Department of Energy

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FEB 12 2020

Ms. Myrna Redfield, Program Manager
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5511 Hobbs Road
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PPPO-02-10002620-20B

Dear Ms. Redfield:

DE-EM0004895: RESPONSE TO SUBMITTAL OF FINAL PROJECT MANAGEMENT PLAN FOR GROUNDWATER STRATEGY

Reference: Letter from M. Redfield to M. Fultz, "Four Rivers Nuclear Partnership, LLC—Transmittal of the Final Project Management Plan for Groundwater Strategy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, FRNP-RPT-0094," (FRNP-20-3446), dated January 30, 2020

The U.S. Department of Energy reviewed the referenced document and has no further comments. If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Jennifer Woodard

Jennifer Woodard
Contracting Officer's Representative
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The Contracting Officer's Representative is not authorized to change the scope, price, time required for contract performance, terms or conditions of the contract. If you believe that a change has been directed as a result of this letter, then in accordance with contract clause DEAR 952.242-70 "Technical Direction," you are directed to contact the Contracting Officer, in writing, within five working days after receipt of this letter and prior to taking any action as a result of this letter.

FRNP-RPT-0094

Project Management Plan for Groundwater Strategy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

This document is approved for public release per review by:

David Hayden
FRNP Classification Support

1-27-2020
Date

FRNP-RPT-0094

Project Management Plan for Groundwater Strategy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—January 2020

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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TABLES

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FIGURES

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
D&R	deactivation and remediation
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
EI	environmental indicator
EMP	Environmental Monitoring Plan
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ES	environmental services
EW	extraction well
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
GPS	global positioning system
GWOU	Groundwater Operable Unit
GWSP	Groundwater Strategy Project
IRA	interim remedial action
ISMS	Integrated Safety Management System
KAR	*Kentucky Administrative Regulation*
LUC	land use control
MW	monitoring well
MWG	modeling working group
N/A	not applicable
NE	northeast
NEPCS	Northeast Plume Containment System
NW	northwest
NWPGS	Northwest Plume Groundwater System
PGDP	Paducah Gaseous Diffusion Plant
PM	project manager
PMP	project management plan
PZ	piezometer
QA	quality assurance
QAPP	quality assurance project plan
RDSI	Remedial Design Support Investigation
RGA	Regional Gravel Aquifer
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SW	southwest
SWMU	solid waste management unit
TVA	Tennessee Valley Authority

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EXECUTIVE SUMMARY

This Project Management Plan (PMP) defines the plans, organization, responsibilities, and systems for managing the Paducah Site Groundwater Strategy Project (GWSP) at the U.S. Department of Energy Paducah Site, which includes the former Paducah Gaseous Diffusion Plant. The activities included in this PMP will be performed consistent with the Environmental Monitoring Plan (EMP) and the EMP Quality Assurance Project Plan, which typically are updated annually. The GWSP also interfaces with a number of projects currently ongoing at the Paducah Site, including the Water Policy Evaluation, Pump-and-Treat Operations for the Northeast Plume Containment System and the Northwest Plume Groundwater System, and the Groundwater Modeling Working Group.

The focus of this PMP is activities planned for near-term implementation (i.e., approximately the next 18 months) based on the overlapping scopes and overall sequence of work. Other activities may be added to this PMP, or a separate PMP may be developed as planning for other activities is initiated.

This PMP is a living, field-level plan documenting agreements, roles and responsibilities, and management processes used in the execution of the GWSP. This PMP may be updated, as appropriate, to facilitate management of the project (e.g., scope refinement or revision, changes to roles and responsibilities, etc.).

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1. INTRODUCTION

Four Rivers Nuclear Partnership, LLC, (FRNP) is the prime contractor to the U.S. Department of Energy (DOE) to achieve the current site goals for deactivation and remediation (D&R) of the Paducah Gaseous Diffusion Plant (PGDP) facilities at the Paducah Site and prepare the facilities for surveillance and maintenance. The extent and nature of support provided by FRNP to DOE at the Paducah Site, as well as the terms and conditions under which FRNP provides support, are defined in the D&R Project Contract DE-EM0004895.

This Project Management Plan (PMP) defines the plans, organization, responsibilities, and systems for managing the Paducah Site Groundwater Strategy Project (GWSP) at the Paducah Site. The PMP is a living, field-level plan documenting agreements, roles and responsibilities, and management processes used in the execution of the project. This PMP will be updated, as appropriate, to facilitate management of the project (e.g., scope refinement or revision, changes to roles and responsibilities, etc.).

This PMP is organized as follows.

- Section 2 includes the project objectives.
- Section 3 describes prior actions.
- Section 4 describes the project scope and end points for each activity.
- Section 5 includes the project organization and communications.
- Section 6 discusses quality assurance (QA).
- Section 7 covers health and safety.
- Section 8 includes a project schedule.
- Section 9 details the project risks.
- Section 10 includes references.

The activities included in this PMP will be performed consistent with the Environmental Monitoring Plan (EMP) and the EMP Quality Assurance Project Plan (QAPP), which typically are updated annually. FRNP procedures, manufacturer's recommendations, other appropriate guidance, and sound engineering principles, as applicable and relevant to the scope of work, also will be followed.

The GWSP also interfaces with a number of projects currently ongoing at the Paducah Site, including the Water Policy Evaluation, Pump-and-Treat Operations for the Northeast Plume Containment System (NEPCS) and the Northwest Plume Groundwater System (NWPGS), and the Groundwater Modeling Working Group (MWG).

2. PROJECT OBJECTIVES

The Sitewide Groundwater Strategy Project is being performed proactively and programmatically by DOE to provide more information to refine the conceptual site model (CSM) in preparation for the final remedy for the Groundwater Operable Unit (GWOU) Dissolved-Phase Plumes, to provide additional data to support changing the status of the Environmental Indicators (EIs) to "Yes," and to address recommended maintenance and updates from the groundwater MWG meetings.

U.S. Environmental Protection Agency (EPA) and Kentucky EIs are used to measure performance and to communicate progress made in protecting human health and the environment, and sites are designated as

Insufficient Data, Under Control, or Not Under Control. The EIs for the Paducah Site are summarized in Table 1. A key goal of the GWSP is to determine what information is needed or what additional information is to be collected to change the status of the first two EIs for the Paducah Site to a "Yes." The other two other EIs, Construction Complete and Sitewide Ready for Anticipated Use, currently are not applicable for the Paducah Site.

Table 1. Paducah Site EIs

EI	EPA Status[a]	Kentucky Status[b]
Human Exposure Under Control	Insufficient Data	Yes
Groundwater Migration Under Control	No	No[c]
Construction Complete	No	No
Sitewide Ready for Anticipated Use	No	No

[a] PGDP EIs [from EPA Site Profile—Paducah Gaseous Diffusion Plant (USDOE), Paducah, KY, https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Healthenv&id=0404794].
[b] November 2009 Kentucky Division of Waste Management EI Update—2008
[c] Based on Kentucky's determination that the migration of trichloroethene (TCE)-contaminated groundwater on the west side of the Northeast (NE) Plume is not stabilized (Kentucky's EI Determination 2008).

Other project goals include the following:

- Prevent exposure to groundwater, prevent or minimize plume migration, and prevent/minimize further migration from sources;

- Resolve data needs in various portions of the dissolved-phase TCE NE, Northwest (NW), and Southwest (SW) Plumes; and

- Provide inputs to maintenance and updates to the groundwater model.

The GWSP is integrated with the strategy for the GWOU, as described in the *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Annual Revision—FY 2018 and FY 2019*, DOE/LX/07-2418&D2/R2, U.S. Department of Energy, Paducah, KY, August (DOE 2018). The GWOU is being implemented in a phased approach to accomplish the following goals.

1. Prevent human exposure to contaminated groundwater;
2. Prevent or minimize further migration of contaminant plumes;
3. Prevent, reduce, or control contaminant sources contributing to groundwater contamination; and
4. Restore the groundwater to its beneficial uses wherever practicable.

The overall sequencing of response actions to accomplish these goals is shown in Figure 1.

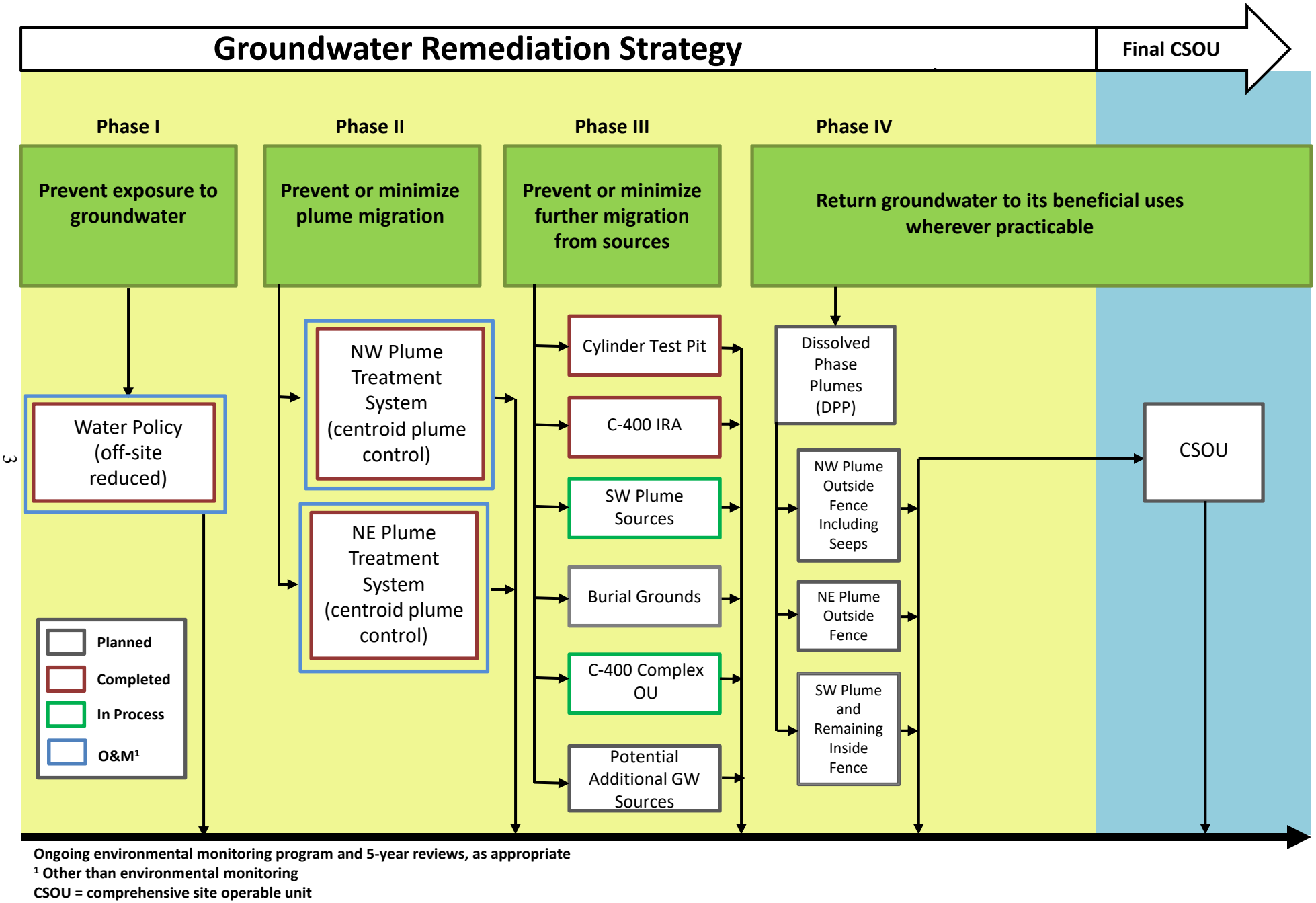

Figure 1. Groundwater Remediation Strategy

3. PRIOR ACTIONS

3.1 PADUCAH SITE PHASED APPROACH TO GROUNDWATER OPERABLE UNIT DISSOLVED-PHASE PLUMES

A phased approach to the groundwater remediation is being employed at the Paducah Site. This phased approach is consistent with EPA guidance (see Figure 1) and includes the following:

1. Performed emergency and interim remedial actions (IRAs) to provide water to local residences with private wells contaminated with trichloroethene (TCE) and Tc-99 and to conduct hydraulic containment and treatment of high concentrations of off-site TCE contamination;

2. Completed, in progress, and planned remediation of areas contributing to groundwater contamination (i.e., source areas);

3. Current and planned focused data collection to further define the GWOU Dissolved-Phase Plumes CSM, also referred to as the Sitewide GWSP; and

4. Remediation of future GWOU Dissolved-Phase Plumes.

These phases are illustrated, as shown in Figure 1, where Phase a corresponds to Phase 1 in Figure 1, Phase b corresponds to Phase II, Phase c overlaps with Phases III and IV, and Phase d corresponds to Phase IV.

3.2 EMERGENCY AND INTERIM REMEDIAL ACTIONS

Interim and immediate actions to control groundwater TCE and Tc-99 migration have been performed as described below. These actions are documented in the Site Management Plan (DOE 2018).

- Local Residences (the Water Policy Box):

  — An emergency removal action provided temporary water to local residences where private wells were contaminated by TCE and Tc-99.

  — A 1994 removal action extended municipal water line to residences affected by off-site groundwater contamination. DOE has provided license agreements to these residences and continues to pay for municipal water for these residences.

  — Additional actions for vapor intrusion (the Water Policy Screening Study) were performed in 2015 as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 2013 Five-Year Review (DOE 2016).

- NW Plume:

  — An IRA was implemented to provide hydraulic containment and treatment of high concentrations of off-site TCE contamination in the NW Plume. The Record of Decision (ROD) for this action was signed in 1993, and construction for the remedial action was completed in 1995. The NWPGS has been operational since this time.

— An optimization of the NWPGS was performed in 2011 through placing existing southern extraction wells (EWs) on standby and installing two new EWs east of the original southern extraction field.

- NE Plume:

  — An IRA was implemented to provide hydraulic containment and treatment of high concentrations of off-site TCE contamination in the NE Plume. The ROD for this action was signed in 1995, and construction for the remedial action was completed in 1996. The NEPCS has been operational since this time.

  — An optimization of the NEPCS was performed from 2011 through 2017 by placing existing EWs on standby, installing two new EWs in the upgradient high concentration area of the NE Plume near the eastern edge of the PGDP facility, and installing new treatment units for air stripping as an alternative to the cooling towers. The system became fully operational in 2017.

3.2.1 Source Area Remediation

- Solid Waste Management Unit (SWMU) 91:

  — An IRA was implemented for the *in situ* treatment of TCE-contaminated soils using the LASAGNA™ technology. The ROD for this action was signed in 1998, and the remedial action was completed in 2001.

- C-400 Cleaning Building Remedial Investigation/Feasibility Study (RI/FS):

  — An IRA was implemented for the *in situ* treatment of TCE-source areas in the UCRS and Regional Gravel Aquifer (RGA) located in the southeast and southwest corners of the C-400 Cleaning Building, using electrical-resistance heating technology. Field operations for Phase I were completed in 2011. Phase IIa operations began in 2013 and ceased in 2014. A treatability study for steam-enhanced extraction was conducted and completed in 2015. The Treatability Study Report was approved in 2016.

  — Additional actions for vapor intrusion (the C-400 Cleaning Building Vapor Intrusion Study) were performed in 2018 as part of the CERCLA 2013 Five-Year Review.

  — The C-400 Cleaning Building is the subject of an ongoing RI/FS. The RI/FS work plan was completed and approved in 2019, with field investigation starting in November 2019.

- SW Plume Sources:

  — SWMU 1—The remedial action for SWMU 1 consisted of *in situ* source treatment using deep soil mixing with interim land use controls (LUCs). The ROD for this action was signed in 2012 and the action was completed in 2015.

  — SWMU 211-A—The Remedial Action for SWMU 211-A is *in situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon remedial design support investigation (RDSI) results. The final characterization report addendum and letter notification proposing remedy for 211-A and 211-B have been evaluated by the Federal Facility Agreement (FFA) parties. The FFA parties have agreed to move forward with a bioremediation remedy at 211-A.

— SWMU 211-B—The Remedial Action for SWMU 211-B is *in situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon RDSI results. The final characterization report addendum and letter notification proposing remedy for 211-A and 211-B were evaluated by the FFA parties. The FFA parties have agreed to determine an appropriate remedial action for 211-B based on a revised CSM consistent with the data in the final characterization report.

4. PROJECT SCOPE

During the prior contracts and continuing under the D&R Contract, several data needs or inputs related to the sitewide groundwater CSM have been identified. These data needs have been grouped into three categories: Human Exposure Under Control Data Needs, Groundwater Migration Under Control Data Needs, and Groundwater MWG recommendations. In many cases, activities to address these data needs are overlapping, and efforts have been made to combine and collect information for multiple activities concurrently and efficiently, as possible.

4.1 REGULATORY FRAMEWORK

The Paducah Site, including PGDP, is located within the Jackson Purchase region of western Kentucky. PGDP is a former uranium enrichment facility that is owned by DOE. PGDP initially was owned and managed by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors.

PGDP (CERCLIS# KY8-890-008-982) was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of the CERCLA, DOE entered into an FFA with EPA and the Kentucky Department for Environmental Protection on February 13, 1998 (EPA 1998). The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with the Resource Conservation and Recovery Act and CERCLA, including stakeholder involvement.

The GWSP has overlap and interface with several ongoing projects at the Paducah Site, including the Water Policy Evaluation; Pump-and-Treat Operations, which include the NEPCS and NWPGS; and the Groundwater MWG. Each of these projects is described briefly below, and information on project integration/communication is included in Section 5.

4.1.1 Water Policy Evaluation

In areas where the groundwater either is known to be contaminated or has the potential to become contaminated in the future, DOE has provided water hookups to the West McCracken County Water District and pays water bills for affected residences and businesses as part of the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1994a). Residential wells have been capped and locked, including those that are used by DOE for monitoring (per license agreement between DOE and each resident, renewed every five years). The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the sampling and analysis plan addendum, which subsequently was superseded by the EMP. Groundwater monitoring frequencies and parameters are detailed in the EMP.

As part of its contract, FRNP is in the process of evaluating the footprint of the Water Policy area. Groundwater levels or analytical samples collected as part of the water policy evaluation may be used to

satisfy one or more data needs defined in the Activities or the data obtained as part of the GWSP may be used as inputs to the Water Policy Evaluation. Activities 1 and 2 in this PMP most directly overlap with the Water Policy Evaluation.

4.1.2 Pump-and-Treat Operations

The NWPGS includes two EWs, EW232 and EW233, located east of the original southern extraction field, with a combined extraction rate of 220 gal per minute.

Two new EWs (EW234 and EW235), 14 monitoring wells (MWs), and 8 piezometers (PZs) were installed as part of optimization of Pump-and-Treat Operations for the NEPCS from July 2016 through August 2017. Included in this system of 14 MWs with single screens were 7 new RGA MWs in a north-south transect located approximately 600 ft east of the C-400 Cleaning Building. As part of the optimization, groundwater levels and samples are being collected, as defined in the EMP; these groundwater levels may be used as inputs to one or more activities in the GWSP or may be used to satisfy one or more data needs defined in the activities.

Activities 2, 8, 14, and 15 in this PMP most directly overlap with the NEPCS optimization project.

4.1.3 Groundwater MWG

The Groundwater MWG is made up of representatives from DOE; the D&R Contractor, FRNP; EPA; Kentucky; and Kentucky Research Consortium for Energy and the Environment. The primary responsibility of the Groundwater MWG is to develop and maintain the sitewide groundwater model for PGDP. Data collected as part of the GWSP will be provided to the Groundwater MWG, as appropriate, for evaluation for inclusion in the sitewide groundwater model.

Activities 13, 14, and 15 in this PMP overlap most directly with the Groundwater MWG.

4.1.4 Other Projects

Data collected as part of other projects that are relevant to the GWSP and this PMP (e.g., implementation of the EMP, the C-400 Cleaning Building RI, sitewide vapor intrusion project, etc.) will be considered as part of the data assessment process. As part of evaluating all data inputs, FRNP will consider the results of the expected independent evaluation of the Paducah Site monitoring well network and contaminant trends conducted by EarthCon.

4.2 HUMAN EXPOSURE UNDER CONTROL DATA NEEDS

The discrete areas associated with the Human Exposure Under Control Data Needs are shown in Figure 2. The two areas outlined in green are related to the nature and extent of dissolved-phase TCE contamination associated with the west side of the Water Policy area (Activity 1) and the east side of the Water Policy area (Activity 2). The data needs also consider potential impacts to Ohio River and the McNairy Formation. The area outlined in red represents a data need associated with stream conditions downgradient of groundwater seeps (Activity 4). Human Exposure Under Control Data Needs associated with vapor intrusion are being addressed through separate ongoing actions. The results of addressing these data needs may be incorporated into addressing other data needs identified for the GWSP.

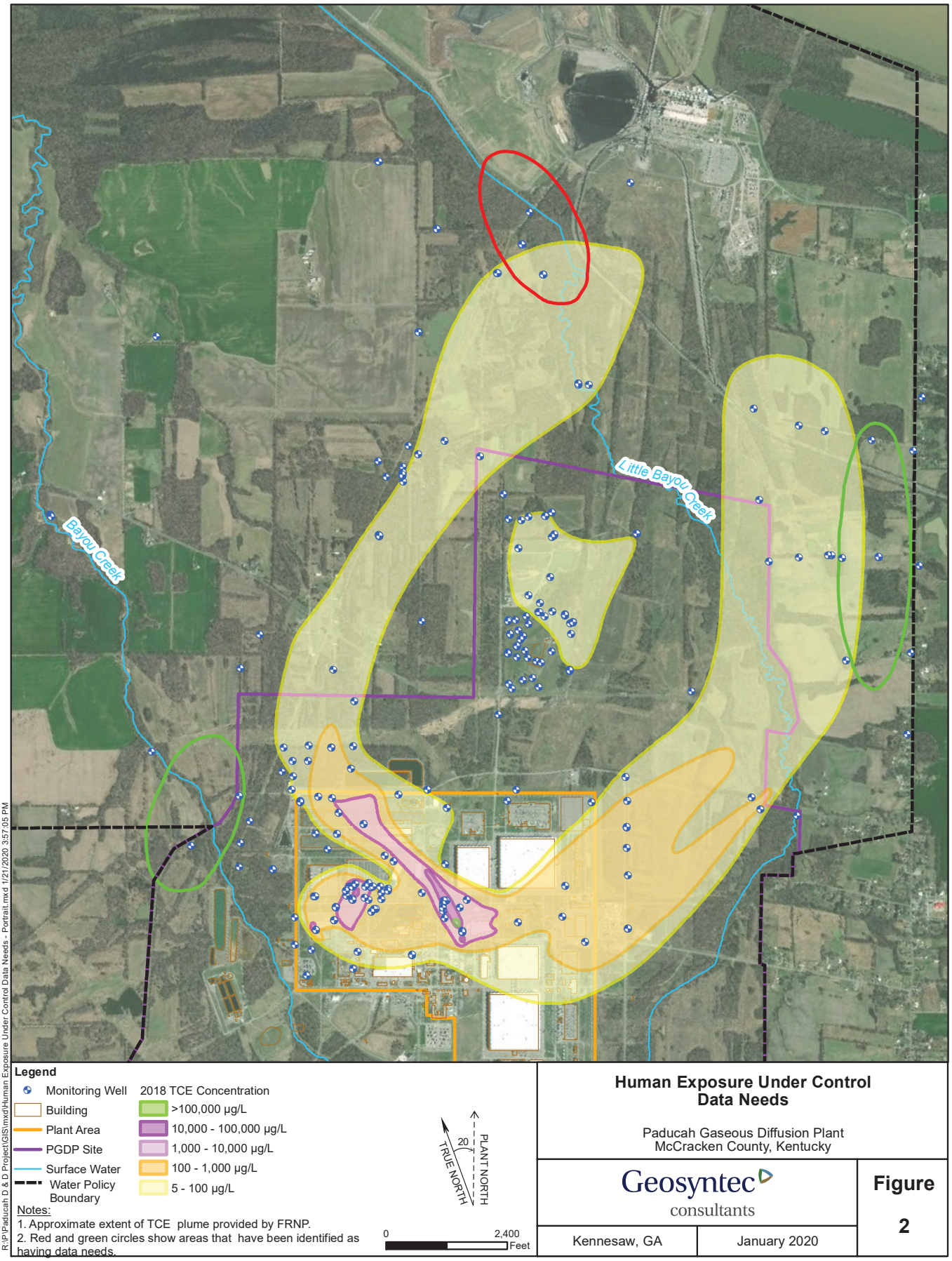

Figure 2. Human Exposure Under Control Data Needs

4.3 GROUNDWATER MIGRATION UNDER CONTROL DATA NEEDS

The discrete areas associated with the Groundwater Migration Under Control Data Needs are shown in Figure 3. The area outlined in red represents a data need associated with the extent of TCE in groundwater in the portion of the NW Plume downgradient of the NW Plume EWs (Activity 6), the area outlined in green represents a data need associated with the extent of TCE in groundwater on the east side of the downgradient NW Plume (Activity 7), and the area outlined in blue represents a data need associated with the extent of TCE in groundwater on the west side of the downgradient NE Plume (Activity 8). The results of addressing these data needs may be incorporated into addressing other data needs identified for the GWSP.

4.4 GROUNDWATER MWG INPUTS

As part of the regular Groundwater MWG meetings, a number of recommendations for further discussion or development have been identified, including the following that were selected based on their overlap with other activities included in this PMP.

- Characterize Underflow from Terrace Area to identify significant sources of upgradient recharge in the model domain (Activity 10).

- Expand Groundwater Monitoring Network to reduce uncertainty regarding groundwater flow direction, contaminant distribution, and potential source areas (Activity 11).

- Evaluate water balance across the Site (Activity 12).

- Monitor continuous RGA Water Level in the vicinity of the Ohio River and along a transect of wells extending back to the PGDP industrial area to better understand hydraulic properties of the RGA (Activity 13).

- Measure Synoptic Water Level during different seasons and associated with the Olmsted Locks and Dam operational changes to document RGA hydraulic potential during different hydraulic stress periods (Activity 14).

- Prepare Water Level Divide Study to assess water level and water quality data collected from the newly installed transect of MWs located east of the C-400 Cleaning Building (Activity 15).

- Measure Hydraulic Conductivity to characterize hydraulic conductivity across the model domain better (Activity 16).

- Characterize the McNairy Formation CSM (i.e., faulting) and potential contaminant impacts (Acitivty 9).

4.5 GROUNDWATER STRATEGY

The GWSP includes the 16 activities described above (5 activities associated with the Human Exposure Under Control Data Needs, 4 activities associated with the Groundwater Migration Under Control Data Needs, and 7 associated with the Groundwater MWG Inputs) as well as 2 additional activities identified during the development of the GWSP. The 18 activities are summarized in Table 2. Other activities may be added to this PMP, or a separate PMP may be developed as planning for each activity is initiated.

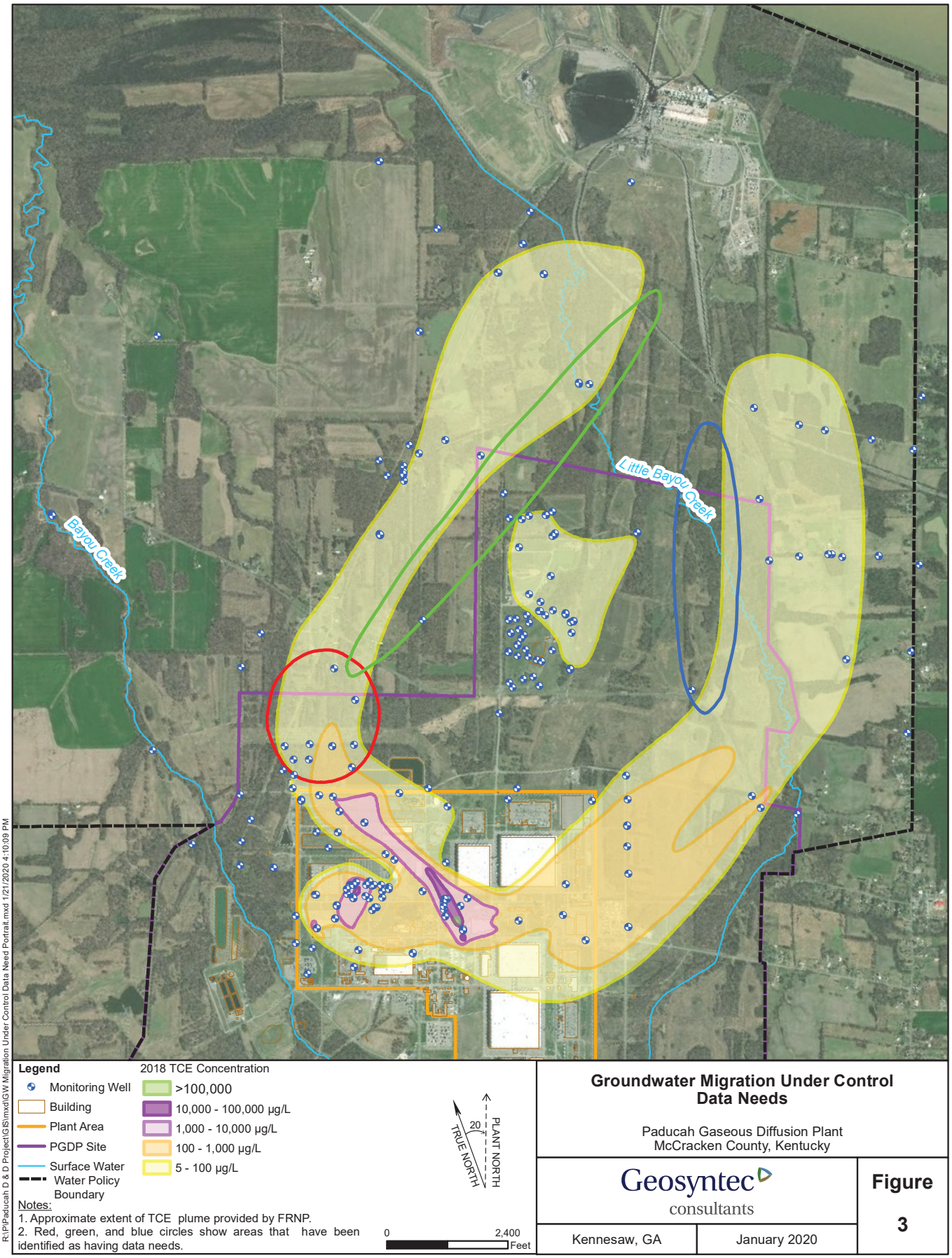

Figure 3. Groundwater Migration Under Control Data Needs

Table 2. Summary of Activities Considered for the Groundwater Strategy

Activity No.	Issue of Concern
Human Exposure Under Control	
1	TCE Extent West of PGDP (SW Plume)
2	TCE Extent East of PGDP (Downgradient NE Plume)
3	North Extent of PGDP TCE Plumes (Impact to Ohio River)
4	Nature and Extent of Contaminants Currently Contributed by Little Bayou Creek Seeps
5	Nature and Extent of Dissolved-Phase Contaminants Other than TCE and technetium-99 (Tc-99)
Groundwater Migration Under Control	
6	Capture Efficiency of NW Plume EWs
7	TCE Extent and Trends in East Side of Downgradient NW Plume
8	TCE Extent and Trends in West Side of Downgradient NE Plume
9	RGA Dissolved-Phase and Dense Nonaqueous-Phase Liquid (DNAPL) Contaminant Impacts to the McNairy Formation
Groundwater MWG Inputs	
10	Characterize Underflow from the Terrace Area
11	Expansion of Groundwater Monitoring Network
12	Water Balance Study
13	Continuous RGA Water Level Monitoring
14	Synoptic Water Level Measurement
15	Water Level Divide Study
16	Hydraulic conductivity
Additional Activities	
17	MW Survey Study
18	Groundwater Chemical Trend Evaluation

The following eight activities were selected for near-term (i.e., 2019–2020) implementation based on their overlapping scopes and overall sequence of work for initial implementation and are the subject of this PMP.

- Activity 1: TCE Extent West of PGDP (SW Plume);
- Activity 2: TCE Extent East of PGDP (Downgradient NE Plume);
- Activity 8: TCE Extent and Trends in West Side of Downgradient NE Plume;
- Activity 13: Continuous RGA Water Level Monitoring;
- Activity 14: Synoptic Water Level Measurement;
- Activity 15: Water Level Divide Study;
- Activity 17: MW Survey Study; and
- Activity 18: Groundwater Chemical Trend Evaluation.

A systematic approach is being used to address data needs and will evolve throughout the site remediation.

- Identify potential data needs collectively with stakeholders.
  - — Evaluate potential known data needs for future action(s).
  - — Evaluate potential unknown uncertainties as they are identified.
  - — Predict changes in the dissolved-phase plume.
- Begin the data quality objective (DQO) process for data needs for further evaluation.
- Evaluate the need for follow-on actions in these areas based on outcome of DQO process.
- Budget and schedule considerations.

Both near-term (defined as 0–3 years) and long-term (greater than 3 years) solutions were considered.

- Near-Term Solutions:
  - Optimize groundwater monitoring (considering EarthCon analysis).
    - Change sampling approach of existing wells.
    - Optimize locations/potentially add new wells or include Tennessee Valley Authority (TVA) wells.
    - Expand water level monitoring (existing and new equipment).
  - Evaluate well pumping rates and pump depths at NW Plume pump-and-treat system.
  - Modeling studies.
    - Dilution attenuation factor (decisions for protection of groundwater at source areas).
    - NE Plume transect well information and pump-and-treat information.
    - Anthropogenic recharge (from PGDP operations).
  - Update CSM.
- Long-Term Solutions:
  - Complete miscellaneous source areas and dissolved-phase RIs.
  - Optimize groundwater monitoring.
  - Groundwater Phase V (e.g., drive point sampling to site additional wells).
  - Revise/optimize groundwater flow model.
  - Update CSM.

Development of DQOs follows a series of steps. The seven steps in the process are shown in a flowchart found in EPA QA/G-4, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006). Similar steps are found in DOE guidance, *Institutionalizing the Data Quality Objectives Process for EM's Environmental Data Collection Activities* (DOE 1994b). The purpose and goal of each step are described in the text in EPA QA/G-4, accompanying the flowchart. EPA QA/G-4 also includes a summary of key elements that may be used in developing DQOs for specific investigations.

The overall GWSP has a defined set of DQOs (Table 3) that are supported further by the DQOs for each activity (see Section 4.9).

4.6 SUMMARY OF SCOPE ELEMENTS INCLUDED IN THIS PROJECT MANAGEMENT PLAN

A summary of each activity and its tasks and subtasks, a summary of the elements needed to complete the tasks, and identification of the primary resources are included in Table 4.

Activities 1 and 2 have significant overlap with the Water Policy Evaluation project, which is managed and funded separately. The overlapping activities described in this PMP also are relevant to resolving the EI portion of the Groundwater Strategy scope and require resources that need to be coordinated with the other four near-term activities included in this PMP.

Table 3. DQOs for the GWSP

DQO	PGDP Groundwater Strategy
1. State the Problem	Data needs and uncertainties limit the site's ability to document completion of the first two objectives of the GWSP and to document better completion of overall sitewide groundwater strategy • Preventing human exposure to contaminated groundwater/human exposure under control and • Preventing or minimizing further migration of the contaminant plume/groundwater migration under control.
2. Identify the Decision	Develop a groundwater strategy with actionable objectives that 1. Closes out documentation of the objectives, 2. Increases understanding of the dissolved-phase plume, and 3. Cross-references with scheduled projects to align data gathering.
3. Identify Inputs to the Decision	• DOE policies • Previous PGDP groundwater strategies • Source unit and plume investigations • Remedial actions • Monitoring data • Modeling results and uncertainties • CSM • Follow-on actions to be defined
4. Define the Study Boundaries	• Nature and extent of dissolved-phase contamination — West DOE property boundary (Water Policy area concern) — Immediate downgradient of NW Plume EWs — East side of downgradient NW Plume — West side of downgradient NE Plume • Streams downgradient of groundwater seeps • Vapor intrusion • Source actions and returning groundwater to beneficial use are out of scope • EM Program • Budget and schedule • Present to 5/10 years out
5. Develop a Decision Rule	**IF** an uncertainty regarding the completion of the first two objectives of the GWSP is significant, **THEN** perform directed investigation(s) to reduce/close the uncertainty.
6. Specify Limits on Decision Errors	• Consider regulatory and public concerns. • Can be addressed, in part, through iterative monitoring and modeling process.
7. Optimize the Design for Obtaining Data	• Perform data needs analysis to determine what additional information is needed to address the first two objectives of the GWSP. • Near-term solution is to optimize groundwater monitoring (helps with Water Policy Evaluation).

Table 4. Summary of Near-Term Groundwater Strategy Scopes

Activity No.	Area of Concern	Task(s)	Subtask(s)	Summary of Elements Required to Complete Task
1	TCE Extent West of PGDP (SW Plume)	Optimize existing groundwater monitoring network	Review frequency of sampling and analysis and synoptic sampling and analysis	N/A
		RGA potentiometric trend investigation	Water level/colloidal borescope investigation	• Manual water level measurements • Colloidal borescopes • Data logger/pressure transducers
			Transient groundwater flow model	N/A
		Develop/revise CSM	Review geology, hydrology, and contaminant trends	N/A
2	TCE Extent East of PGDP (Downgradient NE Plume)	RGA potentiometric trend investigation	Map sitewide synoptic water level data	N/A
			NE Plume synoptic water level measurements	• Manual water level measurements
			Continuous water level measurements	• 4 data loggers/pressure transducers/1 mobilization
			Colloidal borescope investigation	• 3 colloidal borescopes/ 12 mobilizations
		NE Plume optimization hydraulics analysis	N/A	N/A
8	TCE Extent and Trends in West Side of Downgradient NE Plume	RGA potentiometric trend investigation	Map sitewide synoptic water level data	N/A
			NE Plume synoptic water level measurements	• Manual water level measurements
			Continuous water level measurements	• Data loggers/pressure transducers
			Colloidal borescope measurements	• Colloidal borescopes

Table 4. Summary of Near-Term Groundwater Strategy Scopes (Continued)

Activity No.	Area of Concern	Task(s)	Subtask(s)	Summary of Elements Required to Complete Task
13	Continuous RGA Water Level Monitoring	Continuous RGA water level records over a period of a year in the vicinity of the Ohio River and along a transect of wells extending back to the PGDP industrial area	White Paper	N/A
			Continuous and manual water level measurements	• Data loggers/pressure transducers • Manual water level measurements
			Report	N/A
		Deployment of continuous water level recorders in select MWs/PZs within the plant area to assess recharge better and its impact on nearby water levels	Continuous water level measurements	N/A
14	Synoptic Water Level Measurement	Increased water level measurement events conducted during different seasons, including measurement of the water level elevation at Metropolis Lake	Seasonal water level measurements	N/A
		A synoptic data set collected under steady conditions at the higher river stage anticipated to start in 2018 when the Olmsted Locks and Dam are scheduled to be operational	Synoptic data set before operation begins at Olmsted lock and dam	• Synoptic water level events
			Synoptic data set after operation begins at Olmsted lock and dam	• Synoptic water level events

Table 4. Summary of Near-Term Groundwater Strategy Scopes (Continued)

Activity No.	Area of Concern	Task(s)	Subtask(s)	Summary of Elements Required to Complete Task
15	Water Level Divide Study	Assessing water level and water quality data collected from the newly installed transect of MWs located east of the C-400 Cleaning Building	N/A	• Data loggers/pressure transducers
		Colloidal borescope study in the vicinity of the apparent groundwater divide located east of the C-400 Cleaning Building to refine understanding of groundwater flow in the area	N/A	• Colloidal borescopes • Manual water level measurements
17	MW Survey Study	Review existing MW survey information	N/A	• Evaluate need for closed loop survey for main PGDP area and perform if determined to be appropriate • Identify scopes, activities, reports that are sensitive to the measurement and that are being used for decision making or to demonstrate compliance • Prepare white paper
		Assessment of confidence on plume map depiction	N/A	• Review plume maps in context of survey data
18	Groundwater Chemical Trend Evaluation	Assess existing groundwater analytical data for trends and decide whether analyses should be revised	N/A	• Review existing groundwater analytical data

4.7 SUMMARY OF GROUNDWATER STRATEGY ACTIVITIES PREVIOUSLY COMPLETED AND NEAR-TERM TASKS

As part of ongoing work at the Paducah Site, a number of tasks originally included in GWSP Activities have been completed. These are summarized in Tables 5 and 6. The findings or results of these tasks will be incorporated into the GWSP, as appropriate.

4.8 DATA COLLECTION METHODS AND PILOT STUDIES

The field portions of the activities included in this PMP primarily involve one of three types of data collection:

- Manual water level measurements collected using water level meters;
- Continuous water level measurements collected using pressure transducers; and
- Groundwater flow and velocity measurements collected using colloidal borescopes.

The equipment and methods of collection for water levels using water level meters and pressure transducers are included in CP4-ES-2100, *Groundwater Level Measurement*. Figures showing the locations for manual water level measurements, pressure transducer locations, and colloidal borescope locations are included in Section 4.9.

These data provide both regional and localized data that will facilitate the understanding of localized instances of concentration behavior that do not align with regional flow model and/or the current understanding of the regional groundwater flow as determined by potentiometric measurements/maps. The localized information will be provided by the colloidal borescopes, while the manual water level measurements and continuous water level measurements will provide regional patterns. Combining the colloidal borescopes and potentiometric maps provides a more robust data set that supports making better informed decision for future investigations and actions.

4.8.1 Manual Water Level Measurements and Pressure Transducers

Manual water level measurements will be collected using a water level meter (see Activity descriptions for wells). Pressure transducers will be deployed in select wells throughout the data collection period associated with the activities in this PMP (see activity descriptions for wells) to provide more continuous water level measurements. These data will be used to develop an understanding of RGA potentiometric trends.

4.8.2 Colloidal Borescopes

Colloidal borescopes will be used to collect well-specific measurements of groundwater flow (both direction and rate) to compare to the hydraulic gradient as measured locally (in the test well and two adjacent wells) and regionally, as well as to compare to potential sources of recharge. Measurements will be collected over multiple seasons and at multiple depths in the aquifer where collocated wells are present. The colloidal borescope measurements are especially valuable near the perimeter of well coverage where the downgradient flow direction cannot be interpolated and where the greatest uncertainty exists. Colloidal borescope measurements are scheduled most frequently in the perimeter wells.

Table 5. Summary of 2019 Activities

Activity No.	Area of Concern/Description	Previously Completed Tasks	Near-Term Tasks Planned
1	TCE Extent West of PGDP (SW Plume)	• Existing data reviewed and determination of MWs to include in GWSP.	• Water level/colloidal borescope investigation. • Evaluation of data, development of white paper, update transient groundwater flow model (if required).
2	TCE Extent East of PGDP (Downgradient NE Plume)	• Existing data reviewed and determination of MWs to include in GWSP.	• Water level/colloidal borescope investigation. • Evaluation of data, development of white paper, update transient groundwater flow model (if required).
8	TCE Extent and Trends in West Side of Downgradient NE Plume	• Existing data reviewed and determination of MWs to include in GWSP.	• Water level/colloidal borescope investigation. • Evaluation of data, development of white paper, update transient groundwater flow model (if required).
13	Continuous RGA Water Level Monitoring	• Existing data reviewed and determination of MWs to include in GWSP.	• Water level/colloidal borescope investigation. • Evaluation of data and development of white paper.
14	Synoptic Water Level Measurement	• Existing data reviewed and determination of MWs to include in GWSP. • Annual synoptic water level event prior to Olmsted Dam becoming operational (including data from TVA MWs).	• Water level/colloidal borescope investigation. • Evaluation of data and development of white paper.
15	Water Level Divide Study	• NE Plume hydraulic assessment.	• Water level/colloidal borescope investigation. • Evaluation of data, development of white paper, update transient groundwater flow model (if required).

Table 5. Summary of 2019 Activities (Continued)

Activity No.	Area of Concern/Description	Previously Completed Tasks	Near-Term Tasks Planned
17	• The MW Survey Study was developed to address concerns raised regarding confidence of MW survey data. • Issue on MW elevation measurement point selection identified during C-404 Landfill permit reporting. • Review of 2017 MW survey data performed during the NE Plume optimization project and compared to previous MW survey data indicated a need for additional review of MW elevation data. • The findings and actions from the MW Survey Study will ensure the MW elevation survey data used to perform the other activities in GWSP, permit-required reporting, and other decisions regarding sitewide groundwater will be of the appropriate quality.	• A presentation was prepared on well reference points, types of survey, current database structure, and plan/progress for resurvey.	• Closed loop surveying of 139 MWs inside the main plant area and 26 MWs near the main plant area. • Evaluation of existing and new data and review of prior findings.

Table 6. Completed Tasks for Future Activities

Activity No.	Area of Concern/Description	Previously Completed Tasks	Near-Term Tasks Planned
3	North Extent of PGDP TCE Plumes (Impact to Ohio River)	• Pending completion of Activities 2, 8, 13, and 14.	• Data collected under Activities 2, 8, 13, and 14, and the results from an expected independent EarthCon evaluation will support future investigations and/or decisions.
5	Nature and Extent of Dissolved-Phase Contaminants Other than TCE and Tc-99	• Pending completion of other Activities.	• Data collected for other site scopes (e.g., landfill groundwater monitoring, etc.) will support future investigations and/or decisions.
6	Capture Efficiency of NW Plume EWs	• White Paper: *Revised Evaluation of TCE Trends in MW460*, included in the Draft *Compilation of Meeting Summaries and White Papers (2017-2018)* (DOE 2019).	• Data collected for Activities 1, 13, and 14 will support future investigations and/or decisions.
7	TCE Extent and Trends in East Side of Downgradient NW Plume	• Pending completion of Activities 1, 13, and 14.	• Data collected for Activities 1, 13, and 14, and the results from an expected independent EarthCon evaluation will support future investigations and/or decisions.
9	RGA Dissolved-Phase and DNAPL Contaminant Impacts to the McNairy Formation	• Data collected for the C-400 RI/FS Work Plan fieldwork will support future investigations and/or decisions.	• Data collected for other projects will support future investigations and/or decisions.
11	Expansion of Groundwater Monitoring Network	• Compilation and verification (especially measurement points) of TVA MW network data.	• Data collected under Activities 1, 2, 8, 13, 14, and 15 and the results from an expected independent EarthCon evaluation will support future investigations and/or decisions.

Manual water level measurements will be paired with colloidal borescope deployments to provide a basis of comparison of groundwater flow direction measurements. Water level measurements in the well with the colloidal borescope and, at least, two other nearby well locations will be used to determine the hydraulic gradient between the wells using the three-point problem method. Where the colloidal borescope measurement of groundwater flow direction is consistent with the derived intra-well gradient, the aquifer can be assumed to be practically homogenous. Where the measurements diverge, significant heterogeneity of the aquifer matrix or a nearby point source of groundwater recharge are potential explanations. The colloidal borescope record also will provide indications of sub-day length variation in groundwater flow rate and direction, which may be due to the operation of a well pump. The colloidal borescope and continuous and manual water level measurements will be used to focus future field investigation, as needed, to understand contaminant migration and the potential for off-site contaminant migration.

While colloidal borescopes have been used at the Paducah Site in the past, their use currently is not described in a procedure. Appropriate work controls will be developed to complete this work scope. The colloidal borescopes that will be used for the activities in this PMP are Aquavision Colloidal Borescopes.

4.8.3 Colloidal Borescope Pilot Studies

Two colloidal borescope pilot studies will be performed prior to initiating the monthly data collection activities.

1. Flow interval logging will be performed in each of the wells that will have colloidal borescopes deployed. This flow interval logging will consist of obtaining measurements at 2-ft intervals within the well screen. The purpose of this pilot study is to identify the interval within the well screen with the highest velocity. This interval will be used for placement of the colloidal borescope for each activity.

2. A 24-hour duration data collection period will be performed in a well in the NE and SW portions of the water policy box (not on residential property) to evaluate whether a 24-hour duration or a shorter duration (e.g., 8 or 12 hours) is appropriate to meet the DQOs for the activities.

The locations where the pilot studies will be performed are included in Figure 4.

4.9 ACTIVITY DATA COLLECTION

4.9.1 Activity 1: TCE Extent West of PGDP (SW Plume)

Activity 1 consists of three tasks: (1) optimize the existing groundwater monitoring network, (2) perform an RGA potentiometric trend investigation, and (3) develop/revise the CSM[1] as well as optimization of the well network (e.g., drive point, well installation, etc.). DQOs for this activity are included in Table 7.

The field component of Activity 1 is summarized in Table 8 and includes monitoring of 17 wells.

- Install three colloidal borescopes each month in the wells indicated for up to 24-hour data collection.
- Install four pressure transducers in the wells indicated with data collection hourly.
- Take manual water level measurements at each well twice each month.

[1] Questions regarding the McNairy Formation CSM may need to be addressed in the near-term based on current regulatory discussions.

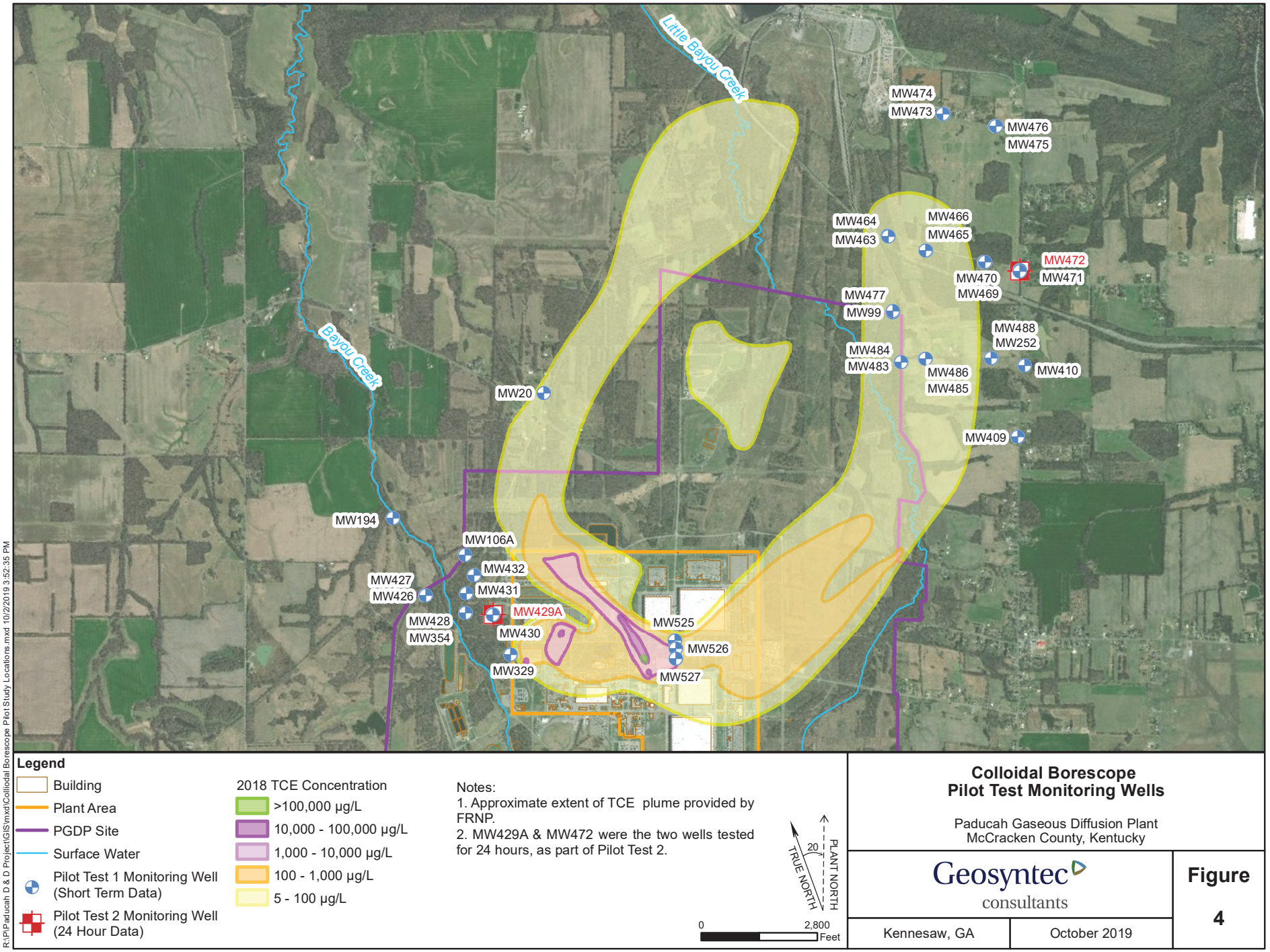

Figure 4. Colloidal Borescope Pilot Test Monitoring Wells

Table 7. DQOs for Activity 1

1. State the Problem	MWs results adjacent to the Water Policy area boundary, to the north of the C-611 Water Treatment Plant, indicate dissolved-phase TCE potentially is migrating outside the Water Policy area in RGA groundwater.	
2. Identify the Decision	Are additional actions (e.g., drive point investigation, installation of new wells, etc.) required to control access to TCE-contaminated groundwater downgradient of the area?	
3. Identify Inputs to the Decision	• TCE extent and trends close upgradient and downgradient of the west Water Policy area • Groundwater flow directions close upgradient and downgradient of the west Water Policy area • Aquifer properties • Current MW distribution • Location of closest potentially impacted water wells	
4. Define the Study Boundaries	• Spatial: See Table 8 • Temporal: One year	• Regulatory: — Water Policy Interim Remedial Action — EIs
5. Develop a Decision Rule	**IF** dissolved-phase TCE is migrating in the RGA to outside the Water Policy area to the north of the C-611 Water Treatment Plant, **THEN** define further studies and/or actions to control access to the contamination.	
6. Specify Limits on Decision Errors	• TCE analytical precision • Groundwater flow direction • Extent of dissolved-phase TCE	
7. Optimize the Design for Obtaining Data	• Adjust RGA MW sampling frequency (documented in the EMP) • Robust RGA water level monitoring program • Colloidal borescope investigation • Develop conceptual model	

Table 8. Monitoring Wells for Activity 1

Monitoring Well	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2

CB = collodial borescope

PT = pressure transducer

M2 = manual well water level measurements twice per month

4.9.2 Activity 2: TCE Extent East of PGDP (Downgradient NE Plume)

Activity 2 consists of two tasks: (1) perform an RGA potentiometric trend investigation and (2) optimize the groundwater monitoring network. DQOs for this activity are included in Table 9.

Table 9. DQOs for Activity 2

1. State the Problem	Monitoring MW edge of the NE Plume, indicate dissolved-phase TCE is potentially migrating outside the Water Policy area in RGA groundwater.	
2. Identify the Decision	Are additional actions (e.g., drive point investigation, installation of new wells, etc.) required to control access to TCE-contaminated groundwater downgradient of the area?	
3. Identify Inputs to the Decision	• TCE extent and trends close upgradient and downgradient of the east Water Policy area • Groundwater flow directions close upgradient and downgradient of the east Water Policy area • Aquifer properties • Current monitoring MW potentially impacted water wells	
4. Define the Study Boundaries	• Spatial: See Table 10 • Temporal: One year	• Regulatory: — Water Policy Interim Remedial Action — EIs
5. Develop a Decision Rule	**IF** dissolved-phase TCE is migrating in the RGA to the Water Policy eastern boundary in the vicinity of the NE Plume, **THEN** define further studies and/or actions to control access to the contamination.	
6. Specify Limits on Decision Errors	• TCE analytical precision • Groundwater flow direction • Extent of dissolved-phase TCE	
7. Optimize the Design for Obtaining Data	• Adjust RGA MW sampling frequency (documented in the EMP) • Robust RGA water level monitoring program • Colloidal borescope investigation • Develop conceptual model	

The field component of Activity 2 is summarized in Table 10 and includes monitoring of 42 wells.

- Install three to nine colloidal borescopes each month in the wells indicated for up to 24-hour data collection.
- Install six pressure transducers in the wells indicated with data collection hourly.
- Take manual water level measurements at each well each month.

Table 10. Monitoring Wells with Collodial Borescops and Pressure Transducers for Activity 2

Monitoring Well	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1

PT = continuous data logger (pressure transducer)

CB = colloidal borescope

M1 = manual water level measurement once per month

Pink shading indicates the well is part of the East Side of Activity 2

Blue shading indicates the well is part of the West Side of Activity 2

Orange shading indicates the well is part of the East Side and West Side of Activity 2

4.9.3 Activity 8: TCE Extent and Trends in West Side of Downgradient NE Plume

Activity 8 consists of three tasks to be performed following completion of Activity 2: (1) perform an RGA potentiometric trend investigation, (2) perform a drive point investigation, and (3) optimize the groundwater monitoring network. DQOs for this activity are included in Table 11.

Table 11. DQOs for Activity 8

1. State the Problem	The extent of dissolved-phase TCE in the RGA along the west side of the downgradient NE Plume requires additional documentation.	
2. Identify the Decision	Is additional monitoring needed to define the west extent of the downgradient NE Plume?	
3. Identify Inputs to the Decision	• Monitoring well locations in the area of the downgradient NE Plume • TCE trends in monitoring wells in the area of the downgradient NE Plume • Conceptual model of trends in the downgradient NE Plume • TCE plume map reporting requirements	
4. Define the Study Boundaries	• Spatial: West side of NE Plume • Temporal: 1 Year	• Regulatory: — NE Plume Interim Remedial Action — Environmental Indicators
5. Develop a Decision Rule	**IF** additional control is required to define the west extent of the NE Plume dissolved-phase TCE groundwater contamination, **THEN** determine type and location of required additional monitoring.	
6. Specify Limits on Decision Errors	• TCE analytical precision • Groundwater flow direction • Extent of dissolved-phase TCE	
7. Optimize the Design for Obtaining Data	• Optimize existing RGA monitoring well network (documented in draft 2018 EMP) • Robust RGA water level monitoring program • Colloidal borescope investigation • Develop conceptual model • Additional RGA monitoring well(s) (location and number to be determined at a later date)	

Activity 8 includes the installation and monitoring of eight new wells following the collection of the water level data and a drive point investigation. At present, it is assumed that the well construction activity will consist of subcontractor installation of eight borings to 100 ft (four MWs to approximately 100 ft and four MWs to approximately 70 ft). Additionally, the MWs from Activity 2 and the MWs installed as part of this task will be sampled for TCE and Tc-99.

4.9.4 Activity 13: Continuous RGA Water Level Monitoring

Activity 13 consists of two tasks: perform a continuous RGA potentiometric trend investigation over the course of one year in the vicinity of the Ohio River and along a transect of wells extending back to the Paducah Site industrial area, and continuous water level measurements within the plant area to assess recharge and its impact on nearby wells. DQOs for this activity are included in Table 12.

Table 12. DQOs for Activity 13

1. State the Problem	Prior groundwater modeling results have indicated uncertainty in the temporal flows between the Ohio River and the Paducah Site, as well as a need for increased data on recharge rates.	
2. Identify the Decision	Are additional data required to update the groundwater model to support completion of other activities (e.g., new wells) and as an input for overall increase in understanding of the site?	
3. Identify Inputs to the Decision	• Groundwater MWG actions and findings • Groundwater flow directions close upgradient and downgradient of the Paducah Site • Aquifer properties • Current MW distribution	
4. Define the Study Boundaries	• Spatial: Between the Ohio River and the Paducah Site (Table 13) • Temporal: One year	• Regulatory: — Groundwater MWG
5. Develop a Decision Rule	**IF** temporal conditions or changes to recharge assumptions are different from what the groundwater model currently employs in such a way as to change the model outputs, **THEN** define actions to update the groundwater model.	
6. Specify Limits on Decision Errors	• Groundwater flow direction • Groundwater recharge	
7. Optimize the Design for Obtaining Data	• Adjust RGA monitoring MW monitoring program • Develop conceptual model	

The field component of Activity 13 is summarized in Table 13 and includes monitoring of 15 wells.

- Install pressure transducers in the wells indicated with data collection hourly.
- Take manual water level measurements at each well each month.

Table 13. Monitoring Wells for Activity 13

Monitoring Well	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW152	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW199	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1

CB = collodial borescope

PT = continuous data logger (pressure transducer)

M1 = manual water level measurement once per month

4.9.5 Activity 14: Synoptic Water Level Measurement

Activity 14 consists of two tasks: (1) seasonal water level measurement events conducted during different seasons[2] and (2) water level measurements to understand the impact to the plumes in response to changes resulting from the change in operations at the Olmstead Dam. DQOs for this activity are included in Table 14.

Table 14. DQOs for Activity 14

1. State the Problem	Prior groundwater modeling results have indicated uncertainty in the temporal flows during different seasons, as well as a need for information on how operational changes at Olmstead Dam may affect site groundwater.	
2. Identify the Decision	Are additional data required to update the groundwater model?	
3. Identify Inputs to the Decision	• Groundwater MWG actions and findings • Groundwater flow directions close upgradient and downgradient of the Paducah Site • Aquifer properties • Current MW distribution	
4. Define the Study Boundaries	• Spatial: Paducah Site (Table 15) • Temporal: One year	• Regulatory: — Groundwater MWG
5. Develop a Decision Rule	**IF** temporal conditions, either seasonal or as a result of changing operations at Olmstead Dam are different from what the groundwater model currently employs in such a way as to change the model outputs, **THEN** define actions to update the groundwater model.	
6. Specify Limits on Decision Errors	• Groundwater flow direction • Groundwater recharge	
7. Optimize the Design for Obtaining Data	• Adjust RGA MW sampling frequency (documented in the EMP) • Robust RGA water level monitoring program • Develop conceptual model	

Prior to operational changes at Olmstead Dam, one synoptic water level measurement event has been conducted using the MWs used for synoptic water level events, as detailed in the EMP, as well as the McNairy Formation and Rubble Zone wells shown in Table 15.

Following operational changes at Olmstead Dam, four synoptic water level measurement events will be conducted using the MWs used for synoptic water level events, as detailed in the EMP, as well as in the McNairy Formation and Rubble Zone wells shown in Table 15. These synoptic events will be conducted quarterly during the course of one year.

[2] Measurement of the water level elevation at Metropolis Lake currently is being considered by the Groundwater MWG and will be added to this scope as appropriate.

Table 15. McNairy Formation and Rubble Zone Monitoring Wells/Locations for Activity 14

Monitoring Well	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW102	MQ	MQ	MQ	MQ
PZ114	MQ	MQ	MQ	MQ
PZ115	MQ	MQ	MQ	MQ
MW120	MQ	MQ	MQ	MQ
MW121	MQ	MQ	MQ	MQ
MW122	MQ	MQ	MQ	MQ
MW133	MQ	MQ	MQ	MQ
MW239	MQ	MQ	MQ	MQ
MW247	MQ	MQ	MQ	MQ
MW356	MQ	MQ	MQ	MQ
MW345	MQ	MQ	MQ	MQ
MW346	MQ	MQ	MQ	MQ
MW347	MQ	MQ	MQ	MQ
Monitoring Location	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**
Metropolis Lake*	MQ	MQ	MQ	MQ

MQ = Manual water level measurement once per quarter
*Measurement of the water level elevation at Metropolis Lake currently is being considered by the Groundwater MWG and will be added to this scope as appropriate.

4.9.6 Activity 15: Water Level Divide Study

Activity 15 consists of two tasks: (1) assessing water level and water quality data collected from the newly installed transect of MWs located east of the C-400 Cleaning Building and (2) conducting a colloidal borescope study in the vicinity of the apparent groundwater divide located east of the C-400 Cleaning Building to refine understanding of groundwater flow in the area and inform the operation of the NEPCS EWs. DQOs for this activity are included in Table 16.

Table 16. DQOs for Activity 15

1. State the Problem	Provide a better understanding of the apparent groundwater divide located east of the C-400 Cleaning Building to refine understanding of groundwater flow in the area.	
2. Identify the Decision	Are additional data required to update the groundwater model or revise the operation of the NEPCS EWs?	
3. Identify Inputs to the Decision	• Groundwater MWG actions and findings • Groundwater flow directions close to the C-400 Cleaning Building • Aquifer properties • Current MW distribution • Data collected during the NEPCS optimization	
4. Define the Study Boundaries	• Spatial: Vicinity of the C-400 Cleaning Building • Temporal: One year	• Regulatory: — Groundwater MWG — NEPCS

Table 16. DQOs for Activity 15 (Continued)

5. Develop a Decision Rule	**IF** temporal conditions are different from current conceptual model in such a way as to change the groundwater model outputs or operation of the NEPCS, **THEN** define actions to update the groundwater model and evaluate operational changes to the NEPCS EWs.
6. Specify Limits on Decision Errors	• Groundwater flow direction • Groundwater recharge
7. Optimize the Design for Obtaining Data	• Adjust RGA MW sampling frequency (documented in the EMP) • Robust RGA water level monitoring program • Revise conceptual model • Operation of the NEPCS EWs

The field component of Activity 15 is summarized in Table 17 and includes monitoring of 46 wells.

- Install colloidal borescopes each quarter in the wells indicated for up to 24-hour data collection.
- Install pressure transducers each quarter in the wells indicated with data collection hourly.
- Take manual water level measurements at each well each quarter.

Table 17. Monitoring Wells for Activity 15

Monitoring Well	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW145	PT+MQ	PT+MQ	PT+MQ	PT+MQ
MW155	MQ	MQ	MQ	MQ
MW156	MQ	MQ	MQ	MQ
MW163	MQ	MQ	MQ	MQ
MW165A	MQ	MQ	MQ	MQ
MW175	MQ	MQ	MQ	MQ
MW177	MQ	MQ	MQ	MQ
MW205	MQ	MQ	MQ	MQ
MW255	MQ	MQ	MQ	MQ
MW256	MQ	MQ	MQ	MQ
MW258	MQ	MQ	MQ	MQ
MW260	MQ	MQ	MQ	MQ
MW288	MQ	MQ	MQ	MQ
MW292	MQ	MQ	MQ	MQ

Table 17. Monitoring Wells for Activity 15 (Continued)

Monitoring Well	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MW341	MQ	MQ	MQ	MQ
MW355	MQ	MQ	MQ	MQ
MW421	MQ	MQ	MQ	MQ
MW425	MQ	MQ	MQ	MQ
MW480	MQ	MQ	MQ	MQ
MW495	MQ	MQ	MQ	MQ
MW496	MQ	MQ	MQ	MQ
MW505	MQ	MQ	MQ	MQ
MW506	MQ	MQ	MQ	MQ
MW507	MQ	MQ	MQ	MQ
MW524	PT+MQ	MQ	MQ	MQ
MW525	MQ	CB+PT+MQ	MQ	MQ
MW526	MQ	MQ	CB+PT+MQ	MQ
MW527	CB+PT+MQ	MQ	MQ	MQ
MW528	MQ	MQ	MQ	MQ
MW529	MQ	PT+MQ	MQ	MQ
MW530	MQ	MQ	PT+MQ	MQ
MW531	MQ	MQ	MQ	MQ
MW533	MQ	MQ	MQ	MQ
MW537	MQ	MQ	MQ	MQ
MW539	MQ	MQ	MQ	MQ
MW556	MQ	MQ	MQ	MQ
MW71	PT+MQ	PT+MQ	PT+MQ	PT+MQ
PZ110	MQ	MQ	MQ	MQ
PZ532	MQ	MQ	MQ	MQ
PZ534	MQ	MQ	MQ	MQ
PZ535	MQ	MQ	MQ	MQ
PZ540	MQ	MQ	MQ	MQ
PZ541	MQ	MQ	MQ	MQ
PZ553	MQ	MQ	MQ	MQ
PZ554	MQ	MQ	MQ	MQ
PZ555	MQ	MQ	MQ	MQ

CB = Colloidal borescope
PT = Continuous data logger (pressure transducer)
MQ = Manual water level measurement once per quarter

4.9.7 Activity 17: Monitoring Well Survey Study

Activity 17 consists of two tasks: (1) a review of existing MW survey information and (2) a review of survey data as it relates to the plume maps. DQOs for this activity are included in Table 18.

Table 18. DQOs for Activity 17

1. State the Problem	In 2018, an issue with selection of MW measurement point(s) was identified as part of C-404 Landfill permit required reporting. Additionally, a review of 2017 MW survey data performed during the NE Plume optimization project and compared to previous MW survey data indicated a need for additional review of MW elevation data.	
2. Identify the Decision	Is the current survey information for the MWs of appropriate tolerance for decision making and required reporting and are measurement points understood?	
3. Identify Inputs to the Decision	• Current and historical survey data in OREIS and working databases or files maintained by staff • History of repairs made to MWs that would affect survey data • Scopes, activities, reports that are sensitive to the measurement and that are being used for decision making or to demonstrate compliance • Procedures for collecting and managing survey data • Plume maps	
4. Define the Study Boundaries	• Spatial: Paducah Site • Temporal: Less than one year	• Regulatory: Environmental permits, CERCLA projects, Groundwater MWG
5. Develop a Decision Rule	**IF** survey tolerances for MWs are not acceptable for the decisions and reporting, **THEN** define actions to resolve the tolerances and audit the use of the survey data.	
6. Specify Limits on Decision Errors	• Groundwater flow direction • Groundwater recharge • Groundwater plume maps	
7. Optimize the Design for Obtaining Data	• Review of available well survey data and techniques used to obtain the data • Identify scopes, activities, reports that are sensitive to the measurement and that are being used for decision making or to demonstrate compliance • Identify significant differences, attempt to understand root cause of differences and evaluate impact of difference • Understand structure and data available in OREIS • Review tools/files used to qualify the usefulness of the data	

The small hydraulic gradient across the Paducah Site (on the order of 0.1 inch vertically/100 ft horizontally) means that small changes in the MW elevations used to calculate groundwater elevations can result in different interpreted flow directions. Differences up to 3.5 in (0.29 ft) have been observed between GPS elevation data and level loop surveys performed at the Paducah Site. Both GPS and level loop surveying are commonly employed at the Paducah Site and the selection of survey method is based on the DQOs, scale of the project, and the distance between points.

The findings and actions from the MW Survey Study will ensure the MW elevation survey data used to perform the other activities in the GWSP, permit-required reporting, and other decisions regarding sitewide groundwater will be of the appropriate quality. Below is a summary of activities that will be performed as part of Activity 17.

There are 397 MWs and PZs, collectively referred to as MWs, in the EMP that either are sampled or have water level measurements taken. Of these, 222 MWs were surveyed in 2016–2018 using GPS. In 2016–2017, 36 MWs were surveyed using level loop. A closed loop survey for 139 wells in the main plant area and 26 wells near the main plant area will be performed as part of Activity 17 (Figure 5). A map of the locations to be surveyed is included as Figure 6.

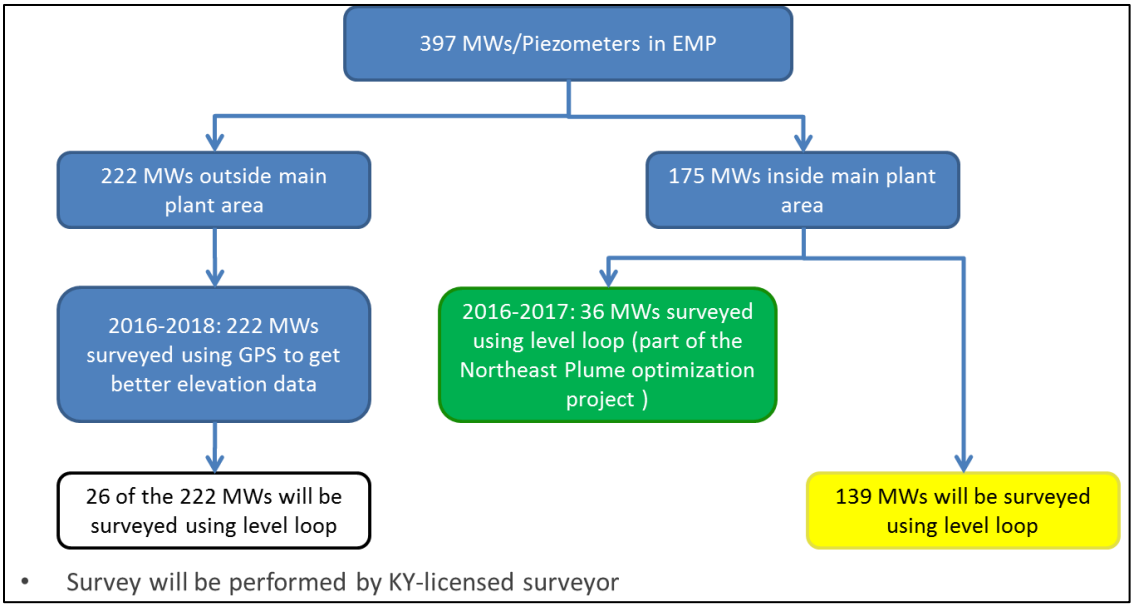

Figure 5. MW Inventory and Survey Scope

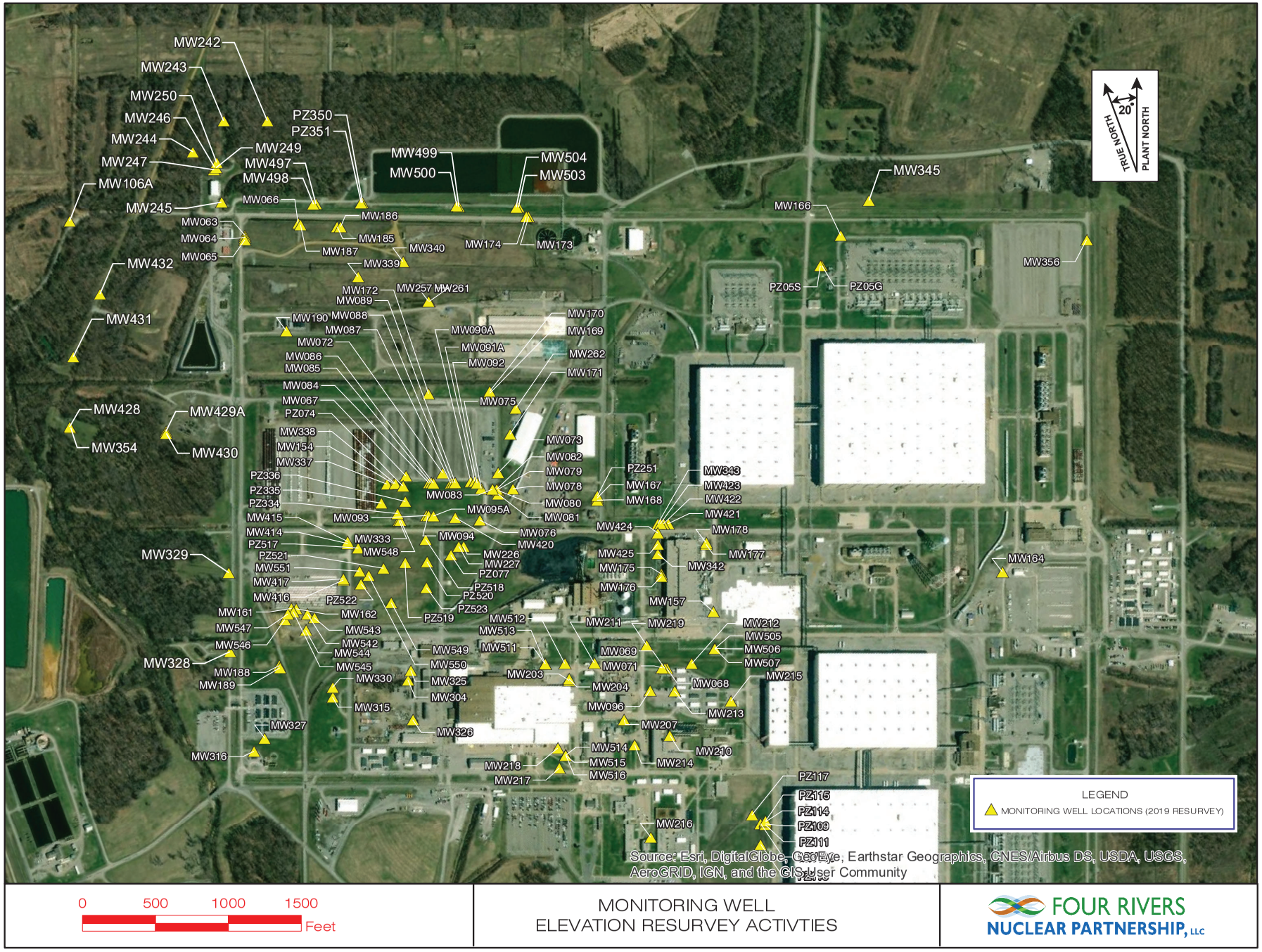

Figure 6. MW Survey Scope

Following completion of this survey scope, there will be MWs with elevations obtained using GPS and MWs with elevations obtained using level loop survey. To understand whether the two datasets may be used as a single dataset, a GPS survey on a subset of MWs in the main plant area following level loop survey will be performed, and the two sets of elevations will be compared. Additionally, the previous GPS survey for the 26 MWs near the main plant area will be compared to the level loop survey elevations performed for these MWs. Follow-on work may be proposed based on findings of these comparisons. New survey data will not be used until all MWs proposed for resurvey are complete, reviewed, and impacts are understood.

Other aspects of Activity 17 include the following.

- Understand any repairs to MWs that have occurred that have resulted in measurement point changes and identify any other differences that could be related to measurement error.

- Identify scopes, activities, reports that are sensitive to the measurement and that are being used for decision making or to demonstrate compliance, including a review of major decisions that have been made in last five years based on well survey data and a review of compliance reporting.

- Revisit water level calculations and compare differences in results for selected periods from the previous scope and identify significant differences, attempt to understand root cause of differences, and evaluate impact of differences.

- Understand structure and data available in OREIS including database management approach (e.g., written procedure) and historical datasets.

- Evaluate the development of a survey procedure identifying tolerances, techniques, and record management.

- Review tools/files that practitioners use to qualify the usefulness of the data, including use of judgmental data/points that are used for mapping.

- Review communication between data collection, data use, and data management and evaluate standardization of data and data processes.

A presentation has been prepared on well reference points, types of survey, current database structure, and plan/progress for resurvey. A white paper will be prepared summarizing the findings of the study.

4.9.8 Activity 18: Groundwater Chemical Trend Evaluation

Activity 18 consists of a review of existing groundwater analytical data. DQOs for this activity are included in Table 19.

Table 19. DQOs for Activity 18

1. State the Problem	A holistic review of analytes monitored in groundwater and their time-trends has not been performed.	
2. Identify the Decision	Is the current chemical monitoring for groundwater monitoring program sufficient for supporting ongoing and future remedial decisions?	
3. Identify Inputs to the Decision	• Current and historical analytical data in OREIS • Scopes, activities, reports that are being used for decision making or to demonstrate compliance • Plume maps	
4. Define the Study Boundaries	• Spatial: Paducah Site • Temporal: Historical data through present	• Regulatory: Environmental permits, CERCLA projects, Groundwater MWG
5. Develop a Decision Rule	**IF** survey tolerances for MWs are not acceptable for the decisions and reporting, **THEN** define actions to resolve the tolerances and audit the use of the survey data.	
6. Specify Limits on Decision Errors	• Groundwater plume maps • Groundwater time-trends • Groundwater analyses needs	
7. Optimize the Design for Obtaining Data	• Review of available groundwater analytical data • Identify scopes, activities, reports that are being used for decision making or to demonstrate compliance • Identify significant changes in concentration trends • Identify whether additional analytes should be sampled for and on what frequency	

4.10 SUMMARY OF ACTIVITIES

Although each activity included in the scope of this Groundwater Strategy PMP is considered to be a discrete activity, each having its own near-term end point (see Section 4.12 and Table 21), there is overlap in the data collection for each activity. The data to be collected are summarized in Table 20 to provide the project team the opportunity to realize efficiencies in data collection. The locations where manual water level measurements will be taken are included in Figure 7. Figures 8 through 19 show the pressure transducer and colloidal borescope locations for each month of the 12-month data collection period.

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1, 14	MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
14	MW63			M1			M1			M1			M1
14	MW65			M1			M1			M1			M1
14	MW66			M1			M1			M1			M1
14	MW67			M1			M1			M1			M1
14	MW68			M1			M1			M1			M1
13, 14, 15	MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW72			M1			M1			M1			M1
14	MW73			M1			M1			M1			M1
14	MW76			M1			M1			M1			M1
14	MW77 (PZ)			M1			M1			M1			M1
14	MW78			M1			M1			M1			M1
14	MW79			M1			M1			M1			M1
14	MW80			M1			M1			M1			M1
14	MW81			M1			M1			M1			M1
14	MW84			M1			M1			M1			M1
14	MW86			M1			M1			M1			M1
14	MW87			M1			M1			M1			M1
14	MW89			M1			M1			M1			M1
14	MW90A			M1			M1			M1			M1
14	MW92			M1			M1			M1			M1
14	MW93			M1			M1			M1			M1
14	MW95A			M1			M1			M1			M1
14	MW98			M1			M1			M1			M1
2, 14	MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
2, 14	MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW102			M1			M1			M1			M1
14	MW103			M1			M1			M1			M1
1, 14	MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
14	MW108			M1			M1			M1			M1
14	MW120			M1			M1			M1			M1
1, 14	MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
14	MW122			M1			M1			M1			M1
14	MW123			M1			M1			M1			M1
14	MW124			M1			M1			M1			M1
14	MW125			M1			M1			M1			M1
2, 14	MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW133			M1			M1			M1			M1
1, 14	MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
2, 14	MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
13, 14	MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW144			M1			M1			M1			M1
13, 14, 15	MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW146			M1			M1			M1			M1
13, 14	MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2, 14	MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
13, 14	MW152	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14, 15	MW155			M1			M1			M1			M1
14, 15	MW156			M1			M1			M1			M1
14	MW161			M1			M1			M1			M1
14, 15	MW163			M1			M1			M1			M1
14, 15	MW165A			M1			M1			M1			M1
14	MW168			M1			M1			M1			M1
14	MW169			M1			M1			M1			M1
14	MW173			M1			M1			M1			M1
14, 15	MW175			M1			M1			M1			M1
15	MW177			M1			M1			M1			M1
14	MW178			M1			M1			M1			M1
14	MW185			M1			M1			M1			M1
14	MW188			M1			M1			M1			M1
14	MW191			M1			M1			M1			M1
2, 14	MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
1, 14	MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
14	MW197			M1			M1			M1			M1
1, 13, 14	MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
14	MW200			M1			M1			M1			M1
1, 14	MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
1, 14	MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
14	MW203			M1			M1			M1			M1
14, 15	MW205			M1			M1			M1			M1
14	MW220			M1			M1			M1			M1
14	MW221			M1			M1			M1			M1
14	MW222			M1			M1			M1			M1
14	MW223			M1			M1			M1			M1
14	MW224			M1			M1			M1			M1
14	MW225			M1			M1			M1			M1
14	MW226			M1			M1			M1			M1
14	MW227			M1			M1			M1			M1
14	MW233			M1			M1			M1			M1
14	MW236			M1			M1			M1			M1
14	MW238			M1			M1			M1			M1
14	MW239			M1			M1			M1			M1
14	MW240			M1			M1			M1			M1
14	MW241A			M1			M1			M1			M1
14	MW242			M1			M1			M1			M1
14	MW243			M1			M1			M1			M1
14	MW244			M1			M1			M1			M1
14	MW245			M1			M1			M1			M1
14	MW247			M1			M1			M1			M1
14	MW248			M1			M1			M1			M1
14	MW249			M1			M1			M1			M1
14	MW250			M1			M1			M1			M1

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2, 14	MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
2, 14	MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14, 15	MW255			M1			M1			M1			M1
14, 15	MW256			M1			M1			M1			M1
14	MW257			M1			M1			M1			M1
14, 15	MW258			M1			M1			M1			M1
14, 15	MW260			M1			M1			M1			M1
14	MW261			M1			M1			M1			M1
13, 14	MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW283			M1			M1			M1			M1
14	MW284			M1			M1			M1			M1
14, 15	MW288			M1			M1			M1			M1
2, 14	MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14, 15	MW292			M1			M1			M1			M1
14	MW293A			M1			M1			M1			M1
14	MW294A			M1			M1			M1			M1
14	MW325			M1			M1			M1			M1
14	MW326			M1			M1			M1			M1
14	MW327			M1			M1			M1			M1
14	MW328			M1			M1			M1			M1
1, 14	MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
14	MW330			M1			M1			M1			M1
14	MW333			M1			M1			M1			M1
14	MW337			M1			M1			M1			M1
14	MW338			M1			M1			M1			M1
14	MW339			M1			M1			M1			M1
14	MW340			M1			M1			M1			M1
14, 15	MW341			M1			M1			M1			M1
14	MW342			M1			M1			M1			M1
14	MW343			M1			M1			M1			M1
14	MW345			M1			M1			M1			M1
14	MW346			M1			M1			M1			M1
14	MW347			M1			M1			M1			M1
13, 14	MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
1, 14	MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
14, 15	MW355			M1			M1			M1			M1
14	MW356			M1			M1			M1			M1
14	MW357			M1			M1			M1			M1
14	MW358			M1			M1			M1			M1
14	MW360			M1			M1			M1			M1
14	MW361			M1			M1			M1			M1
14	MW363			M1			M1			M1			M1
14	MW364			M1			M1			M1			M1
2, 14	MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14	MW367			M1			M1			M1			M1
14	MW369			M1			M1			M1			M1
14	MW370			M1			M1			M1			M1
14	MW372			M1			M1			M1			M1
14	MW373			M1			M1			M1			M1
14	MW376			M1			M1			M1			M1
14	MW380			M1			M1			M1			M1
14	MW381			M1			M1			M1			M1
14	MW384			M1			M1			M1			M1
14	MW385			M1			M1			M1			M1
14	MW387			M1			M1			M1			M1
14	MW388			M1			M1			M1			M1
14	MW391			M1			M1			M1			M1
14	MW392			M1			M1			M1			M1
2, 14	MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW395			M1			M1			M1			M1
14	MW397			M1			M1			M1			M1
14	MW401			M1			M1			M1			M1
14	MW402			M1			M1			M1			M1
2, 14	MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
2, 14	MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
14	MW414			M1			M1			M1			M1
14	MW415			M1			M1			M1			M1
14	MW416			M1			M1			M1			M1
14	MW417			M1			M1			M1			M1
2, 14	MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW419			M1			M1			M1			M1
14	MW420			M1			M1			M1			M1
14, 15	MW421			M1			M1			M1			M1
14	MW422			M1			M1			M1			M1
14	MW423			M1			M1			M1			M1
14	MW424			M1			M1			M1			M1
14, 15	MW425			M1			M1			M1			M1
1, 14	MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
1, 14	MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
1, 14	MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
1, 14	MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
1, 14	MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
1, 14	MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
1, 14	MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14	MW433			M1			M1			M1			M1
14	MW435			M1			M1			M1			M1
14	MW439			M1			M1			M1			M1
14	MW440			M1			M1			M1			M1
14	MW441			M1			M1			M1			M1
14	MW442			M1			M1			M1			M1
14	MW443			M1			M1			M1			M1
14	MW444			M1			M1			M1			M1
13, 14	MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW447			M1			M1			M1			M1
14	MW448			M1			M1			M1			M1
14	MW450			M1			M1			M1			M1
14	MW451			M1			M1			M1			M1
14	MW452			M1			M1			M1			M1
14	MW453			M1			M1			M1			M1
14	MW454			M1			M1			M1			M1
14	MW455			M1			M1			M1			M1
14	MW456			M1			M1			M1			M1
14	MW457			M1			M1			M1			M1
14	MW458			M1			M1			M1			M1
13, 14	MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW460			M1			M1			M1			M1
14	MW461			M1			M1			M1			M1
14	MW462			M1			M1			M1			M1
2, 14	MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
2, 13, 14	MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
2, 14	MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
2, 14	MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
2, 14	MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
2, 13, 14	MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
2, 13, 14	MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
2, 14	MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
2, 14	MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
2, 14	MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
14	MW478			M1			M1			M1			M1
14	MW479			M1			M1			M1			M1
14, 15	MW480			M1			M1			M1			M1
2, 14	MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
2, 13, 14	MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
2, 14	MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
2, 14	MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14	MW489			M1			M1			M1			M1
14	MW490			M1			M1			M1			M1
13, 14	MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
14	MW492			M1			M1			M1			M1
14	MW493			M1			M1			M1			M1
14	MW494			M1			M1			M1			M1
14, 15	MW495			M1			M1			M1			M1
2, 14, 15	MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW497			M1			M1			M1			M1
14	MW498			M1			M1			M1			M1
14	MW499			M1			M1			M1			M1
14	MW500			M1			M1			M1			M1
14	MW501			M1			M1			M1			M1
14	MW502			M1			M1			M1			M1
14	MW503			M1			M1			M1			M1
14	MW504			M1			M1			M1			M1
14, 15	MW505			M1			M1			M1			M1
14, 15	MW506			M1			M1			M1			M1
14, 15	MW507			M1			M1			M1			M1
14, 15	MW524			PT+M1			M1			M1			M1
14, 15	MW525			M1			CB+PT+M1			M1			M1
14, 15	MW526			M1			M1			CB+PT+M1			M1
14, 15	MW527			CB+PT+M1			M1			M1			M1
14, 15	MW528			M1			M1			M1			M1
14, 15	MW529			M1			PT+M1			M1			M1
14, 15	MW530			M1			M1			PT+M1			M1
14, 15	MW531			M1			M1			M1			M1
14, 15	MW532 (PZ)			M1			M1			M1			M1
14, 15	MW533			M1			M1			M1			M1
14, 15	MW534 (PZ)			M1			M1			M1			M1
14, 15	MW535 (PZ)			M1			M1			M1			M1
14	MW536			M1			M1			M1			M1
14, 15	MW537			M1			M1			M1			M1
14	MW538			M1			M1			M1			M1
14, 15	MW539			M1			M1			M1			M1
14, 15	MW540 (PZ)			M1			M1			M1			M1
14, 15	MW541 (PZ)			M1			M1			M1			M1
14	MW542			M1			M1			M1			M1
14	MW543			M1			M1			M1			M1
14	MW544			M1			M1			M1			M1
14	MW545			M1			M1			M1			M1
14	MW546			M1			M1			M1			M1
14	MW547			M1			M1			M1			M1
14	MW548			M1			M1			M1			M1
14	MW549			M1			M1			M1			M1
14	MW550			M1			M1			M1			M1
14	MW551			M1			M1			M1			M1

Table 20. Summary of Monitoring Wells included in Groundwater Strategy Near-Term Activities (Continued)

		Month											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14, 15	MW553 (PZ)			M1			M1			M1			M1
14, 15	MW554 (PZ)			M1			M1			M1			M1
14, 15	MW555 (PZ)			M1			M1			M1			M1
14, 15	MW556			M1			M1			M1			M1
14	PZ107			M1			M1			M1			M1
14	PZ109			M1			M1			M1			M1
14, 15	PZ110			M1			M1			M1			M1
14	PZ114 (if not abandoned)			M1			M1			M1			M1
14	PZ115 (if not abandoned)			M1			M1			M1			M1
14	PZ117			M1			M1			M1			M1
14	PZ118			M1			M1			M1			M1
14	PZ287			M1			M1			M1			M1
14	PZ289			M1			M1			M1			M1
14	PZ290			M1			M1			M1			M1
14	PZ349			M1			M1			M1			M1
14	PZ351			M1			M1			M1			M1
14	EW232			M1			M1			M1			M1
14	EW233			M1			M1			M1			M1
14	EW234			M1			M1			M1			M1
14	EW235			M1			M1			M1			M1

Notes:

CB=Colloidal Borescope Deployment

PT=Pressure Transducer Deployment

M1=Manual Water Level Collected Once per Month

M2= Manual Water Level Collected Twice per Month

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Figure 7. Manual Water Level Measurements
(E-size Drawing)

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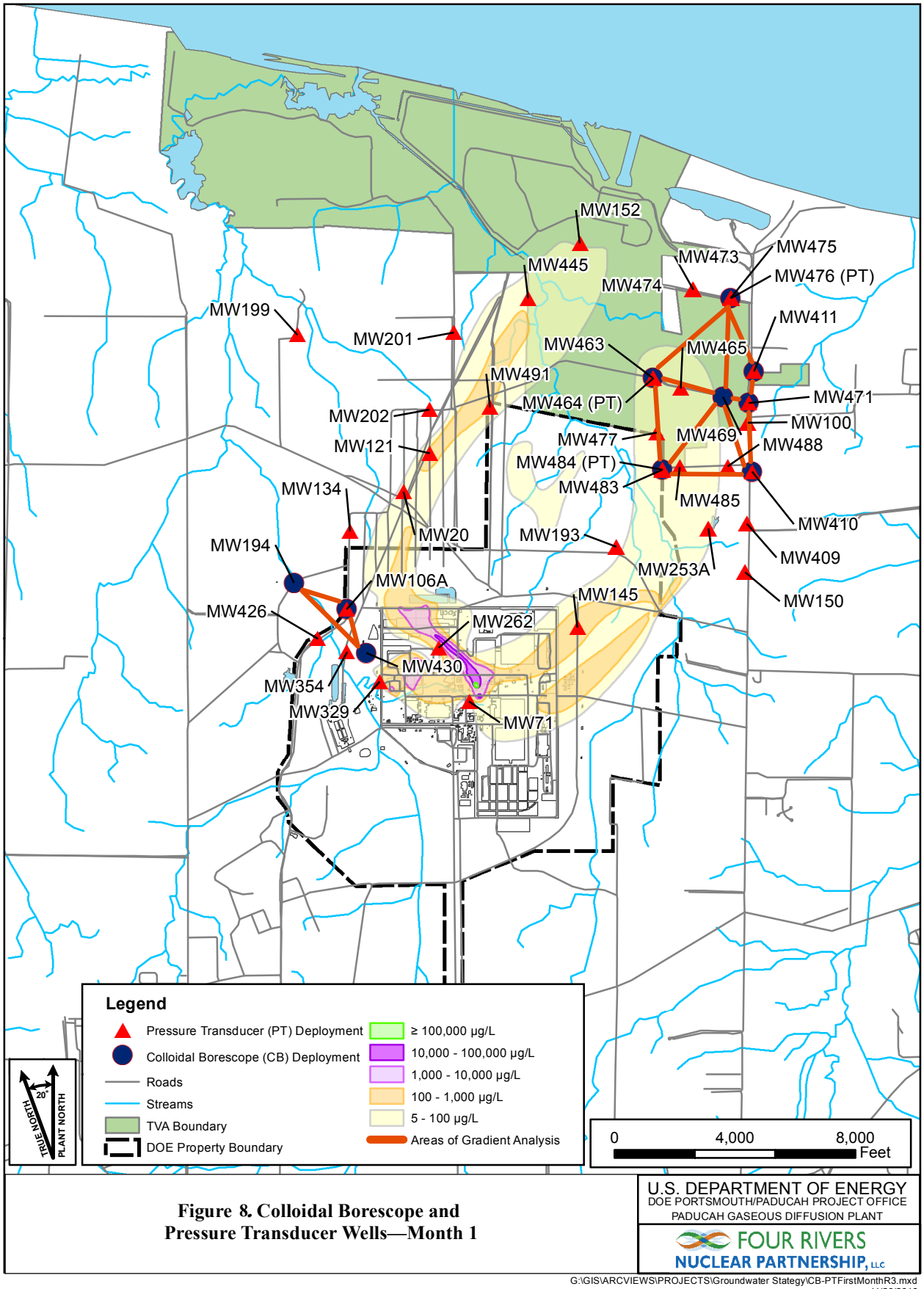

Figure 8. Colloidal Borescope and Pressure Transducer Wells—Month 1

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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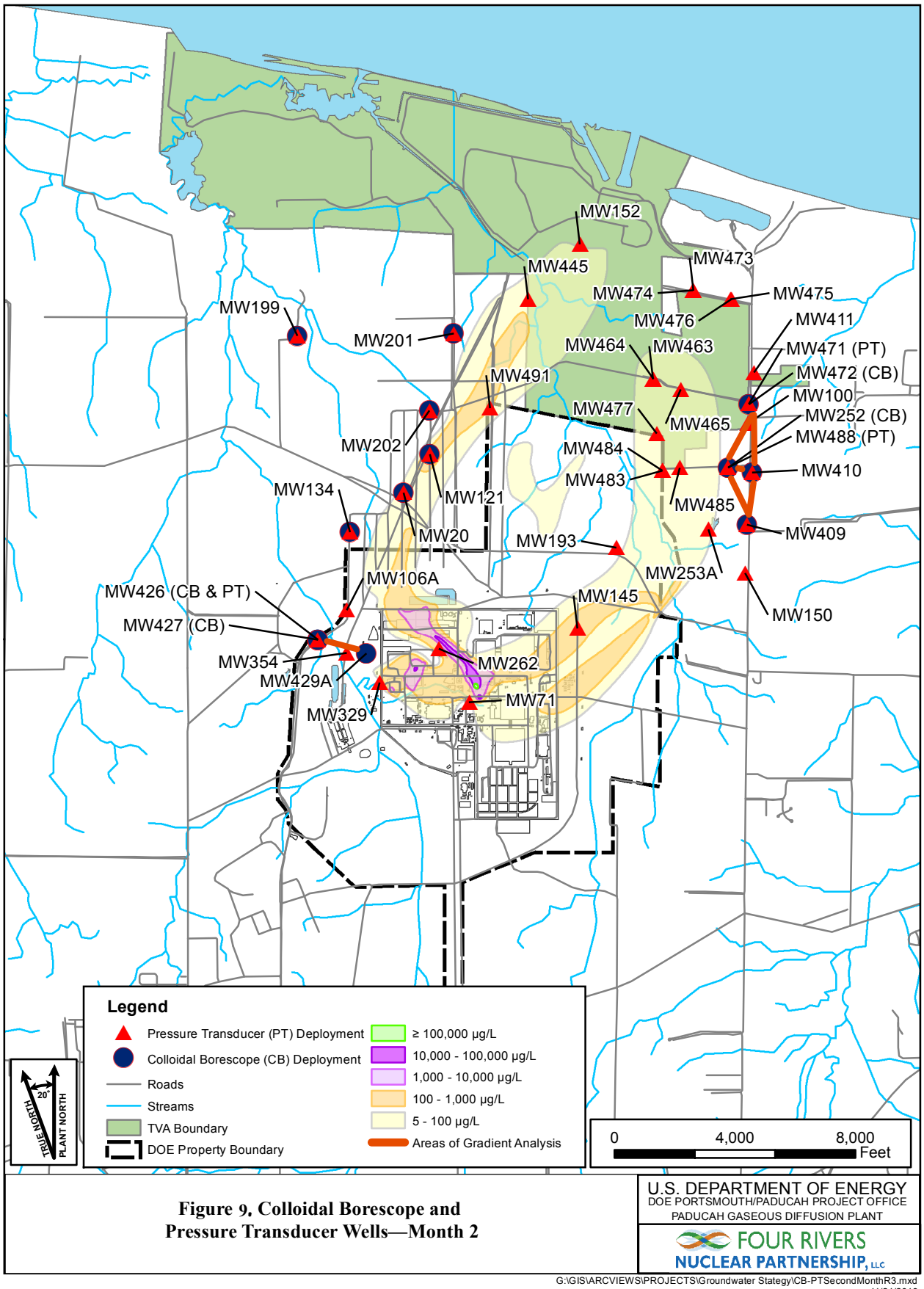

Figure 9. Colloidal Borescope and Pressure Transducer Wells—Month 2

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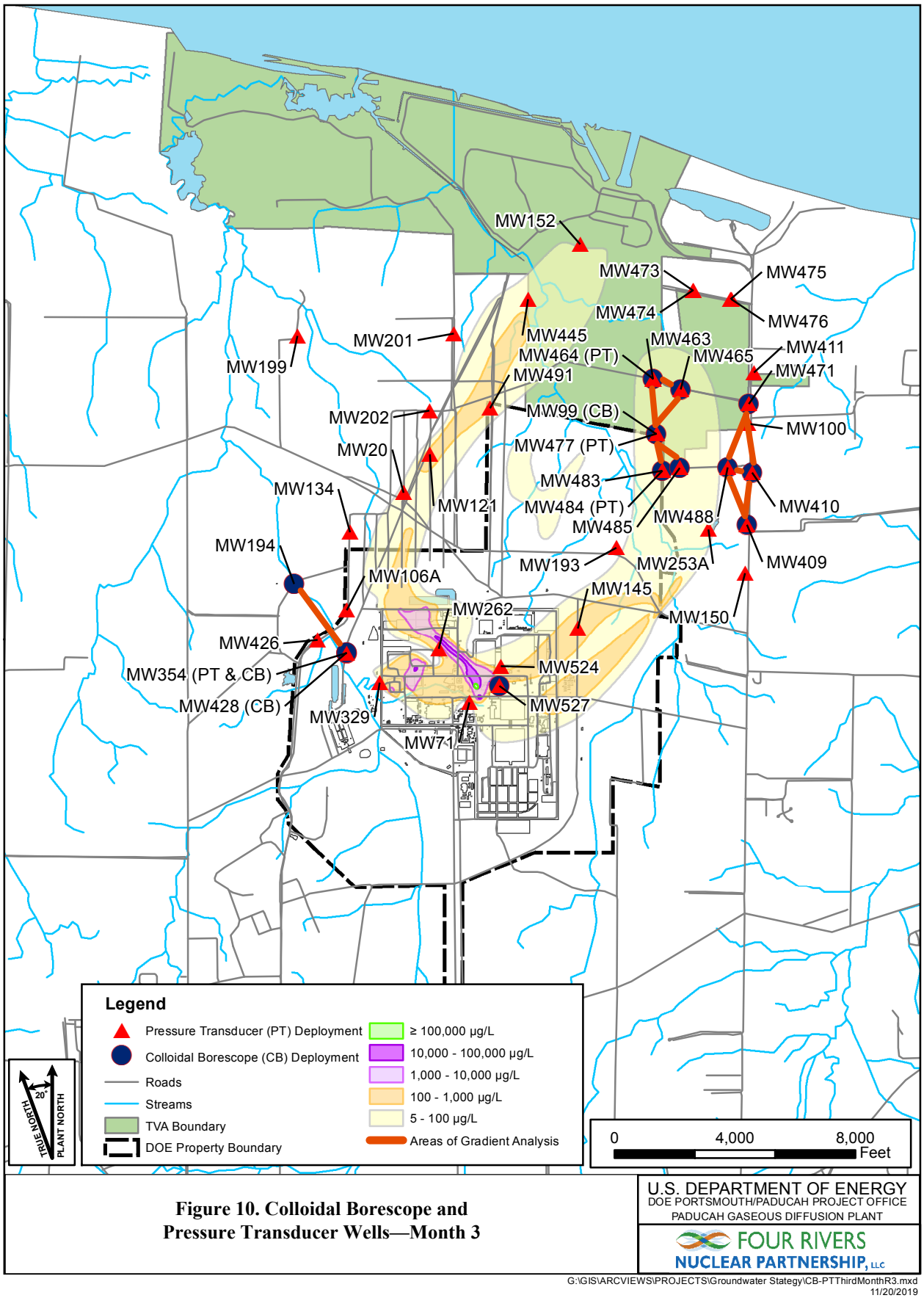

Figure 10. Colloidal Borescope and Pressure Transducer Wells—Month 3

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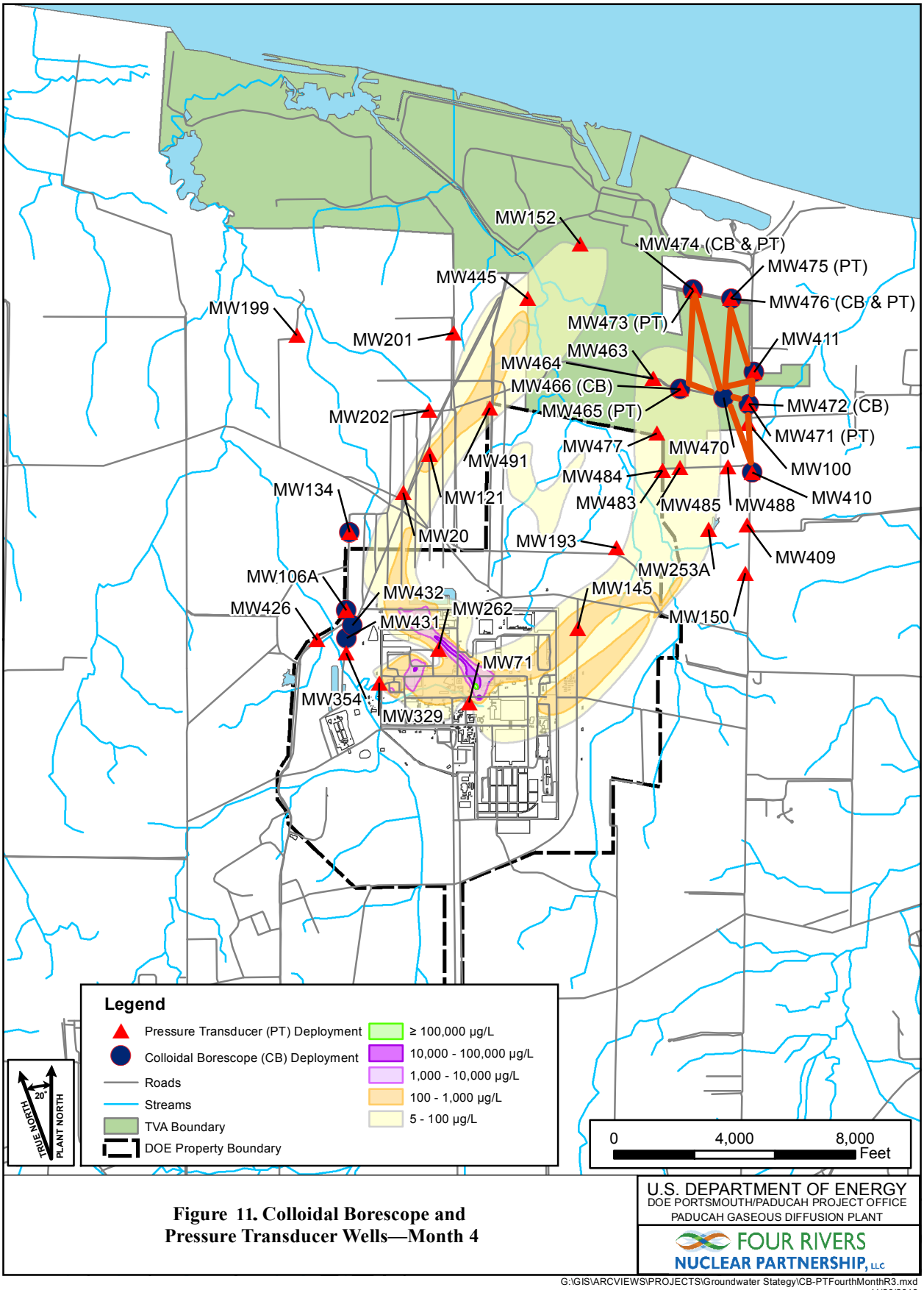

Figure 11. Colloidal Borescope and Pressure Transducer Wells—Month 4

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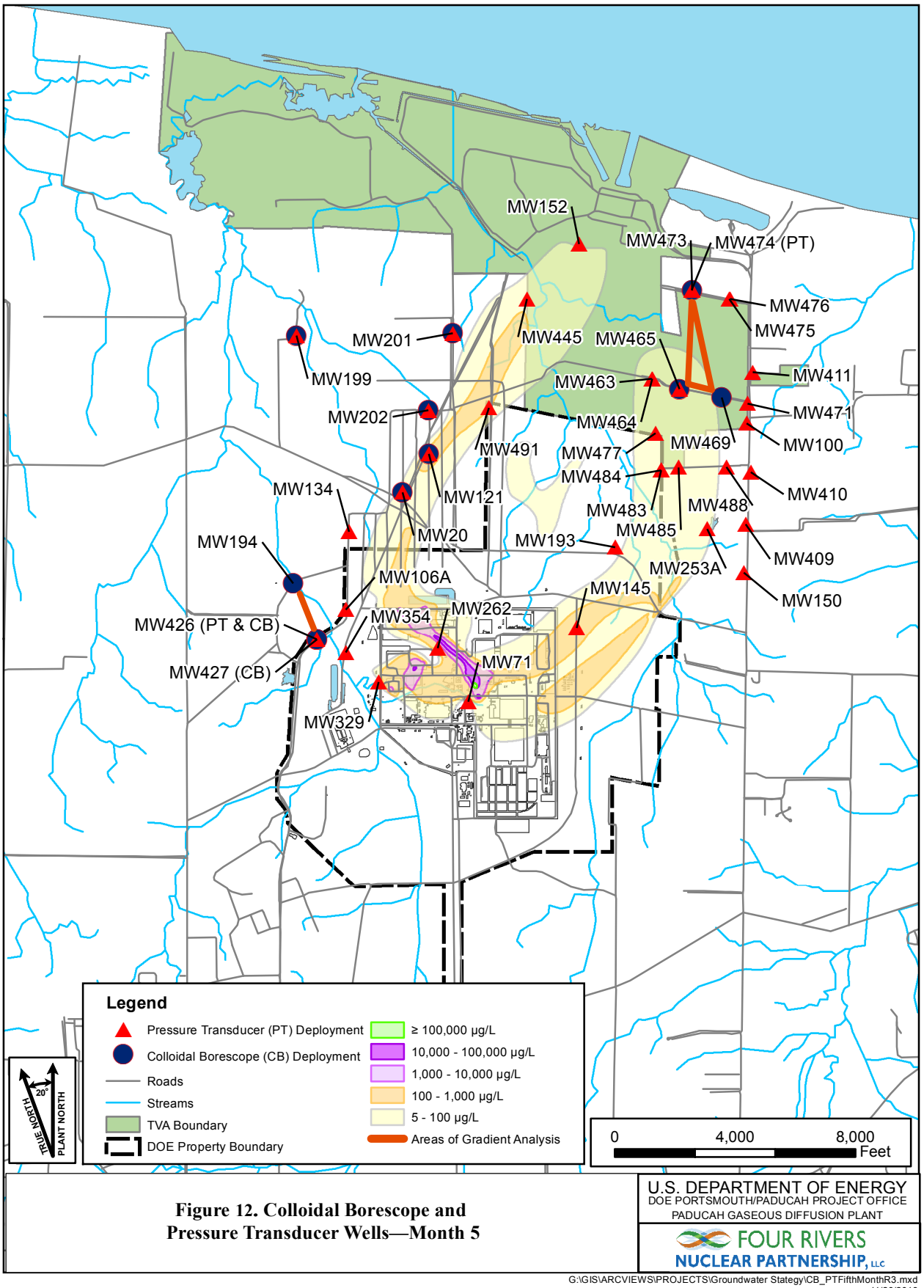

Figure 12. Colloidal Borescope and Pressure Transducer Wells—Month 5

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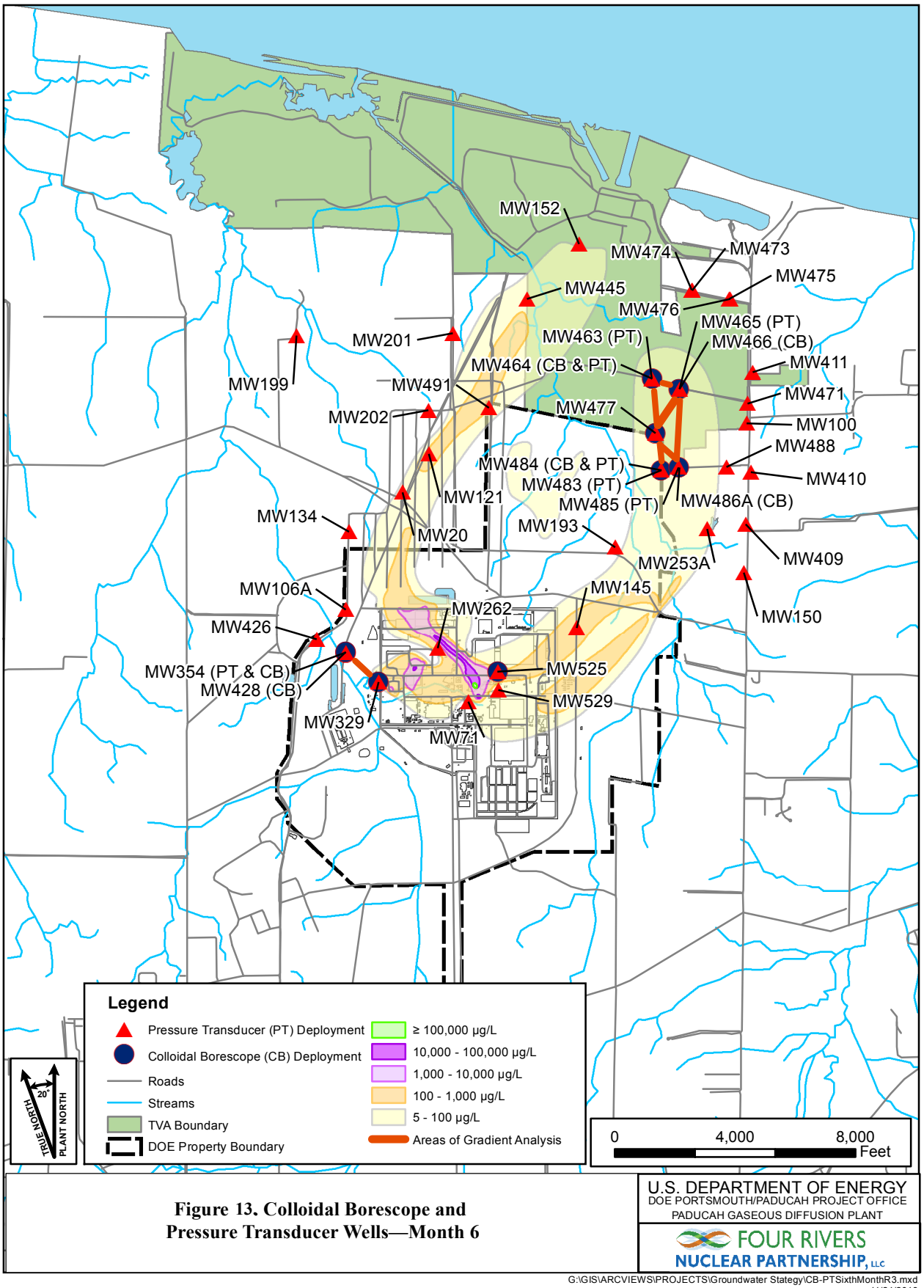

Figure 13. Colloidal Borescope and Pressure Transducer Wells—Month 6

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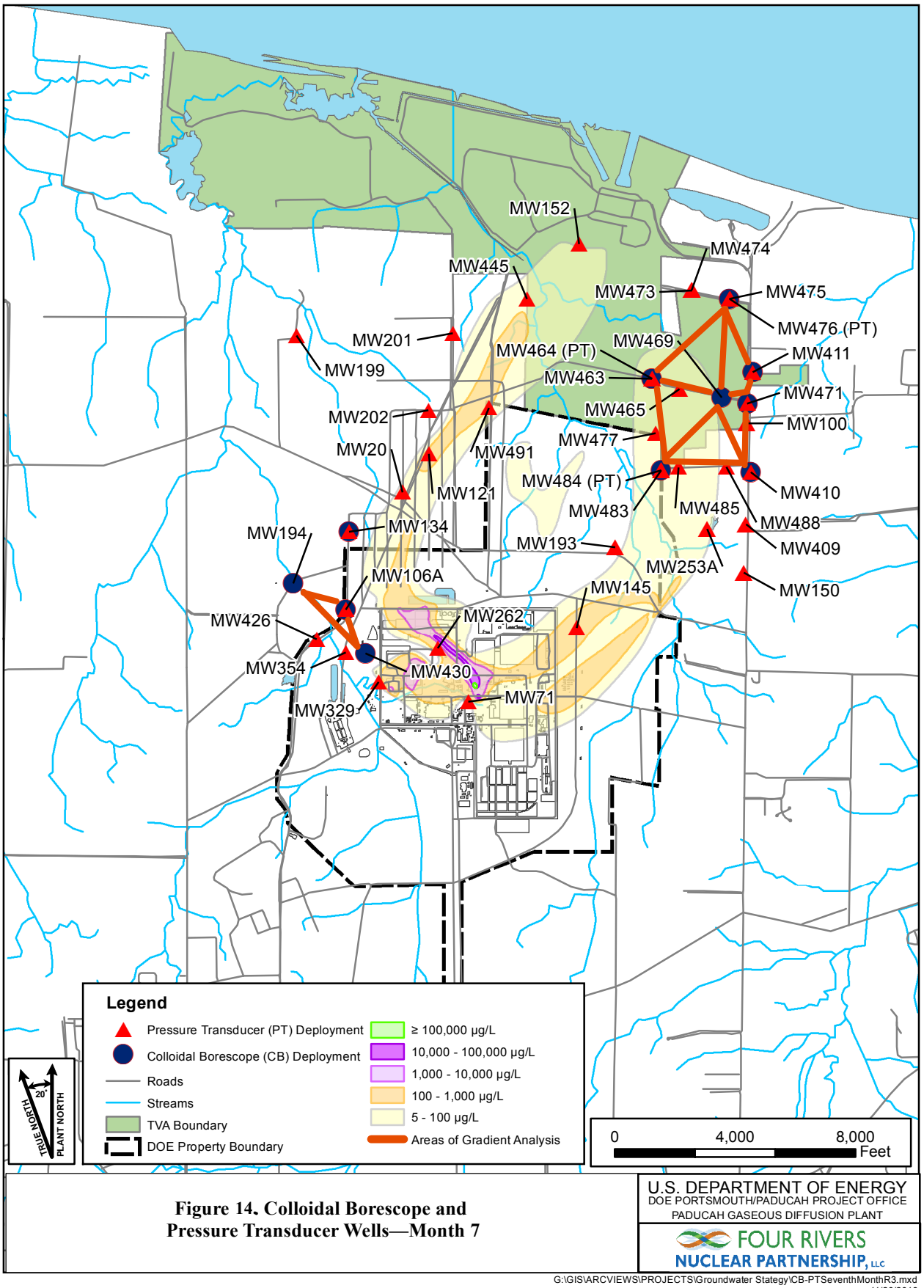

Figure 14. Colloidal Borescope and Pressure Transducer Wells—Month 7

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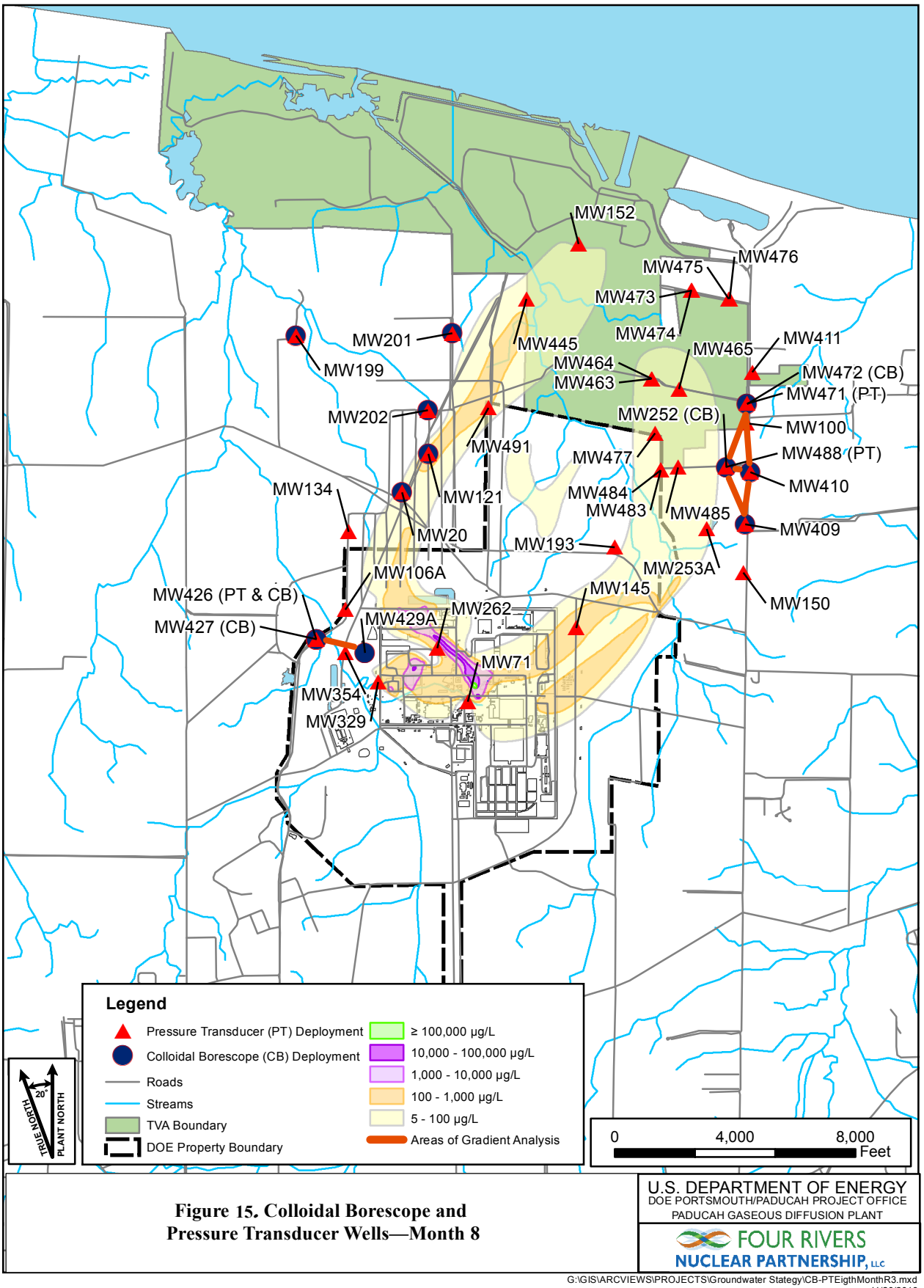

Figure 15. Colloidal Borescope and Pressure Transducer Wells—Month 8

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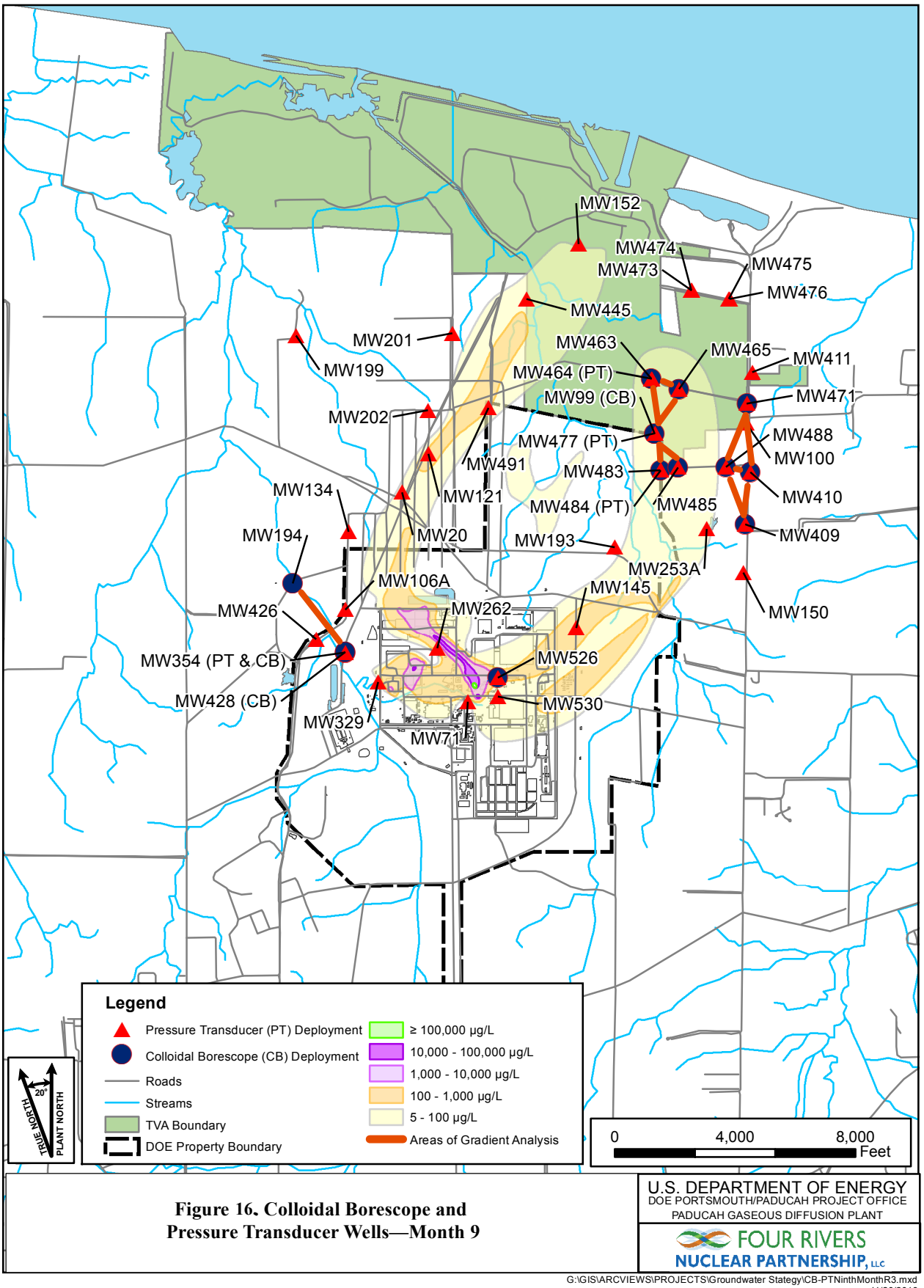

Figure 16. Colloidal Borescope and Pressure Transducer Wells—Month 9

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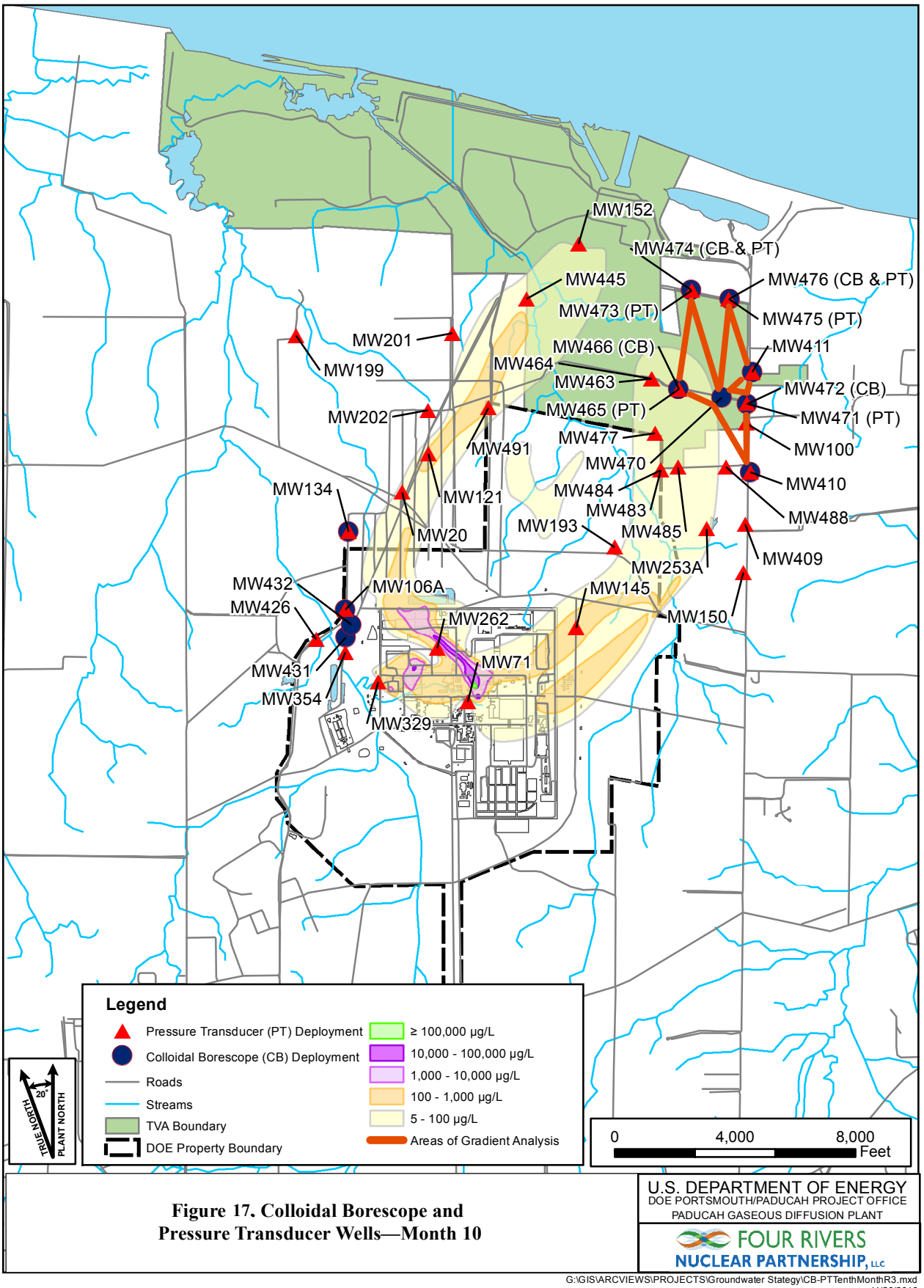

Figure 17. Colloidal Borescope and Pressure Transducer Wells—Month 10

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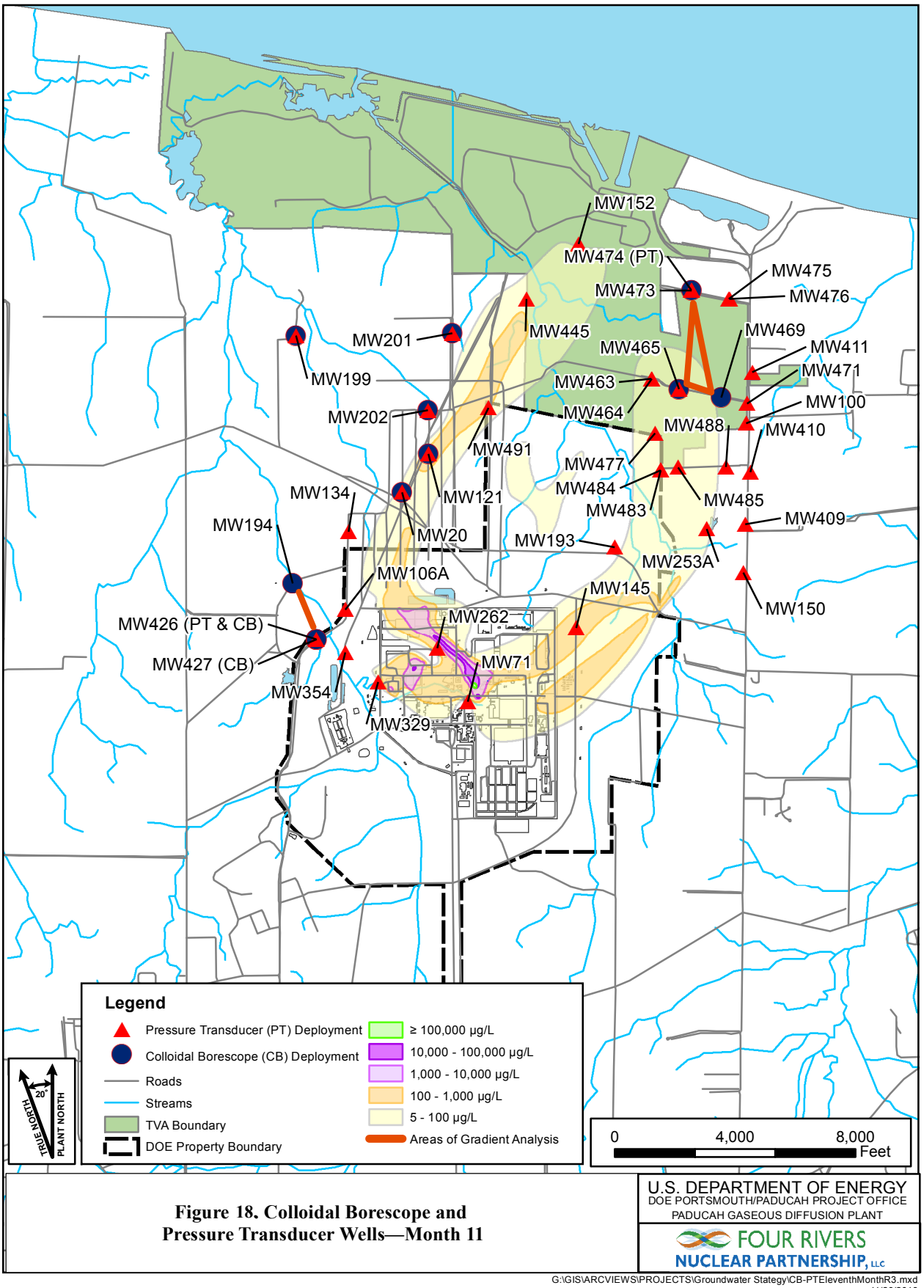

Figure 18. Colloidal Borescope and Pressure Transducer Wells—Month 11

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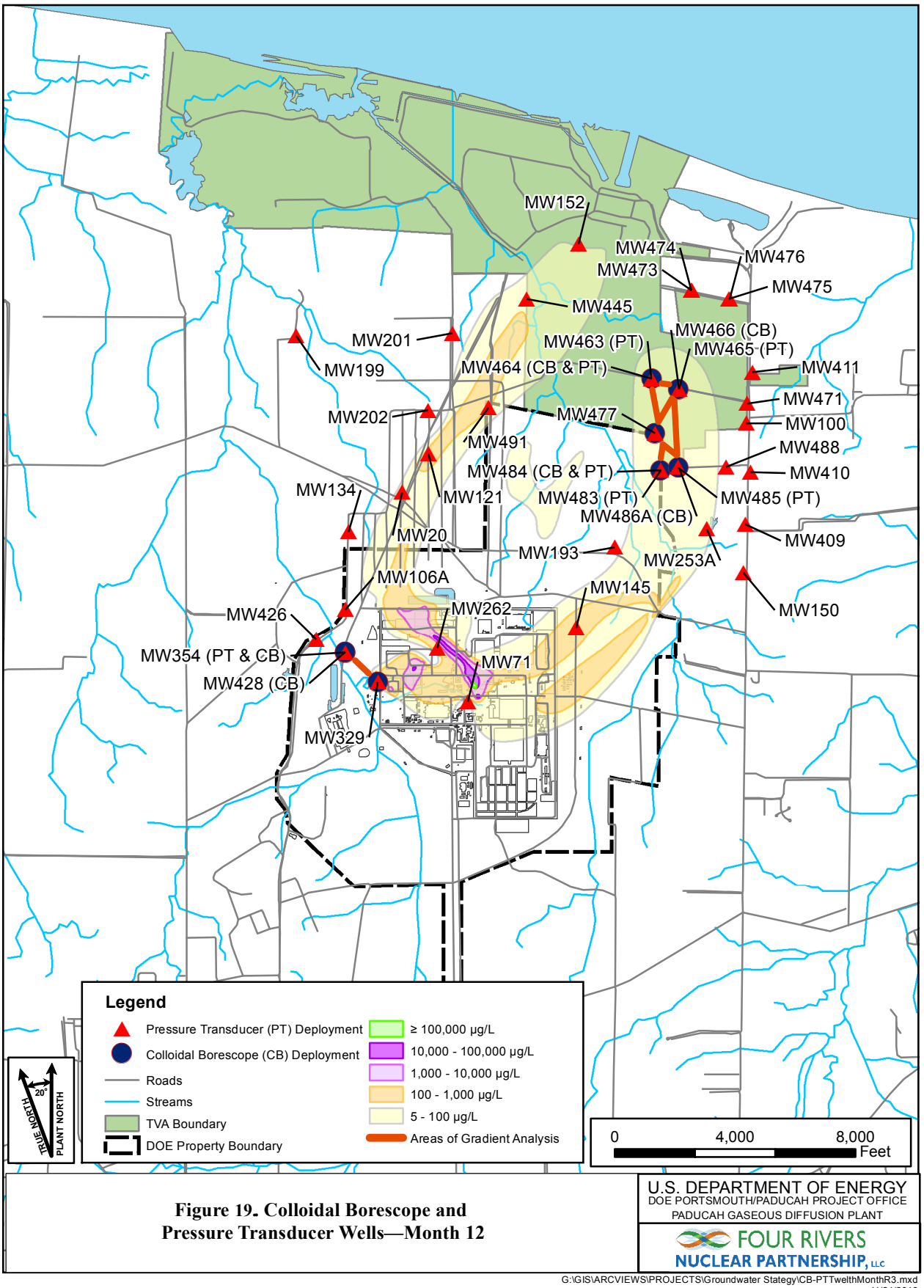

Figure 19. Colloidal Borescope and Pressure Transducer Wells—Month 12

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4.11 NEAR-TERM COMPLETION CRITERIA

Each activity has a specified duration of monitoring, number of laboratory analyses, or completion of soil borings. These data provide the inputs into a white paper for each activity, as applicable. The white papers will contain a summary of the field components, summary of data collected during the activity, and a brief interpretation of the data. The white papers also may provide recommendations for follow-on investigation or additional data analysis. Any follow-on investigation or additional data analysis, including analysis across multiple activities, is not part of the GWSP described by this PMP. Completion criteria or end points for each activity are summarized in Table 21.

4.12 ACCESS

4.12.1 Off-Property Wells

A subset of the wells that will be used for data collection in this PMP are located off-property on residential properties as well as on the TVA reservation. Access to these wells will require transportation of sampling equipment and waste streams associated with the activities on public roads, will require personnel to have TVA training and site access credentials, and also will require notification to residential landowners prior to accessing property.

4.12.2 Monitoring Well Configuration

The wells planned for colloidal borescope deployment will be assessed for access. If needed, replacement well heads will be procured and installed. Additionally, the well surface casings may require modification to allow the borescope data cable access. Modification of the well surface casings will be completed under the supervision of a Kentucky Certified Well Driller, and appropriate documentation will be submitted to the Kentucky Division of Water [401 *KAR* 6:350(10)].

4.13 QUALITY ASSURANCE PROJECT PLAN

The EMP QAPP will be amended and used for the activities in this PMP, as applicable. The QAPP includes information on data assessment, data validation, data handling, and data storage.

Table 21. Summary of Near-Term Completion Criteria

Activity No.	Area of Concern	Task(s)	Subtask(s)	Field Completion	Post-Field Data Completion Criteria
1	TCE Extent West of PGDP (SW Plume)	Optimize existing groundwater monitoring network	Review frequency of sampling and analysis and synoptic sampling and analysis	N/A	N/A
		RGA potentiometric trend investigation	Water level/colloidal borescope investigation	• 12 months of field data collection from 11 wells — 36 colloidal borescope datasets — 4 continuous water level datasets — 264 manual water level measurements	N/A
		Develop/revise CSM	Review geology, hydrology, and contaminant trends	N/A	• White paper
2	TCE Extent East of PGDP (Downgradient NE Plume)	RGA potentiometric trend investigation	Map sitewide synoptic water level data	N/A	• Map showing synoptic data
			NE Plume synoptic water level measurements	• 12 months of field data collection from 42 wells — 70 colloidal borescope datasets — 6 continuous water level datasets — 504 manual water level measurements	• Map showing synoptic data
			Continuous water level measurements		
			Colloidal borescope investigation		
		NE Plume optimization hydraulics analysis	N/A	N/A	• White paper

Table 21. Summary of Near-Term Completion Criteria (Continued)

Activity No.	Area of Concern	Task(s)	Subtask(s)	Field Completion	Post-Field Data Completion Criteria
8	TCE Extent and Trends in West Side of Downgradient NE Plume	RGA potentiometric trend investigation	Map sitewide synoptic water level data	N/A	• Map showing synoptic data
			NE Plume synoptic water level measurements	• 12 months of field data collection from Activity 2	• Map showing synoptic data • White paper
			Continuous water level measurements		
			Colloidal borescope measurements		
13	Continuous RGA Water Level Monitoring	Continuous RGA water level records over a period of a year in the vicinity of the Ohio River and along a transect of wells extending back to the PGDP industrial area	White Paper	N/A	• White paper
			Continuous and manual water level measurements	• 12 months of field data collection from 15 wells — 9 continuous water level datasets — 180 manual water level measurements	N/A
			Report	N/A	• White Paper
		Deployment of continuous water level recorders in select MWs/PZs within the plant area to assess recharge better and its impact on nearby water levels	Continuous water level measurements	• Estimate deployment in 3 wells for a 12 months	• White Paper
14	Synoptic Water Level Measurement	Increased water level measurement events conducted during different seasons	Seasonal water level measurements	N/A	• White paper
		A synoptic data set collected under steady conditions at the higher river stage anticipated to start in 2018 when the Olmsted Locks and Dam are scheduled to be operational	Synoptic data set before operation begins at Olmsted Locks and Dam	• 1 quarter of field data collection from 296 wells	
			Synoptic data set after operation begins at Olmsted Locks and Dam	• 4 quarters of field data collection from 296 wells — 1,184 manual water level measurements	

Table 21. Summary of Near-Term Completion Criteria (Continued)

Activity No.	Area of Concern	Task(s)	Subtask(s)	Field Completion	Post-Field Data Completion Criteria
15	Water Level Divide Study	Assessing water level and water quality data collected from the newly installed transect of MWs located east of the C-400 Cleaning Building	N/A	• 4 quarters of field data collection from 46 wells — 3 colloidal borescope datasets — 6 continuous water level datasets — 184 manual water level measurements	• White paper
		Colloidal borescope study in the vicinity of the apparent groundwater divide located east of the C-400 Cleaning Building to refine understanding of groundwater flow in the area	N/A		
17	MW Survey Study	Review existing MW survey information	N/A	• Survey of 139 MWs inside the main plant area • Survey of 26 MWs near the main plant area.	• Presentation on well reference points, types of survey, and current database structure, plan/progress for resurvey
		Review survey data in context of plume maps	N/A	N/A	• Write-up or presentation on confidence of survey data based on plume map depiction
18	Groundwater Chemical Trend Evaluation	Assess existing groundwater analytical data for trends and whether analyses should be revised	N/A	N/A	• White paper

5. PROJECT ORGANIZATION AND COMMUNICATIONS

5.1 PROJECT ORGANIZATION

This project will be managed by the FRNP Environmental Services (ES) organization. Within the ES organization, the Environmental Stewardship group will have the overall responsibility for implementing the project, project budget, and project schedule. Other organizations and groups will provide support to the project as shown in Figures 20 and 21.

The GWSP has overlap and interface with several ongoing projects at the Paducah Site, including Pump-and-Treat Operations, which include the NEPCS and NWPGS, the Water Policy Evaluation project, C-400 RI/FS, and the Groundwater MWG. These and other projects that may be identified as having overlap or requiring interface with the GWSP will be coordinated through the GWSP Manager [project manager (PM)] (Figure 21).

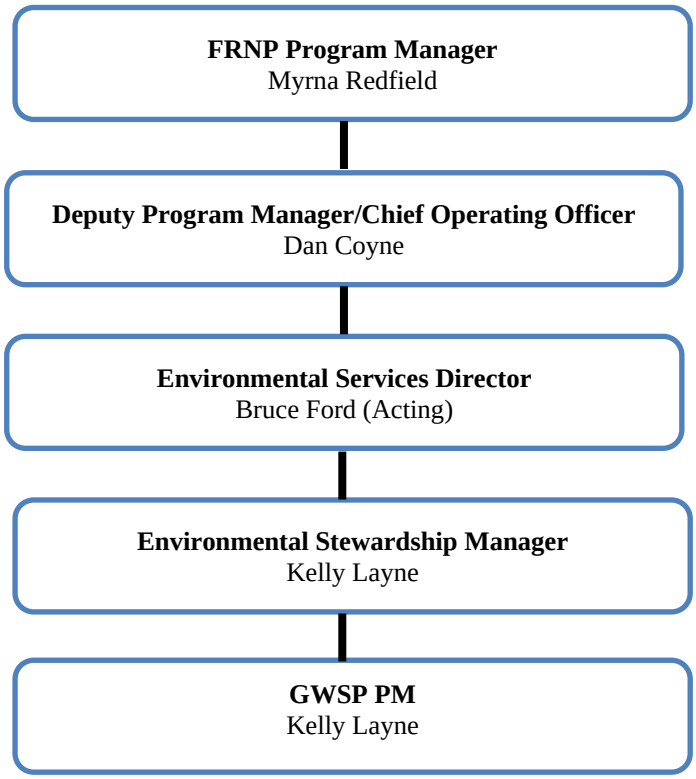

Figure 20. FRNP Senior Management Organization for the GWSP

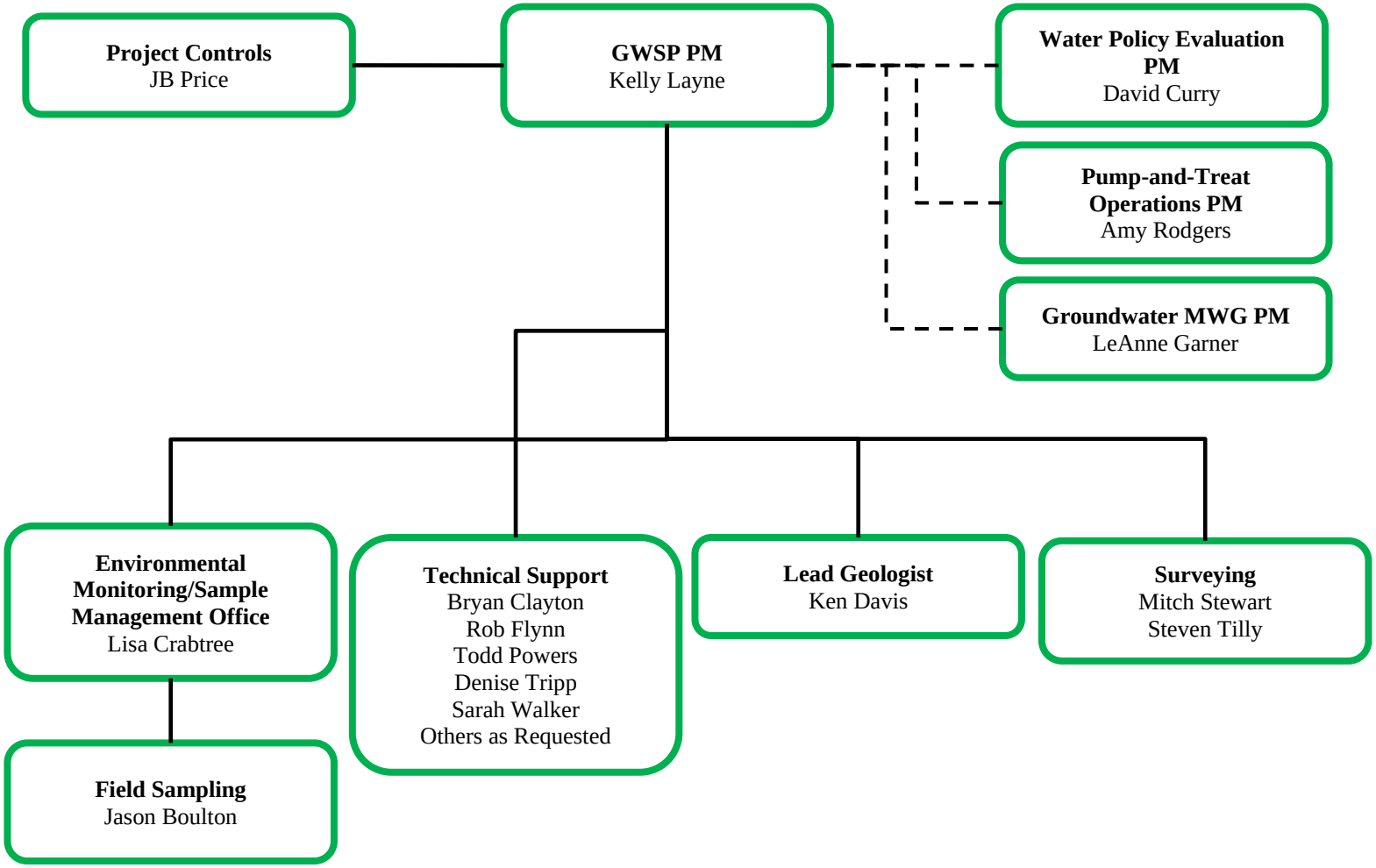

Figure 21. GWSP Organization

5.2 COMMUNICATION

Project communications will be managed by the GWSP PM or designee. The following communications will be approved in advance.

- Communications between the GWSP and different projects or organizations that involve direction, instruction, decisions, or authorization of work associated with this GWSP will be approved by the GWSP PM or designee, in advance.

- All communication between the GWSP and external stakeholders (e.g., EPA, Kentucky, the public, etc.) will be approved in advance by the GWSP PM and the Environmental Stewardship Manager or designees, and DOE.

Records associated with the GWSP will be managed as appropriate and as described in FRNP's record management process.

6. QUALITY ASSURANCE AND RECORDS

6.1 QUALITY ASSURANCE PROGRAM

The activities in this PMP will be performed in accordance with the FRNP Quality Assurance Program, CP2-QA-1000. Performance documents necessary to implement requirements for the Quality Assurance Program and the applicable QA requirements mandated by regulations and the FRNP Contract are contained in project execution and support organization performance documents (e.g., procedures, policies, and directives) and QAPPs.

6.2 SOFTWARE QUALITY ASSURANCE

Both the pressure transducers and colloidal borescopes require software to download and process the data collected by the units. The equipment and software needed for the performance of the GWSP are commercially available and will be evaluated per FRNP procedures, as applicable.

6.3 RECORDS

The QA program is designed in accordance with FRNP CP3-ES-5003, *Quality Assured Data*, and EPA's *Guidance on Systematic Planning using the Data Quality Objectives Process* (EPA/240/B-06/001) (EPA 2006). The following QA records are generated by the activities in this PMP.

- DQOs
- Field logbooks and/or sample data forms
- Chain-of-custody records
- Sample and field measurement data
- Field change from this GWSP
- Data validation

6.3.1 Field Logbook/Sample Data Forms

Samplers and other project personnel shall maintain a field logbook and/or sample data forms in accordance with FRNP procedure CP4-ES-2700, *Logbooks and Data Forms*, as appropriate. This procedure provides guidelines for the minimum entries to be made in field logbooks and/or sample data forms to ensure that day-to-day events are documented properly during the preparation, performance, and closure of field activities. Field logbook/sample data form entries shall be made in a manner that provides a defensible record of the work that has been performed with sufficient data and observations to enable participants to reconstruct events that occurred during work execution. All entries shall be factual, detailed, and objective.

6.3.2 Chain-of-Custody

Samplers shall maintain custody, document transfer, and ship or transfer samples in accordance with chain-of-custody protocols. FRNP procedure CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*, describes the protocol for documenting possession (i.e., custody, transfer, and shipment) of samples from the point of collection to the point of acceptance by the designated laboratory to ensure integrity of the samples. This procedure includes requirements for generation, use, and completion of chain-of-custody forms.

6.3.3 Change Control

Any changes to the activity scopes will be documented through field change. Field changes could impact the number, quality, or collection of planned field or analytical data.

7. HEALTH AND SAFETY

FRNP maintains a Worker Safety and Health Program established to reduce or prevent occupational injuries, illnesses, and accident losses by providing FRNP employees with a safe and healthful workplace. This Worker Safety and Health Program is defined in CP2-HS-2000, *Worker Safety and Health Program for the Paducah Gaseous Diffusion Plant*. It is anticipated that most, if not all, field activities associated with the GWSP are addressed by CP2-ES-0061, *Site-Specific Health and Safety Pan for the Environmental Monitoring Project at the Paducah Gaseous Diffusion Plant*. During implementation of the project, specific work instruction and hazard controls will be developed at the activity level for use by the personnel performing the work in accordance with CP2-SM-1000, *Activity Level Work Planning and Control Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*.

FRNP is committed to implementing an Integrated Safety Management System (ISMS) and an Environmental Management System (EMS) that join together personnel and environmental safety into management and work practices at all levels so that missions are accomplished while protecting the public, the workers, and the environment. The concepts of ISMS/EMS will be utilized to provide a formal, organized process to ensure the safe performance of work. The ISMS/EMS Plan identifies the methodologies that will be used to address previously recognized hazards and how the hazards are mitigated using FRNP-accepted practices.

8. SCHEDULE

A draft schedule is provided in Figure 22. Activities included in this PMP are denoted in blue, with activities to be developed indicated in green. This schedule is intended to show the interrelationship between different activities and general sequencing. Activity and task start dates and durations will be adjusted as appropriate and will be managed in a field execution schedule.

9. PROJECT RISKS

Project risk identification, documentation, management, reviews, and reporting are described in CP3-PO-0100, *Risk Management*. Project team members are responsible for identifying project risks; participation in the risk assessment process, including identifying handling strategies, review or project risk assessments, and providing input to cost and schedule impact estimates. These inputs are evaluated as part of CP3-PO-0100 and added as appropriate to FRNP's Risk Management Plan.

Project risks may involve uncertainty, schedule, and technical-based risk and may change over the course of the project. Table 22 summarizes the project risks for the GWSP activities included in this PMP. The project risks may be revised, added, or deleted as the project progresses or as information becomes available.

Figure 22. Draft Schedule

Activity	Task Name	CY2018	CY2019 Q1	CY2019 Q2	CY2019 Q3	CY2019 Q4	CY2020 Q1	CY2020 Q2	CY2020 Q3	CY2020 Q4	CY2021	CY2022	CY2023
Environmental Indicator - Human Exposure Under Control													
1	**#1 - TCE Extent West of PGDP (SW Plume)**												
	Optimize Existing GW Monitoring Network	Complete											
	Procure Colloidal Borescopes		Complete										
	Procure Groundwater Level Data Loggers		Complete										
	Calibrate On-Site Groundwater Data Loggers		Complete										
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)												
	Develop/Revise Conceptual Site Model												
	Reporting												
2	**#2 - TCE Extent East of PGDP (Downgradient NE Plume)**												
	NE Plume Optimization Hydraulic Assessment	Complete											
	Map Sitewide Synoptic Water Level Data	Complete											
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)												
	Review Data and Prepare Map(s)												
	Reporting												
3	**#3 - North Extent of PGDP TCE Plumes (Impacts to Ohio River)**												
	Develop/Revise Conceptual Site Model							**2, 8, 13, 14 Task Development and Schedule Pending**					
	Reporting												
4	**#4 - Nature and Extent of Dissolved-Phase Contaminants Currently Contributed by Little Bayou Creek Seeps**												
	Hydraulic Trend Investigation							**1, 2 Task Development and Schedule Pending**					
	Develop/Revise Conceptual Site Model												
	Stream Flow Gain/Loss in the Seeps Area and Stream Sampling												
	Reporting												
5	**#5 - Nature and Extent of Dissolved-Phase Contaminants Other than TCE and Tc-99**												
	Develop/Revise Conceptual Site Model										**1, 2, 4, 8 Task Development and Schedule Pending**		
	Review/Summary of Analytical Data												
	Reporting												
Environmental Indicator - Groundwater Migration Under Control													
6	**#6 - Capture Efficiency of NW Plume Extraction Wells**												
	White Paper: *Revised Evaluation of TCE Trends in MW460* (DOE 2019)		Complete										
	Develop/Revise Conceptual Site Model									**1, 13, 14 Task Development and Schedule Pending**			
	Optimize Extraction Well Pump Rates and Pump Depths												
	Optimize Groundwater Monitoring Network												
	Colloidal Borescope Investigation												
	Monitoring Well Installation												
	Update NW Plume Extraction Well Capture Zone Assessment												
	Reporting												
7	**#7 - TCE Extent and Trends in East Side of Downgradient NW Plume**												
	Map Sitewide Synoptic Water Level Data									**1, 13, 14 Task Development and Schedule Pending**			
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)												
	Drive Point Geology/TCE investigation												
	Monitoring Well/Piezometer Installation												
	Reporting												
8	**#8 - TCE Extent and Trends in West Side of Downgradient NE Plume**												
	Map Sitewide Synoptic Water Level Data	Complete											
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)												
	Drive Point Geology/TCE Investigation							**2 Task Development and Schedule Pending**					
	Monitoring Well/Piezometer Installation												
	Reporting												
9	**#9 - RGA Dissolved-phase and DNAPL contaminant impacts to the McNairy formation**												
	Develop/Revise Conceptual Site Model									**8 Task Development and Schedule Pending**			
	Review/Summary of Analytical Data												
	Reporting												
Modeling Working Group - Recommendations and Data Needs													
10	**#10 - Characterize Underflow from the Terrace Area**												
	Conceptual Site Plan									**8 Task Development and Schedule Pending**			
	Piezometer Installation												
	Terrace Area Synoptic Water Level Measurements												
	Reporting												

Figure 22. Draft Schedule (Continued)

Activity	Task Name	CY2018	CY2019				CY2020				CY2021	CY2022	CY2023
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
11	**#11 - Expansion of GW Monitoring Network**												
	Review of Earthcon evaluation				**1, 2, 8, 13, 14, 15 Task Development and Schedule Pending**								
	Monitoring Well Installation												
	Civil Survey of Creek Bottom												
	Reporting												
	Obtain and Review TVA Monitoring System Data		**Complete**										
12	**#12 - Water Balance Study**												
	Monitoring and Documentation of the Ongoing Utility Optimization Program									**Task Development and Schedule Pending**			
	Compilation of Available Information Regarding the Chronology of Roof Drain Repairs												
	Expanded Assessment of the Water Supply and Storm Water Systems												
	Reporting												
13	**#13 - Continuous RGA Water Level Monitoring**												
	White Paper: *Continuous Regional Gravel Aquifer Water Level Monitoring at the Paducah Site*		**Complete**										
	Water Level Investigation (1 Year of Data Collection)												
	Reporting												
14	**#14 - Synoptic Water Level Events**												
	Field Synoptic Water Level Measurement Pre-Olmstead Dam Operation	**Complete**											
	Field Synoptic Water Level Measurement Post-Olmstead Dam Operation												
	Reporting												
15	**#15 - Water Level Divide Study**												
	White Paper: *Assessment of Sitewide Groundwater Flow Model Using Monitoring Wells at the Paducah Site*		**Complete**										
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)												
	Reporting												
16	**#16 - Hydraulic Conductivity**												
	White Paper: *Measurement of Hydraulic Conductivity in the Regional Gravel Aquifer Using Monitoring Wells at the Paducah Site*		**Complete**										
	Characterization of Bottom Sediments in Metropolis Lake										**Task Development and Schedule Pending**		
	Slug Testing to Better Define Hydraulic Conductivity Across the Model Domain												
	Reporting												
Additional Activities													
17	**#17 - Monitoring Well Survey Study**												
	Review Existing Monitoring Well Survey Information												
	Survey of Monitoring Wells												
	Assessment of Confidence on Plume Map Depiction and Other Site Reports												
	Reporting												
18	**#18 - Groundwater Chemical Trend Evaluation**												
	Review Existing Groundwater Analytical Data												
	Reporting												

Notes

	Activity/Task Currently In-Progress or Completed
	Future Activity/Task Pending Scope Development
#	Future Activity/Task Pending Scope Development where the # indicates a precursor Activity

Table 22. Project Risks

Risk Item	Description	Probability of Occurrence	Mitigation	Risk to Project
1	Missing a planned sample or groundwater level measurement	Low	• Review of monthly activities at the beginning of each month by PM or designee • Review of collected data each week by PM or designee	Low
2	Equipment malfunction	Moderate	• Maintain spare equipment • Target measurements early in month to allow for installation of replacement equipment in time to collect planned data • Install data logger as per CP4-ES-2100, *Groundwater Level Measurement* • Develop procedure or work controls for installation of colloidal borescopes to CP4-ES-2100	Low
3	Sample shipment delayed, samples not intact upon arrival at off-site laboratory, or otherwise not received in appropriate condition at the off-site laboratory	Low	• Target collection of samples early in month to allow for resampling if needed • Target measurements early in month to allow for installation of replacement equipment in time to collect planned data • Prepare sample shipments as required by procedure CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*.	Low
4	Laboratory data rejected during data validation	Low	• Use DOE Consolidated Audit Program-audited and accepted off-site laboratories • Follow QAPP requirements	Low
5	Error in manual groundwater level measurements	Low	• Perform measurements per CP4-ES-2100, *Groundwater Level Measurement* • Use reference point as indicated by PEMS form; any deviation is to be discussed with the PM prior to measurement	Low
6	Changing weather conditions influence groundwater level measurements	High	• Review weather forecast prior to initiating manual groundwater level measurements for any given activity; do not perform groundwater level measurements if weather patterns are anticipated to change during the days planned for measurements • Collect manual groundwater level measurements for any given activity in 4 days or less	Low
7	Equipment theft	Moderate	• Secure equipment (e.g., computers, generators, etc.) with chains, locks, locked boxes, etc., as appropriate • Provide signage for equipment external to the well	Moderate

10. REFERENCES

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