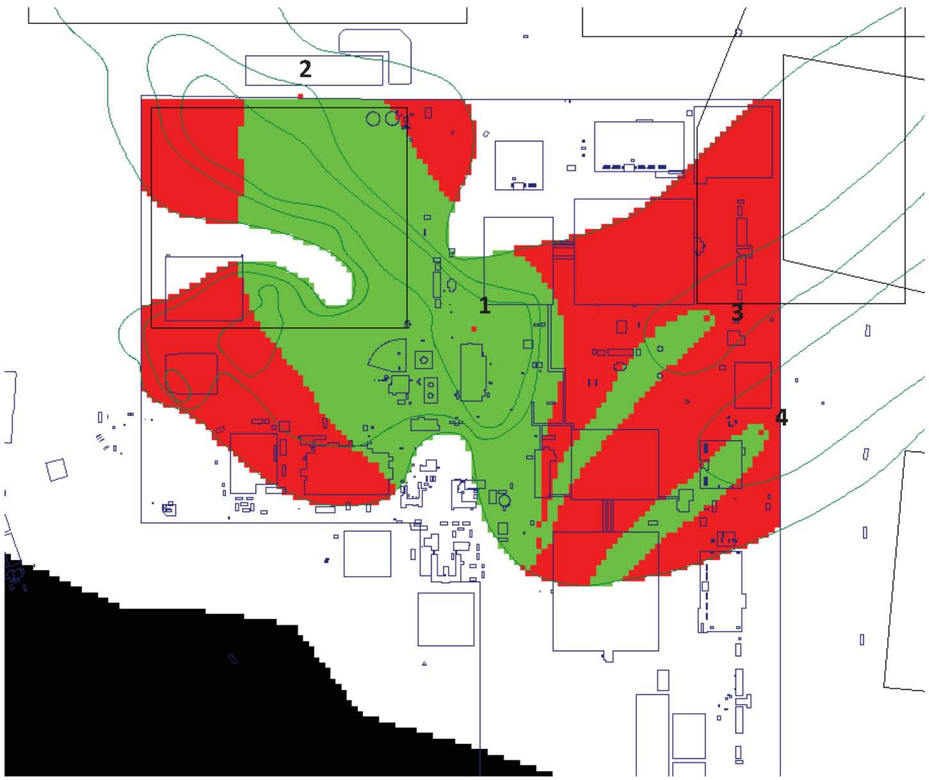
Mass Capture

Well	Iteration			
	1	2	3	4
1	53.58%	51.68%	51.90%	52.24%
2		37.82%	38.11%	38.67%
3			0.13%	0.13%
4				0.12%
Total	53.58%	89.50%	90.14%	91.17%

50 GPM

October 2011 – Maximum Anthropogenic Recharge

C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

October 2011 – Maximum Anthropogenic Recharge

GPM

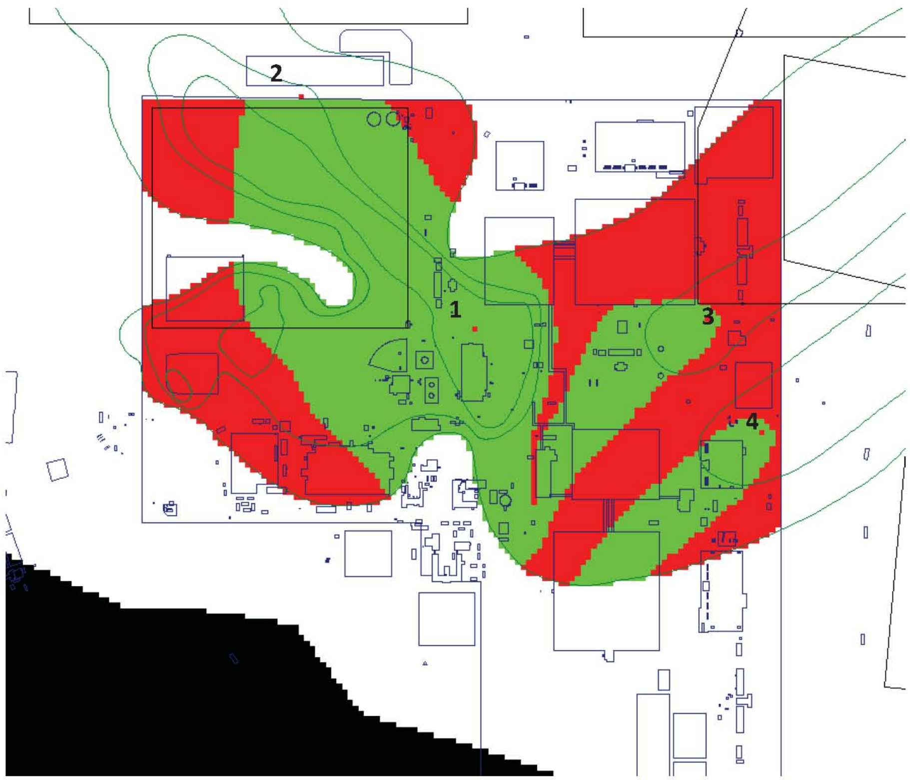
Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			50	50
4				50
Total	80	300	350	400

Mass Capture

Well	Iteration			
	1	2	3	4
1	53.58%	51.68%	51.90%	52.24%
2		37.82%	38.11%	38.67%
3			0.13%	0.13%
4				0.12%
Total	53.58%	89.50%	90.14%	91.17%

50 GPM

C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

October 2011 – Maximum Anthropogenic Recharge

GPM

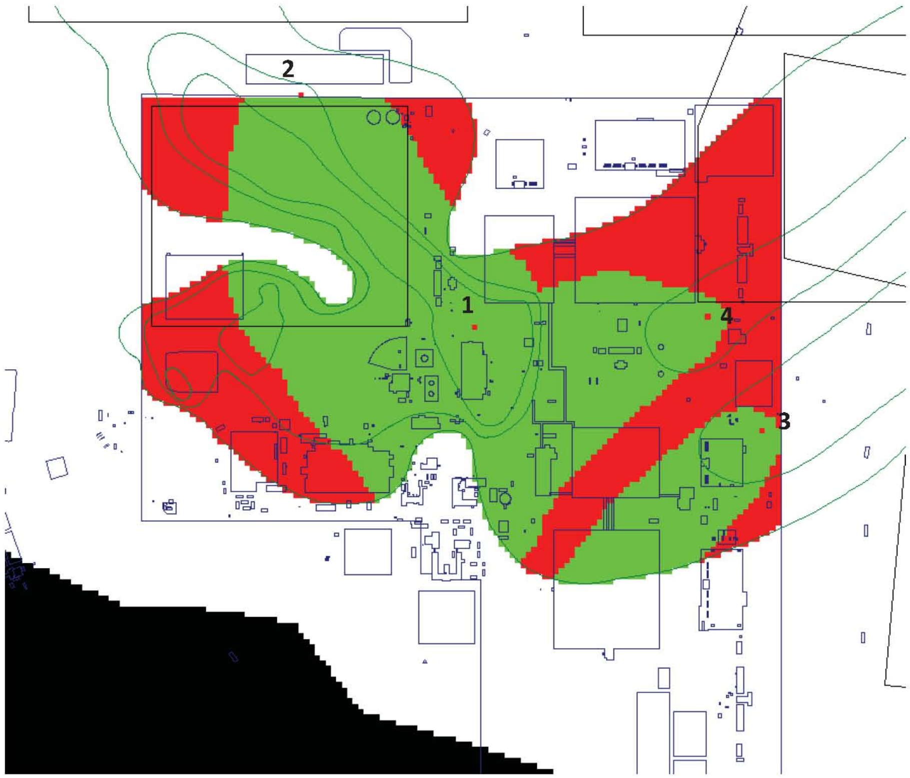
Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	80	80	80	80
2		220	220	220
3			100	100
4				100
Total	80	300	400	500

Mass Capture

Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	53.58%	51.68%	52.17%	53.18%
2		37.82%	38.80%	38.65%
3			0.23%	0.25%
4				0.22%
Total	53.58%	89.50%	91.20%	92.30%

100 GPM

C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

GPM

Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			150	150
4				150
Total	80	300	450	600

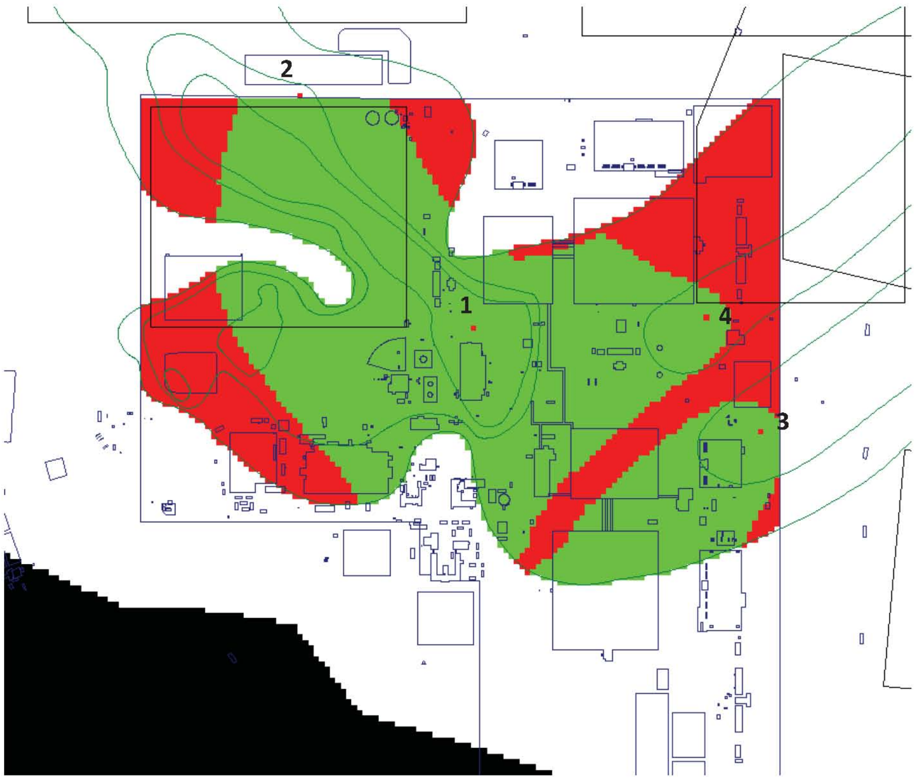
Mass Capture

Well	Iteration			
	1	2	3	4
1	53.58%	51.68%	52.83%	54.34%
2		37.82%	38.30%	38.67%
3			0.31%	0.31%
4				0.33%
Total	53.58%	89.50%	91.44%	93.65%

150 GPM

October 2011 – Maximum Anthropogenic Recharge

C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

October 2011 – Maximum Anthropogenic Recharge

GPM

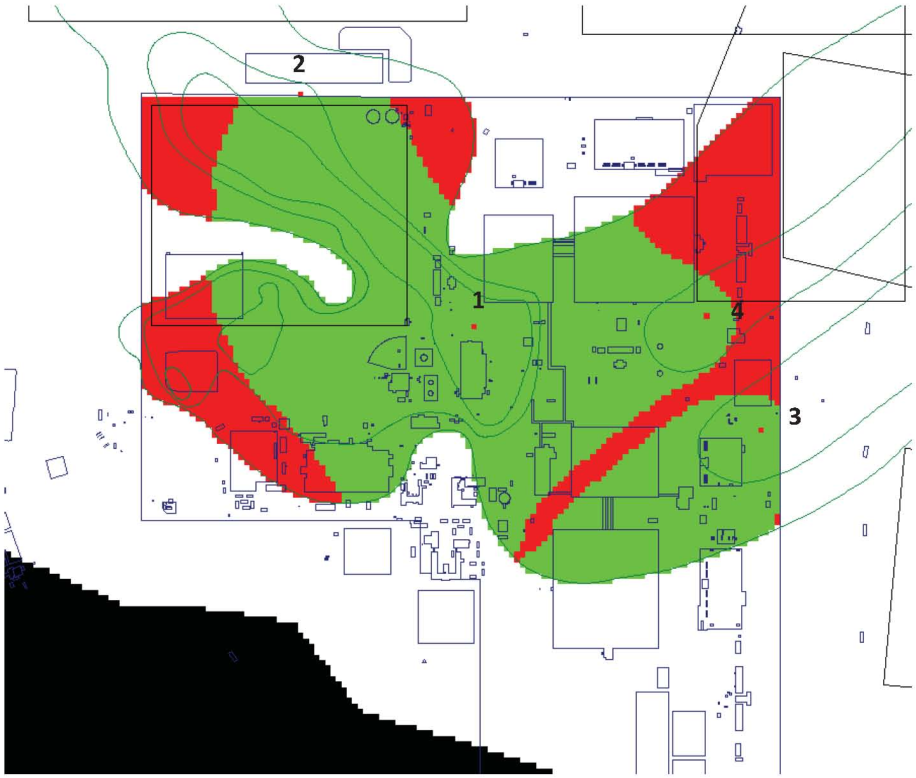
Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	80	80	80	80
2		220	220	220
3			200	200
4				200
Total	80	300	500	700

Mass Capture

Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	53.58%	51.68%	53.29%	55.91%
2		37.82%	38.51%	38.18%
3			0.36%	0.37%
4				0.52%
Total	53.58%	89.50%	92.16%	94.98%

200 GPM

C400 Extraction Well Evaluation : PGDP



Not Captured   Captured

October 2011 – Maximum Anthropogenic Recharge

GPM

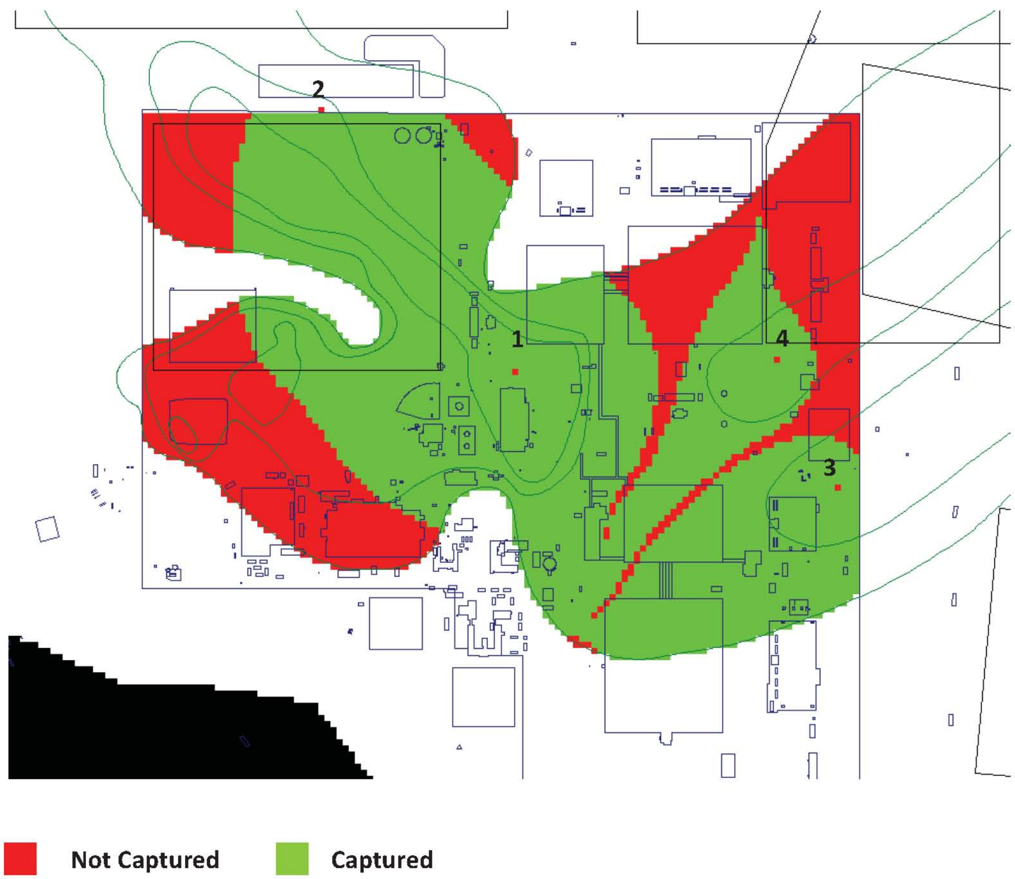
Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	80	80	80	80
2		220	220	220
3			250	250
4				250
Total	80	300	550	800

Mass Capture

Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	53.58%	51.68%	53.77%	57.34%
2		37.82%	38.48%	37.35%
3			0.40%	0.40%
4				1.09%
Total	53.58%	89.50%	92.65%	96.18%

250 GPM

C400 Extraction Well Evaluation : PGDP



1Q 2007 – Average Anthropogenic Recharge

GPM

Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			150	150
4				150
Total	80	300	450	600

Mass Capture

Well	Iteration			
	1	2	3	4
1	53.55%	51.65%	52.85%	54.81%
2		37.99%	38.83%	38.97%
3			0.41%	0.41%
4				0.42%
Total	53.55%	89.64%	92.08%	94.62%

150 GPM

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C400 Extraction Well Evaluation : PGDP

GPM

Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	80	80	80	80
2		220	220	220
3			150	150
4				150
Total	80	300	450	600

Mass Capture

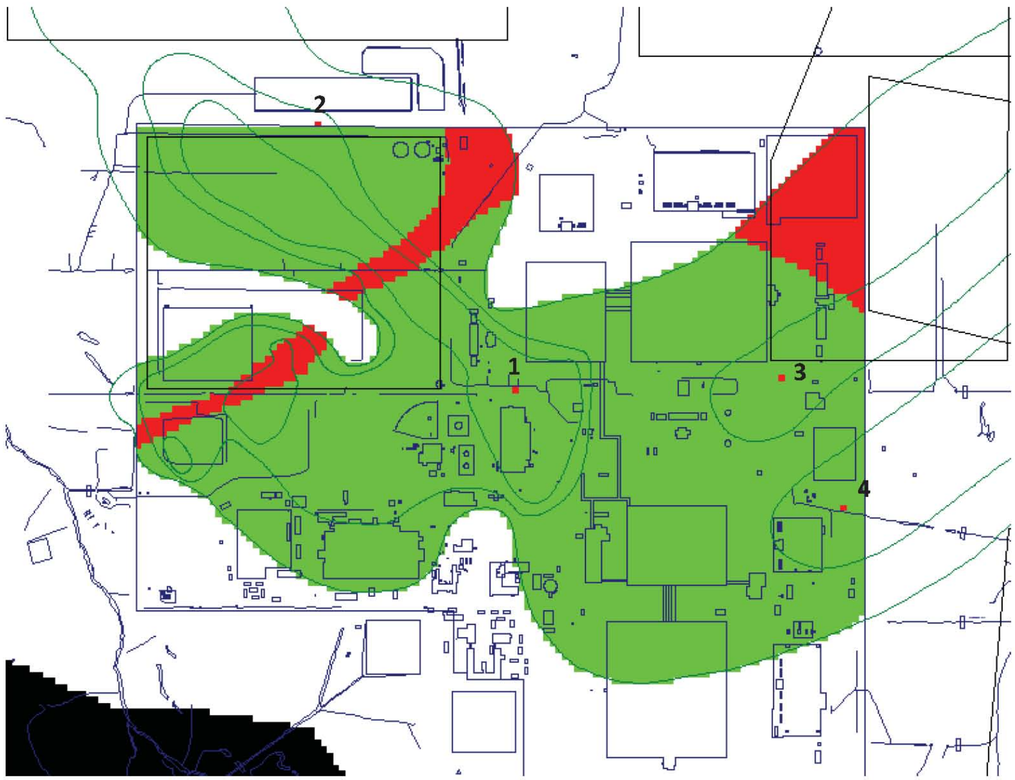
Well	Iteration 1	Iteration 2	Iteration 3	Iteration 4
1	56.02%	52.65%	54.31%	57.44%
2		43.95%	43.86%	41.46%
3			0.54%	0.45%
4				0.53%
Total	56.02%	96.60%	98.71%	99.89%

Not Captured **Captured**

150 GPM

April 2012 – Minimum Anthropogenic Recharge Conditions

C400 Extraction Well Evaluation : PGDP



GPM

Well	Iteration			
	1	2	3	4
1	80	80	80	80
2		220	220	220
3			150	150
4				150
Total	80	300	450	600

Mass Capture

Well	Iteration			
	1	2	3	4
1	62.89%	57.94%	60.59%	62.02%
2		36.30%	31.68%	27.07%
3			0.84%	7.03%
4				0.42%
Total	62.89%	94.25%	93.11%	96.54%

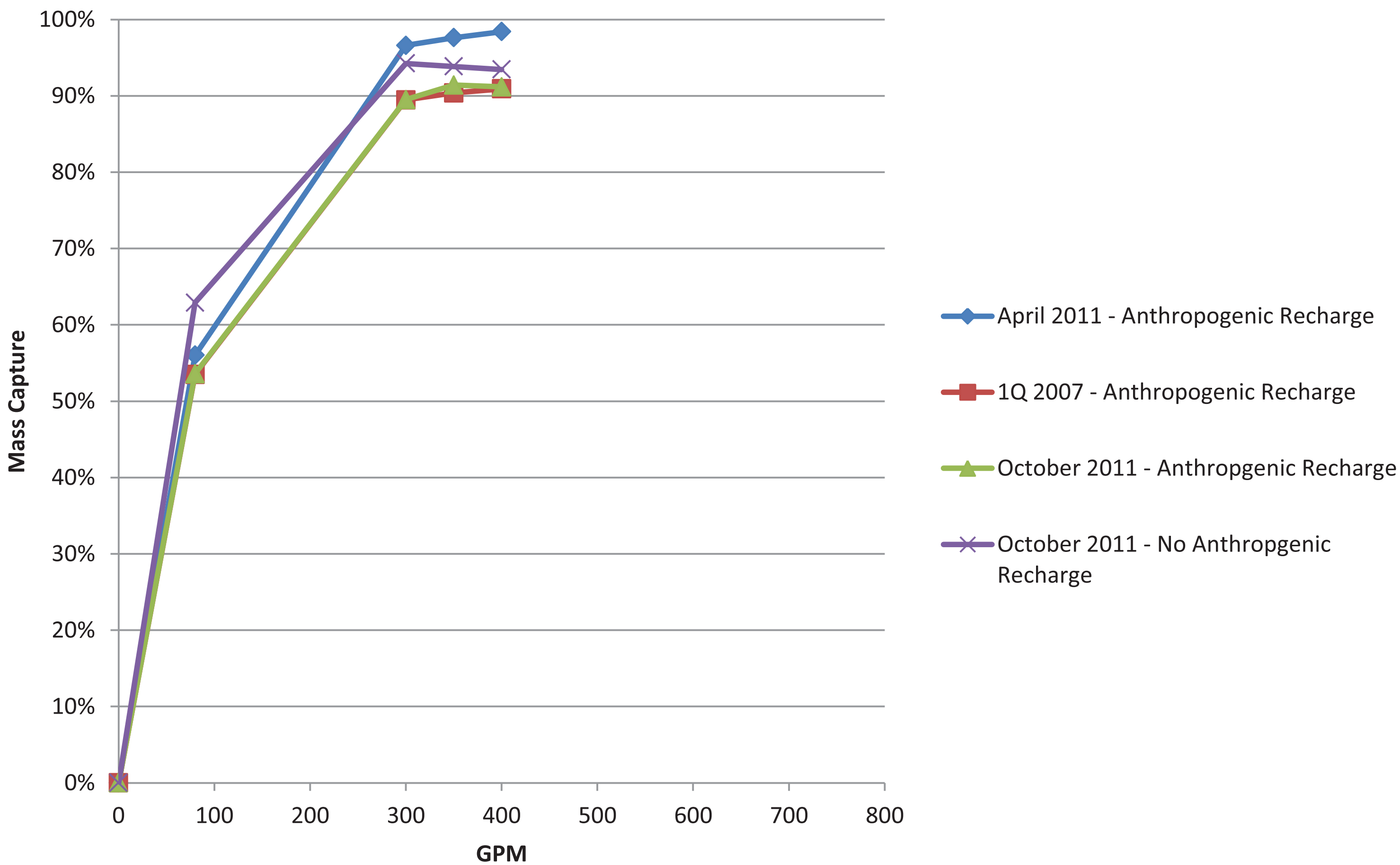
Not Captured **Captured**

150 GPM

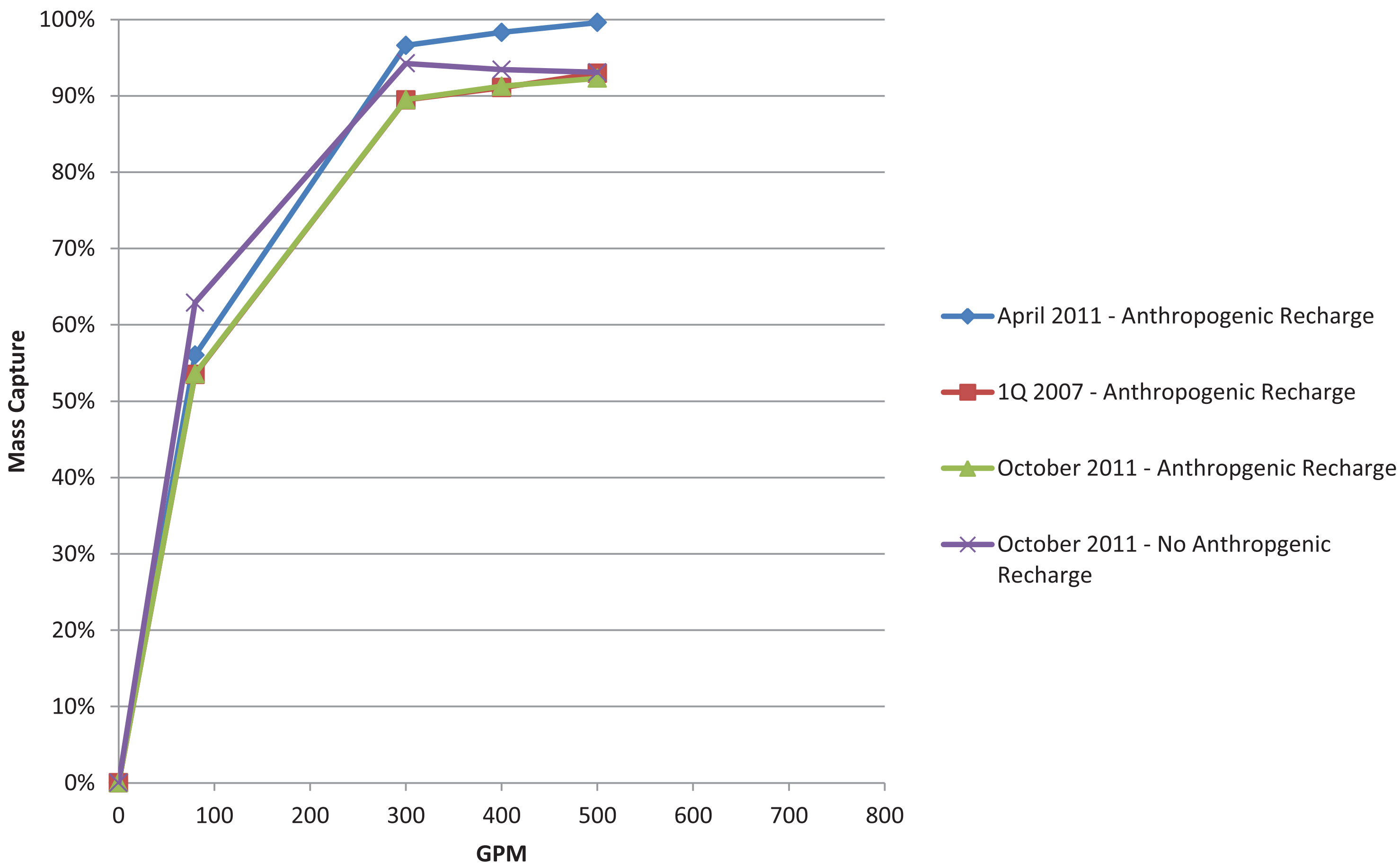
October 2012 – No Anthropogenic Recharge

Graphical Summary

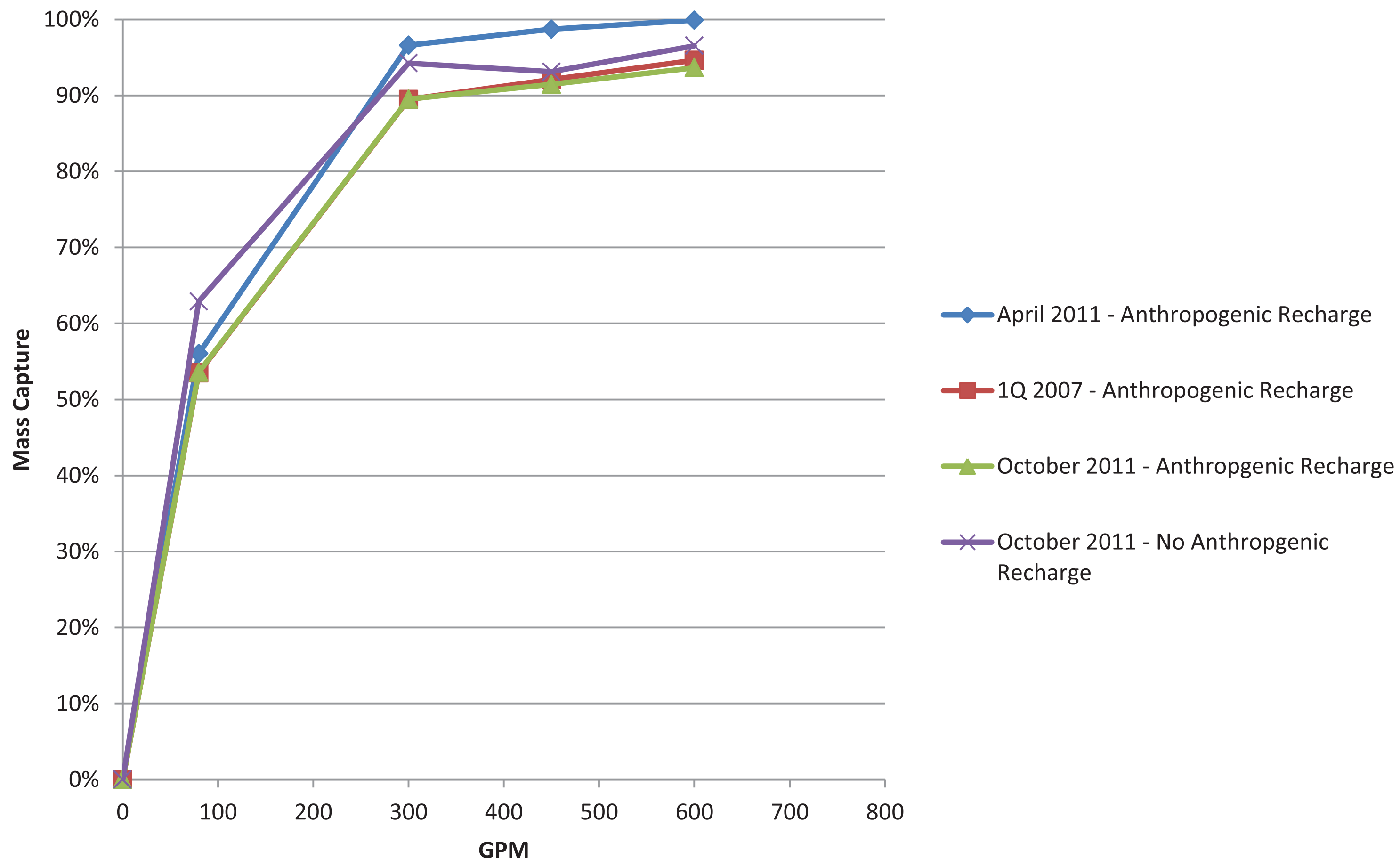
NE Lobe Extraction Wells – 50 gpm/each



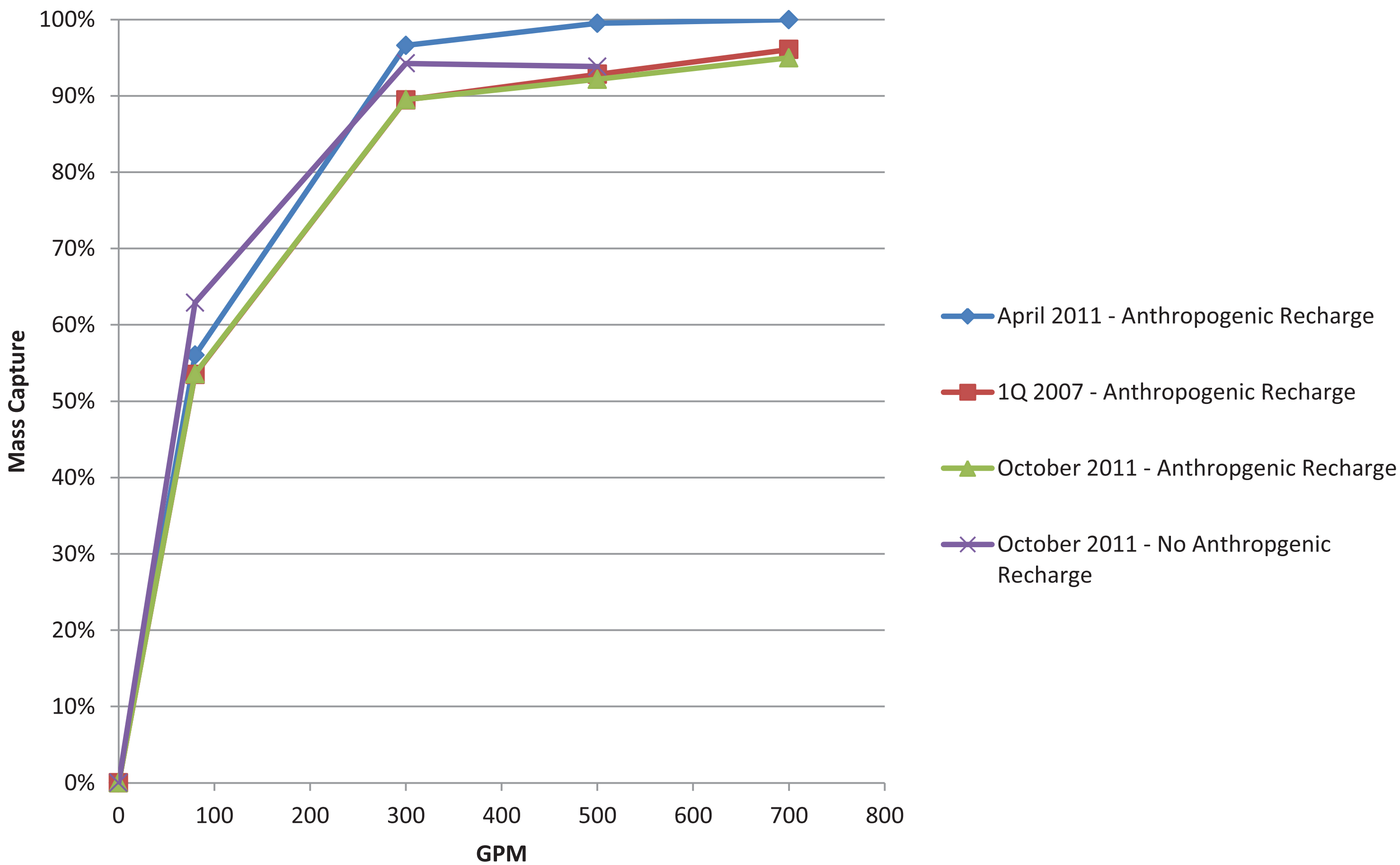
NE Lobe Extraction Wells – 100 gpm/each



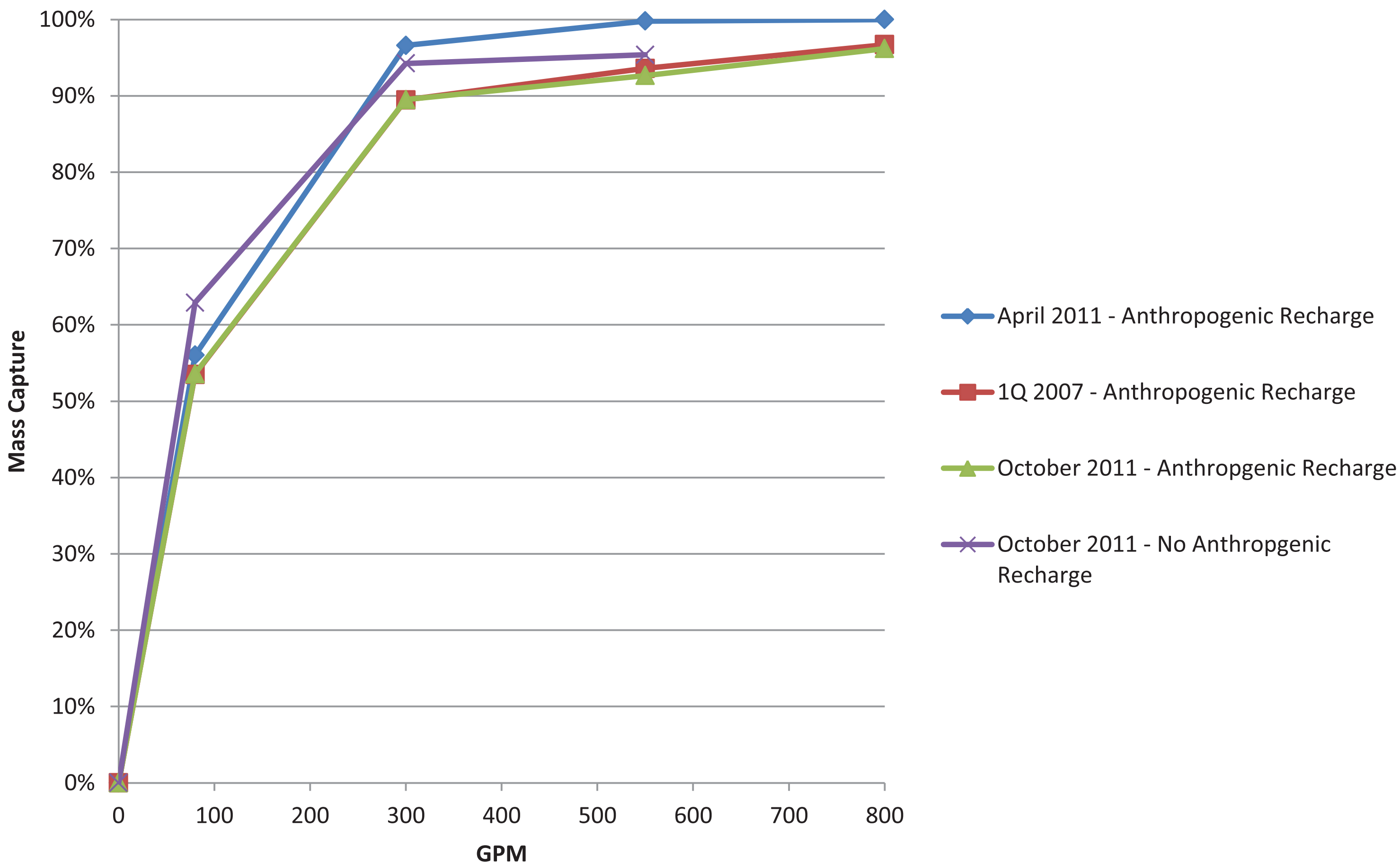
NE Lobe Extraction Wells – 150 gpm/each



NE Lobe Extraction Wells – 200 gpm/each



NE Lobe Extraction Wells – 250 gpm/each



Performance Comparison Tables

50 GPM/Lobe Well	April 2011	1Q 2007	Oct 2011	No Anthropogenic Rechage
0	0.00%	0.00%	0.00%	0.00%
80	56.02%	53.50%	53.58%	62.89%
300	96.60%	89.47%	89.50%	94.25%
350	97.61%	90.38%	91.40%	93.85%
400	98.41%	90.92%	91.17%	93.44%

200 GPM/Lobe Well	April 2011	1Q 2007	Oct 2011	No Anthropogenic Recharge
0	0.00%	0.00%	0.00%	0.00%
80	56.02%	53.50%	53.58%	62.89%
300	96.60%	89.47%	89.50%	94.25%
500	99.49%	92.82%	92.16%	93.82%
700	99.98%	96.06%	94.98%	

100 GPM/Lobe Well	April 2011	1Q 2007	Oct 2011	No Anthropogenic Recharge
0	0.00%	0.00%	0.00%	0.00%
80	56.02%	53.50%	53.58%	62.89%
300	96.60%	89.47%	89.50%	94.25%
400	98.30%	91.07%	91.25%	93.42%
500	99.59%	92.96%	92.30%	93.08%

250 GPM/Lobe Well	April 2011	1Q 2007	Oct 2011	No Anthropogenic Recharge
0	0.00%	0.00%	0.00%	0.00%
80	56.02%	53.50%	53.58%	62.89%
300	96.60%	89.47%	89.50%	94.25%
550	99.79%	93.58%	92.65%	95.38%
800	99.99%	96.70%	96.18%	

150 GPM/Lobe Well	April 2011	1Q 2007	Oct 2011	No Anthropogenic Recharge
0	0.00%	0.00%	0.00%	0.00%
80	56.02%	53.50%	53.58%	62.89%
300	96.60%	89.47%	89.50%	94.25%
450	98.71%	92.08%	91.44%	93.11%
600	99.89%	94.62%	93.65%	96.54%

Summary

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Satisfying Design Constraints

- Minimize trajectory impacts at C400 (YES)
- Complement NW Extraction Well capture zones (YES)
- Avoid potential CERCLA Cell locations (YES)
- Manage anthropogenic recharge variability (YES)
- Design for both anthropogenic and no anthropogenic recharge conditions to the extent possible (PGDP vs Post-PGDP) (YES)

Proposed Design

- EW 232 or EW233 Pumping at 220 gpm
  - Further evaluation planned
- C400 Extraction Well Pumping at 80 gpm
- Two NE Plume Higher Concentration Lobe Wells Pumping at 150 gpm/well
- Cumulative Extraction Rate is 600 gpm
- System performance monitoring, both water-levels and concentrations