



REGION 4
ATLANTA, GA 30303

March 27, 2025

ENVIRONMENTAL COMPLIANCE &

MAR 27 2025

Mr. Matthew Baker, SRS Remedial Project Manager
Remediation and Deactivation & Decommissioning Division
U.S. Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

AREA COMPLETION PROJECTS

**EPA Comments: EFFECTIVENESS MONITORING REPORT (EMR) FOR THE P-AREA
GROUNDWATER (PAGW) OPERABLE UNIT (OU) ZERO VALENT IRON
PERMEABLE REACTIVE BARRIER (ZVI-PRB) REMOVAL ACTION (U)
APRIL 2023 THROUGH MARCH 2024, SEMS NUMBER: 81, SRNS-RP-2024-00914
REVISION 0, DECEMBER 2024**

Dear Mr. Baker,

The U.S. Environmental Protection Agency, Region 4 (EPA), has reviewed the EMR for the PAGW OU for the ZVI-PRB Removal Action, April 2023 through March 2024, Dec, 2024. Our comments are attached:

If you have any questions or require additional information, please contact me at (404) 431-1340.

Sincerely,

**JON
RICHARDS** 
Digitally signed by JON RICHARDS
Date: 2025.03.27 10:51:57 -04'00'

Jon Richards
FFA Remedial Project Manager
Superfund & Emergency Management Division

cc: C.L. Bergren, SRNS-ACP
Susan Fulmer, SCDHEC

GENERAL COMMENTS

1. It is unclear if additional characterization is warranted to determine whether groundwater may be bypassing the zero-valent iron (ZVI) permeable reactive barrier (PRB). It is noted that the observed volatile organic compound (VOC) concentrations, trends and groundwater chemistry at the PRW004 and the PRW007 well clusters may indicate bypass of the ZVI-PRB is occurring. Specifically:
 - a. PRW004DL and PRW004DU are located immediately downgradient of the ZVI-PRB, and first quarter 2024 (1Q24) concentrations of trichloroethene (TCE) are elevated above the maximum contaminant level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) at 101 $\mu\text{g/L}$ and 10.4 $\mu\text{g/L}$, respectively. The TCE concentrations in PRW004DL and PRW004DU have been increasing since 2022 (see Figure 12, Time-Series Plot for TCE at UAZ Monitoring Well Clusters for P002U, PW002 and PRW004). The EMR indicates that the elevated and rebounding concentrations observed at the PRW004 well cluster are likely due to back diffusion from low-permeability sediments downgradient of the ZVI-PRB, however, it is also possible that slow groundwater velocities or preferential flow paths may be contributing to incomplete treatment or localized bypass of the ZVI-PRB.
 - b. The PRW007 well cluster is located on the downgradient of the ZVI-PRB. Appendix A (PAGW OU RA EMR Analytical Data 2023-2024) indicates total iron remained below the method detection limit (MDL) at PRW007DL and ranged between 320 and 1790 micrograms per liter ($\mu\text{g/L}$) at PRW007DU, and oxidation-reduction potential (ORP) ranged between 84.7 and 346 millivolts (mV) at the PRW007 well cluster, suggesting that the reducing environment is not strongly ZVI-influenced. This geochemical combination is not the same fingerprint as other downgradient well clusters (i.e., PRW002 and PRW004) which had total iron ranging between 2580 and 21,600 $\mu\text{g/L}$ and ORP ranging between -284 and 59.2. As water passes through the ZVI, iron corrodes and additional Fe^{2+} (ferrous iron) is produced in groundwater. So, elevated total iron is expected downgradient of the ZVI-PRB and a greater reducing environment is expected. As such, it is unclear whether there is evidence, based on the geochemical fingerprint at the PRW007 well cluster, that groundwater is bypassing the southern end of the ZVI-PRB and the bypass is contributing to the VOC concentrations and groundwater chemistry noted at the PRW007 well cluster.

To differentiate between back diffusion and potential bypass, additional characterization actions, such as conducting tracer tests to confirm flow paths or installation of an additional monitoring well on the southern side of the ZVI-PRB, could be performed to verify ZVI-PRB performance. *Please revise the EMR to discuss whether additional characterization is needed to demonstrate that bypass is not occurring.*

2. Calcium analyses should be performed at monitoring locations on both the east and west side of the ZVI-PRB to support the conclusions of the treatability study. The treatability study determined that there were no observations of mineral precipitation causing loss of reactivity and no expectation of precipitation/clogging causing significant loss in permeability. Therefore, in regard to the elevated calcium concentrations, Section 4.3 (ZVI-PRB Health and Longevity) concludes that, “the performance of the ZVI-PRB is not anticipated to be impacted by the resulting calcium levels.” However, calcium concentration data from the monitoring wells east and west of the ZVI-PRB is not presented to support these conclusions (see Table 4, Baseline Concentration Comparison with Most Recent Results for UAZ (1Q24)). Even small volumes of calcium leaching could have significant effects over time and the results of a treatability study may not accurately reflect the complexity of the actual system performance. If calcium concentrations are found to decrease across the ZVI-PRB, this may indicate precipitation is occurring, however, if calcium concentrations are similar on both

sides, this would support that minimal precipitation is occurring. *Please recommend additional calcium analysis at the monitoring locations on the east and west sides of the ZVI-PRB to support the statement that the performance of the ZVI-PRB is not likely impacted by calcium levels.*

3. The EMR does not contain the reports issued by the laboratory for the analysis of the samples. *Please attach the laboratory data reports as an attachment.*
4. The EMR indicates that the estimated groundwater flow velocity was calculated to be 77.3 meters per year (m/yr) (253.7 feet per year (ft/yr)) in 1Q24 (calculated on the hydraulic gradient estimated between PMW005DL and PRW006DU); however, it is unclear whether a single observation of hydraulic gradient in the northern portion of the ZVI-PRB is sufficient to demonstrate groundwater flow velocity across the entire ZVI-PRB. Reliance on a single data point may overlook localized seasonal changes in flow, particularly given concerns about reduced permeability. *Please revise the EMR to discuss why a single observation of hydraulic gradient in the northern portion of the ZVI-PRB is sufficient to accurately characterize groundwater flow across the ZVI-PRB and if the single observation is insufficient, propose additional locations where hydraulic gradients will be established in the future.*

SPECIFIC COMMENTS

1. **Section 2.4, Removal Action Implementation and Monitoring Goals, Page 7 of 58:** The text states, “The implemented ZVI-PRB is anticipated to reduce the mass flux of TCE through the neck area of the PAGW [P-Area Groundwater] OU [operable unit] TCE plume by at least 80% [percent] in order to meet the RAO [remedial action objective];” however, the text does not discuss the estimated timeline for reaching the 80% reduction. *For clarity, please revise the EMR to discuss the RAO timeline and whether the results are within the estimated time ranges for achieving the RAO.*
2. **Section 3.0, Monitoring Results and Deviations, Page 10 of 58:** The text states, “The data quality level for permanent groundwater monitoring well stations and field duplicate samples is Verified and Validated (V&V) level data;” however, this section lacks a detailed narrative on the findings of the data validation and data validation reports are not provided as supporting documentation. For example, Appendix A (PAGW OU RA EMR Analytical Data 2023-2024) indicates that several ferrous iron samples were rejected due to exceeding hold time, but it is unclear whether any other samples were affected. *Please revise the EMR to discuss the outcome of the data validation and provide data validation reports.*
3. **Section 3.2.4, Field Measurements, Page 17 of 58:** The text indicates that pH levels at in-wall monitoring wells for the first quarter of 2024 were 12.6 to 13.3 and goes on to state, “Elevated pH levels associated with ZVI have been well documented at other sites and the elevated levels are not expected to have an impact on ZVI-PRB performance;” however, it is unclear whether this statement is accurate. Elevated pH conditions can result in precipitation of calcium, magnesium and iron minerals, which may decrease the permeability and effectiveness of the barrier and reactive surface over time (passivation). As such, if high pH persists within the barrier, additional investigations, such as hydraulic testing or tracer dye analysis downgradient and within the ZVI-PRB should be conducted to verify the statement. *Please revise the EMR to clarify that elevated pH may have an impact on the ZVI-PRB performance and additional characterization may be required to assess performance of the ZVI if elevated pH conditions persist.*

4. **Appendix A, PAGW OU RA EMR Analytical Data 2023-2024, PDF Page 69:** The table notes indicate that the yellow highlighted cells were, “Requested to be sampled but was not. See comments as to why not;” however, no comment cells providing explanations are included in the table. *Please include the comment cells, or include a note clarifying why these were omitted.*
5. *The EMR would benefit if bookmarks were included for quick reference to specific sections of the report.*
6. **List of Appendices, Page v of viii:** The title of Appendix A is listed as PAGW OU RA EMR Analytical Data 2022-2023; however, the analytical data presented is from 2023-2024. *Please revise the title of Appendix A to accurately describe the years of data analysis.*