UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
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ATLANTA, GEORGIA 30303-8960

December 4, 2013

4WD-FFB

Rachel Blumenfeld
United States Department of Energy
Portsmouth/Paducah Project Site Office
P.O. Box 1410
Paducah, Kentucky 42002

RE: **EPA Comments on the Treatability Study Work Plan for Steam Injection, Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX-07-1294&D1)**

Dear Ms. Blumenfeld,

The Environmental Protection Agency (EPA) has received the *Treatability Study Work Plan for Steam Injection, Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX-07-1294&D1).* EPA has reviewed the document, and our comments are attached.

If you have any questions or require additional information, please contact me at (404) 562-8513.

Sincerely,

Jennifer Tufts

Digitally signed by Jennifer Tufts
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Treatability Study Work Plan for Steam Injection, Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX-07-1294&D1)

I. GENERAL COMMENTS

1. EPA is concerned that the extensive time frame for modeling the treatability study data will be conducted by contractors that do not have experience with steam injection for remediation. DOE should request that the steam injection venders propose a bid (including a conceptual design and cost estimate) for the remediation that is based on the field test data. This will provide much more reliable design and cost information on which to base decisions on the remediation of the site. It is imperative that experienced vendors of the technology be utilized both in the design and implementation of the pilot scale, and in evaluating the data to develop a conceptual full scale design and cost estimate. Much has been learned from the early implementations of the technology, and the lessons learned must be considered in designing new systems in order to achieve the greatest effectiveness for the least cost.

   EPA's technical expert has seen firsthand how venders not experienced with the Steam Enhanced Extraction (SEE) technology will considerably lengthen the design process and very substantially increase the overall costs, while losing some of the effectiveness possible in a well designed and operated SEE system. A poorly designed and implemented pilot scale steam injection may yield very little or no useful information that can be applied to the full scale. If the SEE vendors are not utilized to the fullest extent in designing and implementing the pilot scale, and in the development of the conceptual design and cost estimate for full scale, then the technology will not be adequately evaluated for its application in the RGA at Paducah by the proposed treatability study. Please ensure that SEE venders are provided the TS field data so that a realistic conceptual design and cost estimate may be developed as part of the data evaluation and modeling phase of the project.

2. The estimated costs associated with the proposed treatability study should be provided. This value should be compared to cost estimates already in hand for the full scale remediation to help in determining whether the proposed TS is cost effective, or if proceeding to full scale, even with a less than perfect design, can overall lead to a lower cost remediation.

3. The Appendix B QAPP does not present sufficiently detailed project quality objectives (PQOs) to convey how all of the data needs for the project will be met. As discussed in Section 2.6.1 of the UFP-QAPP Manual, the PQOs should define the type, quantity, and quality of data that are needed to answer specific environmental questions and support proper environmental decisions. However, the QAPP does not clearly define all of the types and quantity of data needed to make the appropriate treatment design decisions. The following are examples of where additional detail is needed.

a. The decision statement in Worksheet #10 is defined as, "If technically effective steam front propagation in the RGA can be demonstrated then the resulting information can be used to develop design and cost concepts for technology selection." However, the QAPP does not establish criteria for what will be considered effective propagation of the steam front. Therefore the QAPP has not defined how the data need for this decision will be met.

b. Worksheet #10 indicates that this study will refine estimates of permeability, anisotropy/heterogeneity, and local groundwater velocity. However, neither QAPP Worksheets #10, #11, nor #13 discuss or reference the background information for the site to clarify what existing data need to be refined or what types and quantities of data would be needed to provide this information. Therefore, it is unclear what data is needed or how the proposed sampling and measurements will provide the refined estimates of permeability, anisotropy/heterogeneity, and groundwater velocity.

c. Worksheet #11 states that data are needed to define the "operational parameters," but it is unclear what the operational parameters include and how the proposed sampling and measurements will meet this data need.

d. Worksheet #11 states that some field screening for VOCs in soil using a PID will be conducted, but this is not identified as a type of data needed and it is unclear what data need this information will address. Additionally, this PID screening is not included in Worksheet #18 (Sampling Locations and Methods/Standard Operating Procedure Requirements for Table for Screening Samples).

Please revise the QAPP to provide detailed PQOs that define how the treatment design data needs will be addressed by the proposed sample/data collection under this QAPP as listed in the bulleted items.

II. SPECIFIC COMMENTS

1. **Section 1.2 Background, Page 2, last paragraph**

The first sentence of this paragraph states that an independent technical review team determined that thermally enhanced removal technologies are poorly matched to the RGA conditions. However, the review team did only a cursory evaluation of steam injection based on a generalized equation of steam flow. A much more detailed evaluation and modeling effort was conducted by TerraTherm in June 2012. The modeling was based on information supplied to TerraTherm by Paducah for the range of possible conditions in the RGA, and, according to TerraTherm, the model they used is one that they have employed to successfully design SEE remediation systems for other sites. The conclusion drawn from their modeling is that SEE can be effectively deployed in the RGA. TerraTherm is the leading company in the world for providing steam

injection remediation services, and their evaluation should be given more credence than the cursory evaluation done by the independent technical review team.

2. **Section 1.4 Geology, Page 8, second to last paragraph**

This paragraph discusses geologic variability that it states is within the treatability study area. However, based on the depths given for the geologic variability described, which varies from 24 to 60 feet below ground surface, all of this variability is within the UCRS. The RGA is the subject of this treatability study, and it lies 60 to 96 feet below ground surface. A bullet should be added that describes the variability of this zone.

3. **Section 1.4 Geology, Page 8, last paragraph**

The relief of the top of the McNairy Formation discussed in this paragraph in the Southwest treatment area should be shown in cross sections.

4. **Section 1.5 Hydrogeology, Page 12, Table 1**

Please show on a figure the locations of each pumping test provided in the table relative to C-400.

5. **Section 1.5 Hydrogeology, Page 12, next to last paragraph**

What is the basis for saying that the ground water flow in the RGA averages 1 to 3 feet per day?

6. **Figure 6. Potentiometric Surface of the RGA in the Area of C-400, July 17, 2012**

Based on the groundwater elevation contours of the RGA potentiometric surface depicted in Figure 6 there appears to be uncertainty in the groundwater flow direction in the RGA south of building C-400. For example, Figure 2 shows the RGA groundwater flow direction to the northwest. However, although no RGA groundwater flow direction is shown in Figure 6, the potentiometric surface contours are only loosely constrained by monitoring well data and a trough shaped potentiometric surface is depicted beneath building C-400. As such, the resulting groundwater flow direction shown near the Proposed Study Area is variable with northeast and southwest flows depicted. The uncertainty in the RGA groundwater flow direction is furthermore increased based on an alternative interpretation of the potentiometric surface of the RGA. For example, based on the 2012 water level measurements shown in Figure 6, instead of a trough shape as currently depicted, the potentiometric surface can be re-drawn to show a closed contour (e.g., 325.00 mean sea level) beneath building C-400. The closed contour results in a slight groundwater mound with radial flow to the south in the area of the Proposed Test Area. Based on potentiometric surface maps provided in the DOE *TCE and Tc-99 Groundwater Contamination in the RGA* annual reports, groundwater flow directions shift and often groundwater flows radially from C-400 to the northwest, southeast and northeast. The local, immediate groundwater flow direction in the vicinity of the

Proposed Test Area should be clearly understood as this potentially impacts the movement and distribution of the injected steam. Table 2 indicates that groundwater flow direction will be evaluated. Please revise the TS WP to address how the uncertainty of the RGA groundwater flow direction near the Proposed Test Area will be addressed.

7. **Section 2.2 Data Quality Objectives Scoping Results, Page 17**

It is not clear what is meant by, "Metrics to assess steam injection as a viable technology will be developed during the treatability study design." It appears from the discussions that have been held that cost is the actual question in relation to applying the SEE technology to this site. It is already agreed that it has been well-demonstrated that the application of heat can recover contaminants such as trichloroethylene (TCE) (see page 4, first paragraph of Section 1.3, fifth sentence), which is the main contaminant of concern at this site. During scoping of the TS we were also in agreement that steam injection can heat the entire target area of the RGA. The remaining question was what spacing between steam injection and extraction wells is required to heat the target zone, in particular the RGA/McNairy interface. Then, it becomes a question of cost. This agreement should be reflected in the text.

8. **Section 3.1 Conceptual Design, Page 17**

The first sentence of this section states that this treatability study will inform the regulatory decision process for determining the appropriate technology for Phase IIb. While this treatability study can, if implemented and evaluated correctly, aid in determining the cost effectiveness of the SEE technology for the RGA, the TS does not address the appropriateness and/or cost effectiveness of in situ chemical oxidation (ISCO), the other technology proposed for the site. Thus, if, based on the TS, the FFA parties believe SEE is not cost effective for this site, that does not lead to a conclusion that ISCO is appropriate or cost effective for the Phase IIb area. If ISCO were to again be considered for implementation in the RGA, a more thorough evaluation of its potential effectiveness and costs, compared to those of SEE, should be made. Revise the sentence to state the objective of the SEE treatability study in Section 3 and throughout the document as appropriate.

9. **Section 3.1 Conceptual Design, Page 17**

The last sentence on this page states that the post-injection cooling profiles will determine ground water flow velocity and direction. However, as already discussed in comment #6, the direction (and presumably also the velocity) of groundwater flow in the RGA in the vicinity of C-400 is variable. There are no assurances that the groundwater flow direction and velocity during a full scale SEE implementation would be the same as during the cooling phase of the steam injection pilot test.

10. **Section 3.1 Conceptual Design, Page 21**

The second paragraph of this section states that the design will allow for steam injection pressures up to 75 – 100 psig. Steam injection pressures cannot exceed the lithologic

pressure in order to not fracture the soils and vent steam to the atmosphere. The general rule is that the steam injection pressure should not exceed approximately one half of the depth of injection (Davis, E. L., Steam Injection for Soil and Aquifer Remediation, United States Environmental Protection Agency, EPA/540/S-97/505, January 1998), indicating that the maximum injection pressure should be in the range of 50 psig. Due to the highly permeable nature of the RGA, it should be anticipated that lower injection pressures will be adequate to produce the desired flow rates. Statements like this demonstrate the lack of understanding of the principals of the SEE technology, and the need to involve the SEE vendors in all aspects of the design, implementation, and evaluation of the SEE technology for the RGA.

11. **Section 3.2 Implementation, Page 23, 4th paragraph**

It is not clear what is meant by, "An adaptive management approach . . . will allow for a shortened time frame for the treatability study if early scenarios provide sufficient data to reach treatability study objectives." What type of data from early scenarios would allow the treatability study to be shortened? This would indicate that significant modeling, as proposed in the treatability study work plan, is not actually needed to interpret the data, otherwise it is counter-intuitive to think that the data alone (before it is manipulated by modeling) can indicate that the objectives of the treatability study have already been met, before the full treatability study is implemented. Please clarify the text.

12. **Section 3.4 Data Collection, Page 25**

The first sentence states that spatially distributed pressures will be measured. How and where will spatially distributed subsurface pressures be measured, and how will the data be used? This should also be detailed in the QAPP.

13. **Section 3.4 Data Collection, Page 26, first sentence**

What properties of the area soil and groundwater will be measured to support the evaluation?

14. **Section 3.4 Data Collection, Page 26, Table 3**

What laboratory measurements of water are proposed to study TCE migration?

15. **Section 4.1 Data Evaluation and Modeling, Page 27, second full paragraph**

The text states that the effectiveness of steam injection cannot be properly evaluated without three dimensional simulations. The appropriateness of simulations is not so much based on whether the simulation is two- or three-dimensional, but on whether the model has been verified for the intended use of the simulations. TerraTherm used a two dimensional model for the simulations they performed, which they felt was adequate due to superposition provided by the boundary conditions and their experience with the model at other field sites. Another three dimensional model that has not been validated and

verified for the design of SEE systems should not be considered appropriate for designing a SEE system.

16. **Section 4.2 Full-Scale Design Concept Development and Section 4.3 Full-Scale Cost Estimation**

The proposal in these two sections for developing a conceptual full scale design and cost estimate produces essentially a +50/-30 percent, feasibility level, cost estimate. In order to get a more realistic cost estimate, the conceptual full scale design and cost estimate must be done by the vendors of the SEE technology. Those who are not familiar with the technology cannot design a cost effective system based on what has been learned from other sites where the steam injection technology has been used. Also, the vendors have some of the required equipment already that can be used at various sites, yielding cost savings that cannot be realized in cost estimates prepared by others. Having the conceptual full scale design and cost estimate done by the vendors will save considerable time and money, as the vendors commonly produce these bids for potential customers in 60 to 90 days or less. Only by going to the SEE vendors can a realistic conceptual design and cost estimate be produced.

17. **Section 5.3.1 Location of the Treatability Study**

The text states that the location for the TS was selected based on site data. Please provide this data in the work plan.

18. **Section 5.3.2 Sampling Strategy and Appendix B QAPP**

The text states that groundwater samples may be collected from an extraction well to characterize contaminant trends but does not discuss how it will be determined that the extraction well is necessary. It is not clear what would be the purpose of this sampling or what the data would be used for. The last paragraph of Section 3.1 states that if an extraction well is included in the design, it will be outside of the range of the injected steam, and thus concentrations in the extracted water would not be representative of extraction concentrations during a full scale SEE remediation. Revise the text to discuss how it will be determined that an extraction well is necessary (e.g. the decision criteria that determine if the well will be installed and sampled) and include sampling and analysis requirements for the well.

19. **Table 4, Page 34**

The text states that a specialty subcontractor will be hired to provide equipment and expertise during the implementation of the TS. It is EPA understands that a subcontractor has been hired for the design of the TS. Please provide documentation of the experience of the subcontractor with the SEE technology to verify their qualifications for performing the TS.

As was discussed during the TS scoping conference call, EPA has serious reservations about the approach taken with this TS to do separate procurements for the design and implementation of the TS. Other vendors may be hesitant to bid on a design produced by others; in some cases they may refuse to do so. Eliminating or reducing the competition for the project may have the effect of increasing the overall cost of the system – this has happened at other sites. It is standard practice in the thermal remediation industry to use design/build contracts.

20. **Section 5.3.2.2 Operational sampling**

The text states that water temperature readings will be made. There has been no other mention of temperature of extracted water being measured. Is this meant to say that subsurface temperatures will be measured? If so, please clarify.

21. **Section 5.3.4 Sampling Schedule**

The text states that states that temperature measurements will be made several times per hour and will continue for weeks or months after steam injection has been completed. This will create a data file that is so large as to be unmanageable, and is far more data than is required to meet the TS objectives. Consider reducing the number of temperature measurements for the study.

22. **Section A, Environment, Safety, and Health Plan for Steam Injection Treatability Study**

Appendix A does not include all of the suggested elements in Table 10 in the Guidance for Conducting Treatability Studies under CERCLA, U.S. EPA, dated October 1992 (TS Guidance). For example, the HASP identifies VOCs, primarily TCE, and Tc-99 as contaminants present at the site. However, the HASP does not identify these chemicals in the discussion of hazards in Section A.6., General Project Hazards, or discuss decontamination procedures related to these chemical hazards. Revise the HASP to include the suggested elements as outlined in the TS Guidance.

23. **Section A.5, Key Project Personnel and Responsibilities, Page A-10**

Section A.5 identifies key team members; however, the titles of the members are not consistent with those presented in Table 4, Roles and Responsibilities, of the TS WP. For example, Table 4-1 identifies a “Contractor Manager of Projects”, while Section A.5 of the HASP identifies a similar role as the “Environmental Restoration (ER) project manager.” Revise the TS WP and associated HASP to present consistent titles, roles and responsibilities for all team members.

24. **Section A.6, General Project Hazards, Page A-11**

In Section 3.3, Equipment and Materials, the second bullet states that equipment and infrastructure for providing power to the boiler is needed (electricity or liquid fuel); however, information regarding potential secondary containment or spill prevention measures for potential liquid fuel is not included in the HASP. Revise the HASP to include a discussion of the secondary containment/spill prevention measures for liquid fuels.

25. **Section A.6, General Project Hazards, Page A-11**

The TS WP indicates that the planned study will include the design, installation, and operation of one steam injection location. However, the specific environmental hazards (e.g., potential for cross-contamination) associated with installing and operating the steam injection system are not specified in the HASP. For clarity, ensure that all steam injection system installation and operational hazards are identified in the HASP.

26. **Section A.6.12, Steam, Page A-13**

This section notes that pressurized steam poses special hazards associated with unique equipment, temperature extremes, equipment failures, and noise; however, the special hazards are not identified. Identify these special hazards that could arise from the operation of the steam system (e.g., potential for cross-contamination resulting from equipment failures) and incorporate them into Section A.6.12.

27. **Section A.7, Site Control, Page A-13**

This section identifies the Exclusion Zone (EZ), Contamination Reduction Zone (CRZ), Support Area (SA), and Construction Zone (CZ) for the site; however, for clarity, it appears these should be identified on a site figure. Revise the HASP to include a site figure showing the EZ, CRZ, SA and CZ.

28. **Appendix B, QAPP**

The Appendix B, QAPP, is incomplete and therefore cannot be fully evaluated. The QAPP indicates that the Steam Remediation Vendor will determine the groundwater and temperature sampling design (e.g., number and locations of monitoring points) and the sampling requirements for where, when, and how the data will be collected. However, the subcontractor is not identified and the sampling information is not presented in the QAPP. In addition, Worksheet #30 indicates that the laboratory will be selected after the treatability study, but the laboratory should be identified in the QAPP and the laboratory-specific information should be included to ensure the laboratory meets the criteria established in the QAPP (e.g., laboratory standard operating procedures [SOPs], detection limits, statistically derived quality control [QC] acceptance limits, etc.) as specified in the *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (EPA-505-B-04-900A) dated March 2005 (UFP-QAPP Manual). Ensure that the QAPP is revised in the D2 TS WP to identify these subcontractors and include the

corresponding sampling and analysis information as prescribed by the UFP-QAPP Manual.

29. **Appendix B, QAPP**

Several of the investigation tasks (e.g., soil sampling, groundwater sampling, document management, data validation) and Appendix B QAPP worksheets (including but not limited to Worksheets #27, #28, #31, #32, #36, and #37) rely on references to SOPs for the necessary information, but these SOPs are not provided. Therefore, these SOPs cannot be reviewed and verified that they contain the appropriate information. Please provide the referenced SOPs as an attachment or appendix.

30. **Appendix B, QAPP**

The Appendix B QAPP does not include the temperature measurements in all worksheets and does not discuss how it will be ensured that the temperature data are sufficient to meet project goals. For example, Worksheet #11 states that data need to "meet the measurement quality objective and data quality indicators established by the systematic planning process," but measurement performance criteria are not defined for the temperature monitoring (e.g., the calibration and required accuracy of the measurement equipment). Additionally, temperature monitoring equipment and measurement procedures are not discussed in Worksheet #22. Revise the QAPP to include the temperature measurements in all applicable worksheets, and to discuss how it will be ensured that the temperature data are sufficiently accurate to support treatment design decisions.

31. **Appendix B, QAPP**

The key personnel for this investigation and their project roles/tasks are unclear and inconsistently presented in the Appendix B QAPP. The following information should be clarified in the QAPP prior to implementation of this investigation:

a. The subcontractors to be used in the investigation and their tasks are not clearly defined in the QAPP. For example, Worksheet #7 should identify the project roles and responsibilities for the subcontractor personnel. As another example, Worksheets #7 and #35 indicate that a third party/subcontractor will perform data validation, but Worksheet #36 indicates that personnel within LATA Kentucky may perform this task. Revise the QAPP to clearly define which roles will be performed by each subcontractor, and to consistently include these subcontractors in each appropriate worksheet.

b. The project roles identified in Worksheets #4, #5, and #7 are inconsistent. For example, Worksheet #4 identifies a Task Lead, but Worksheet #5 includes a Site Superintendent and Worksheet #7 does not define either of these roles. It is unclear who will act as the field team leader, and what tasks this role includes. Revise the QAPP to consistently identify the project roles for the investigation.

c. The distribution list in Worksheet #3 does not identify the project personnel for LATA Kentucky who will receive the QAPP. In addition, both Worksheets #3 and #4 should include all subcontractors that will receive the QAPP (e.g., the laboratory, data validation subcontractor, and steam remediation vendor) and be required to sign acknowledge it. These personnel should be identified to ensure the appropriate personnel have copies of the QAPP available during the investigation (e.g., the field team leader). Revise the list to identify the key project personnel for LATA Kentucky and the subcontractors who will receive the QAPP.

d. Worksheet #4 identifies personnel required to read and perform tasks found within the QAPP, but does not include the organization to which these personnel belong. As a result, it is unclear which of these roles may be contractor or subcontractor personnel. Revise QAPP Worksheet #4 to include the organization for the personnel required to read and acknowledge the QAPP.

e. Worksheet #5-B, Project Level Organizational Chart, indicates that all subcontractors will communicate with the Site Superintendent; however, according to Worksheet #6, a laboratory coordinator will perform all communication tasks with the laboratory. Revise the Organizational Chart in Worksheet #5-B to include the analytical laboratory and appropriate lines of communication/reporting for the laboratory.

32. **Appendix B, QAPP Worksheet #1, Title Page, Page B-9**

The signature lines for two required approvals are absent from QAPP Worksheet #1, Title Page. According to Section 2.1, Title and Approval Page, of the UFP-QAPP Manual, the investigative organization's project quality assurance (QA) officer (or equivalent) and the lead organization's (U.S. Department of Energy [DOE]) project manager are required approval signatures for the Title and Approval Page of the QAPP. Revise QAPP Worksheet #1 to include signature lines for the project QA officer and the lead organization's Project Manager.

33. **Appendix B, QAPP Worksheet #2, QAPP Identifying Information, Pages B-12 to B-14**

The crosswalk table identifies the information required in each worksheet of the QAPP, but does not include the references to other documents found within these worksheets (e.g., Worksheet #16 does not provide the project schedule but references Work Plan Section 5.2). Revise this table to include the references to other documents when the listed worksheets do not contain the required information, as discussed in Section 1.2.4, QAPP Requirements, of the UFP-QAPP Manual (page 11).

34. **Appendix B, QAPP Worksheet #6, Communication Pathways, Pages B-19 and B-20**

QAPP Worksheet #6 lacks the necessary detail to meet the requirements of Section 2.4.2, Communication Pathways, of the UFP-QAPP Manual. For example, the worksheet does

not discuss all of the communication drivers (e.g., stop work, corrective actions, notification of delays or changes to field work) and does not include the modes of communication and timeframes for any notifications. Also, this worksheet should indicate that regulatory agencies will be notified when significant corrective actions occur or changes to QAPP are made in the field. Revise QAPP Worksheet #6 to identify all communication pathways and ensure that communication requirements for critical information impacting the scope or success of the project are defined in this worksheet. Also, revise this worksheet to specify that the regulatory agencies will be notified when significant corrective actions or changes to the QAPP occur, and include the form of communication and timeframe for this notification.

35. **Appendix B, QAPP Worksheet #8**

QAPP Worksheet #8 states that the Steam Remediation Vendor is required to have specialized training in the form of a related college degree from an accredited college. To EPA's knowledge related college degrees are not offered from any accredited college. Extensive experience in the application of SEE at a variety of sites should be the qualification or training required of the steam remediation vendor.

36. **Appendix B, QAPP Worksheet #10, Problem Definition, Page B-27**

QAPP Worksheet #10 in Appendix B does not include the second principal study question (PSQ) listed in the data quality objectives (DQOs) presented in Table 2 of the Work Plan, as follows: "How does steam injection using two injection intervals (middle and lower RGA) differ from injection using a single deep injection interval?" Revise the QAPP Worksheet #10 to resolve this discrepancy. If this PSQ is added to Worksheet #10, ensure that the QAPP Worksheet #17 details how this question will be addressed in the sampling design.

37. **Appendix B, QAPP Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Page B-29**

QAPP Worksheet #11 states that a DOE subcontractor will use the data to model steam injection in the RGA. Please see General Comment #1. In order to have a valid evaluation of the data, the evaluation should be performed by a steam remediation vendor, using a model that has been validated for this purpose.

38. **Appendix B, QAPP Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Page B-29**

The discussion for how "good" the data need to be in order to support the environmental decision states that 10% of the fixed-laboratory data will be validated at Level III, but it is unclear what this validation includes and why this level of validation will meet project goals. Revise the QAPP to discuss what is included in a Level III validation and why this is sufficient to meet project goals.

39. **Appendix B, QAPP Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Page B-29**

QAPP Worksheet #11 states that a 'sample team of individuals . . . skilled in the collection of temperature data . . . will make the field measurements . . .". Is manual collection of subsurface temperature data planned? Normally during thermal remediation the collection of subsurface temperature data is automated. Considering the potential number of thermocouples to be installed (5 to 10 temperature monitoring strings, with approximately 15 thermocouples per string), the frequency of monitoring, and the length of time proposed for the TS (according to Section 5.3.4, temperature monitoring frequency is several times per hour and will continue potentially for months after steam injection has been terminated), this will require an extreme amount of manpower. A much better plan is to hire a steam injection vendor who has automated temperature monitoring systems already developed and available so that this data can be collected automatically. Please clarify.

40. **Appendix B, QAPP Worksheet #17, Sampling Design and Rationale, Page B-36**

QAPP Worksheet #17 states that soil samples will be obtained, but never states what they will be analyzed for and the method to be used. Please revise Worksheet #17 to include this information.

41. **Appendix B, QAPP Worksheet #18, Sampling Locations and Methods/SOP Requirements Table for Screening Samples, Page B-37**

QAPP Worksheet #18 states that TCE concentrations are assumed to be 11,000 μg/L. However, Figure 8 shows that the TCE concentrations in the Southwest area range from 20,000 to greater than 1,000,000 μg/L. Please clarify.

42. **Appendix B, QAPP Worksheet #18, Sampling Locations and Methods/SOP Requirements Table for Screening Samples, Page B-37**

QAPP Worksheet #18 states that temperature measurements will be in the range of 18 to 90°C. The actual range should be from the injection temperature of the steam (which will be greater than 100°C) to ambient temperatures. Please clarify.

43. **Appendix B, QAPP Worksheet #19, Analytical SOP Requirements Table, Page B-38**

The holding time for groundwater samples to be analyzed for VOCs is identified as 14 days if preserved, but the holding time for unpreserved samples is not defined. Since the VOCs listed in Worksheet #15 include vinyl chloride as an analyte for groundwater samples, it is recommended that a second set of samples be collected and submitted to the laboratory unpreserved for analysis within seven days, in accordance with Solid Waste 846 (SW-846) Chapter four, Table 4.1 (http://www.epa.gov/epawaste/hazard/testmethods/sw846/pdfs/chap4.pdf). Table 4.1 of SW-846 Chapter four indicates that aqueous samples for analysis of vinyl chloride should

not be preserved with acid and should be analyzed as soon as possible or within a holding time of seven days. This is due to the fact that preservation with acid may adversely impact the stability of vinyl chloride and cause this compound to not be recovered in the analysis. It is recommended that consideration be given to applying this current SW-846 recommended preservation and holding time for groundwater samples that possibly contain vinyl chloride as an analyte for VOC analysis and revise the QAPP accordingly.

44. **Appendix B, QAPP Worksheet #21, Project Sampling SOP References Table, Page B-40**

QAPP Worksheet #21 indicates that SOP PAD-ENM-2101, Groundwater Sampling, will be modified for project work. However, there is no information in the comments section of the table describing how the SOP will be modified for this project. Revise QAPP Worksheet #21 to indicate how SOP PAD-ENM-2101 will be modified to perform groundwater sampling for this investigation.

45. **Appendix B, QAPP Worksheet #22, Field Equipment Calibration, Maintenance, Testing, and Inspection Table, Page B-41**

The calibration, maintenance, and testing activities for some of the equipment listed (e.g., the alpha scintillator) are not provided. Instead, it appears that the frequencies for the activities are listed for each piece of equipment in the columns. Also, this worksheet indicates that the manufacturers' specifications will be used for calibration, maintenance, testing, and inspection activities, but these specifications are not provided. Revise this worksheet to define the calibration, maintenance, and testing activities for all equipment, and to include the manufacturers' specifications or reference where this information may be found (e.g., as a QAPP appendix).

46. **Appendix B, QAPP Worksheet #22, Field Equipment Calibration, Maintenance, Testing, and Inspection Table, Page B-41**

QAPP Worksheet #22 includes field equipment for radiological screening, but this screening is not discussed elsewhere in the QAPP. Revise the QAPP to clarify how this instrumentation will be used during this investigation (i.e. sample screening and/or personnel monitoring), and revise all applicable QAPP worksheets to describe how and when the radiological measurements will be collected and to include all sample collection and measurement performance criteria.

47. **Appendix B, QAPP Worksheet #28, QC Samples Table, Page B-48**

The information presented in QAPP Worksheet #28 for the laboratory QC samples for VOCs is unclear. Only one row is provided with the laboratory QC samples, so the frequency/number of the QC samples and method/SOP QC acceptance limits for each sample type are unclear. For example, this table appears to indicate that spiked field samples (assumed to be matrix spikes [MSs]) and laboratory spiked blanks (assumed to be laboratory control samples [LCSs]) will be analyzed for each sample and standard.

However, one LCS and one MS (and a matrix spike duplicate) are usually analyzed per each batch of samples. In addition, surrogates are not included in this table, and therefore the QAPP does not define the measurement performance criteria for surrogate recoveries. Revise QAPP Worksheet #28 to clarify the laboratory QC requirements by using separate rows for each laboratory QC sample with the frequency/number and acceptance limits for each QC sample.

48. **Appendix B, QAPP Worksheet #33, QA Management Reports Table, Page B-53**

The text at the top of QAPP Worksheet #33 on page B-53 indicates reports to management include project status reports, field/laboratory audits, and data quality assessments, but only audits are included in the table. Revise this table to include the project status reports and data quality assessments, and the frequency, delivery date, and personnel responsible for preparing these reports.

49. **Appendix B, QAPP Worksheet #37, Usability Assessment, Page B-57**

QAPP Worksheet #37 indicates that data quality indicators (DQIs) (e.g., precision, accuracy, representativeness, completeness, comparability, and sensitivity) will be evaluated per SOP PAD-ENM-5003, but does not provide project specific completeness goal(s) for this investigation. Revise this worksheet to provide the completeness goal(s) for this investigation.