Department of Energy
Savannah River Operations Office
P O Box A
Aiken, South Carolina 29802

MAY - 4 2021

Ms. Susan B. Fulmer, P. G., Manager
Federal Remediation Section
Division of Site Assessment, Remediation and Revitalization
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Mr. Jon Richards
Savannah River Site Remedial Project Manager
Superfund Division
U. S. Environmental Protection Agency, Region 4
61 Forsyth Street, SW
Atlanta, Georgia 30303

Dear Ms. Fulmer and Mr. Richards:

SUBJECT: Savannah River Site's Responses to the Regulatory Comments on the Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U) April 2019 through June 2020 (SRNS-RP-2020-00566, Revision 0, September 2020) SEMS Number: 82

The U.S. Department of Energy (DOE) is submitting the enclosed responses to regulatory comments for your review. The South Carolina Department of Health and Environmental Control (SCDHEC) and the U. S. Environmental Protection Agency (EPA) provided comments on the Revision 0 document on February 2, 2021 and February 5, 2021, respectively. This report will not be revised; however, all comment responses will be included and or addressed in the next data report, as applicable. Please review the information and provide your response within thirty (30) days of receipt. The effort and time that the EPA and the SCDHEC have provided on this operable unit are greatly appreciated.

Questions from you or your staff may be directed to me at (803) 952-8365, or the DOE Federal Project Director, Ms. Karen Adams, at (803) 952-7871.

Sincerely,

Brian T. Hennessey

Digitally signed by Brian T. Hennessey
Date: 2021.05.03 10:25:51 -04'00'

Brian T. Hennessey
SRS Remedial Project Manager
Infrastructure and Area Completion Division

IACD-21-134

Enclosures:
1. SRS Responses to the U. S. Environmental Protection Agency's Comments on Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U) April 2019 through June 2020 (SRNS-RP-2020-00566, Revision 0, September 2020) SEMS Number: 82
2. SRS Responses to the SCDHEC Comments on Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U) April 2019 through June 2020 (SRNS-RP-2020-00566, Revision 0, September 2020) SEMS Number: 82

cc w/o encl:
J. Blalock, SCDHEC-Columbia
S. French, SCDHEC-Columbia
M. Reece, SCDHEC-Columbia
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B. Cameron, SCDHEC–Aiken Environmental Affairs Office
K. L. Beatty, SCDHEC–Aiken Environmental Affairs Office
R. H. Pope, EPA-Atlanta

cc w/encl:
J. Tufts, EPA-Atlanta
M. McRae, TechLaw, Inc.

SRS Responses to South Carolina Department of Health and Environmental Control Comments on: Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U) – April 2019 through June 2020, SEMS Number: 82 (SRNS-RP-2020-00566, Revision 0, September 2020) received October 6, 2020.

Received February 2, 2021

Specific Comments

1. Section 2.0, Operable Unit Description and History, page 1. The first paragraph of this section lists known sources associated with reactor operations that have resulted in tritium and VOC contamination in groundwater at CAGW OU. Please update one of the figures in the report to include these source locations or provide a separate figure depicting them.

   Response: Agree.

   Figure 2 will be revised in the 2021 report to show the locations of these source areas, similar to the revised Figure 2 attached to these responses. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

2. Figure 3, CAGW OU NTC RA Areas (Baseline Conditions), page 29 and Figure 6, CAGW OU Monitoring Stations, page 35. Figure 3 depicts monitoring well CRW 15A grouped with CSB 15D and CSB015B, yet Figure 6 shows monitoring well CRW 13A at this location instead. CRW 15A is shown on Figure 6 downgradient of this cluster with wells CRW015B and CRW 15C/D. Please revise the figures as appropriate.

   Response: Agree.

   Figure 6 has the wells correctly labeled, and Figure 3 will be revised in the 2021 report with well CWR 13A labeled correctly, similar to the revised Figure 3 attached to these responses. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

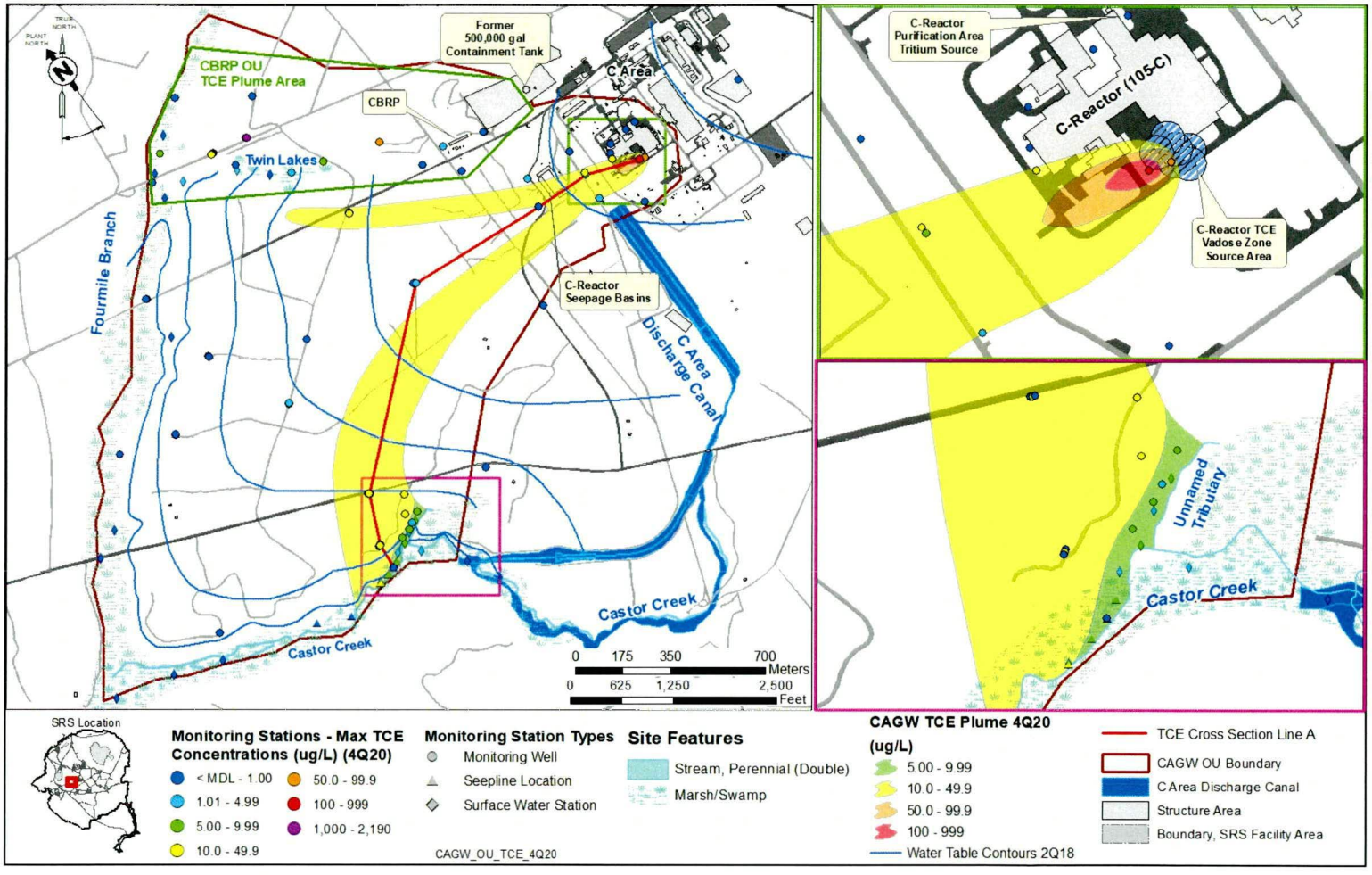

Figure 2 Revised for Inclusion in 2021 EMR

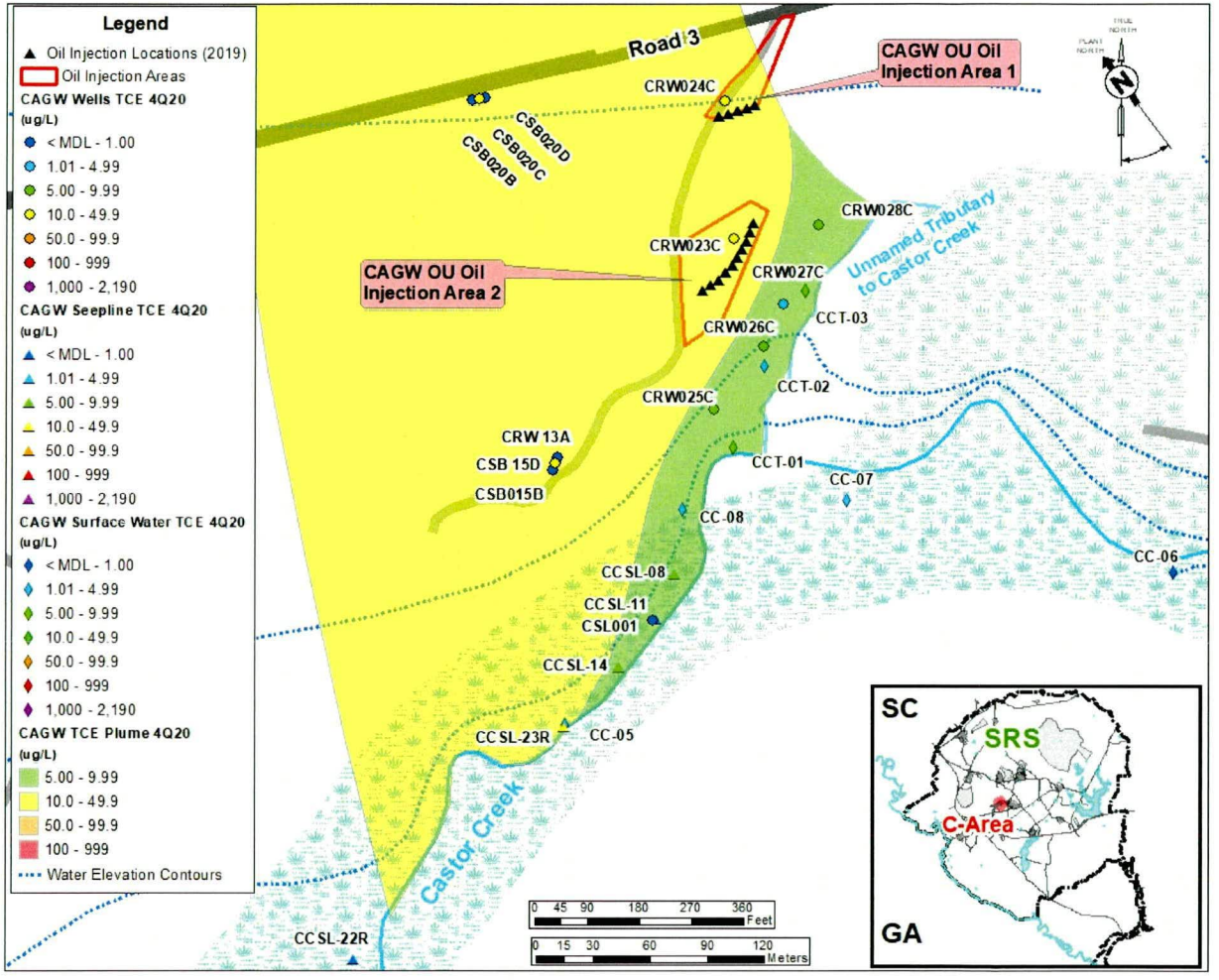

Figure 3 Revised for Inclusion in 2021 EMR

SRS Responses to EPA Comments on the Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U) – April 2019 through June 2020, SEMS Number: 82, SRNS-RP-2020-00566, Revision 0, September 2020, Savannah River Site, South Carolina

Received February 5, 2021

GENERAL COMMENTS

1. Based on the information presented in the Environmental Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal (U) (the EMR), it appears the C-Area Groundwater (CAGW) Operable Unit (OU) Non-Time Critical Removal Action (NTC RA) has had minimal impact on the groundwater trichloroethylene (TCE) concentrations from reductive dechlorination (RD). In general, the results of the field measurement data indicate the optimum levels necessary for complete RD to occur were not achieved in the middle aquifer zone (MAZ). For example, the field measurement trends for oxidation-reduction potential (ORP), dissolved oxygen (DO), and pH levels as reported in Appendix A, CAGW OU NTC RA Analytical Data 2019-2020, and as depicted in Figure 21 and Figure 22 for primary monitoring wells CRW023C and CRW026C, respectively, were not within the optimal ranges necessary for complete RD to occur. Ideally, pH should be in the 7 to 8 range for RD, and no lower than 6.5. To reduce vinyl chloride (VC), ORP should be less than -200 millivolts (mV), and preferably below -250 mV. DO should be less than 0.5 milligrams per liter (mg/L). However, as seen in Figures 21 and 22, ORP readings remained in the positive range, DO remained greater than 0.5 mg/L, and pH was never measured above 6. As such, conditions suitable for RD were not achieved during the subsequent monitoring events. This is evidenced primarily by increasing TCE concentration in CRW026C and the detection of TCE contamination at the seepline wells and from surface water samples collected from the tributary to Castor Creek.

   The text in Section 5.0 (Summary) on Pages 20-21 of 100 indicates field measurements for DO, ORP, and pH indicate reduced oxygen, which is favorable for anaerobic biodegradation of TCE. However, as noted, favorable conditions suitable for RD were not achieved and it is not clear that conditions will improve in the future without additional actions. Revise the Effectiveness Monitoring Report (EMR) for the C-Area Groundwater (CAGW) Operable Unit Removal Action (U), April 2019 Through June 2020; SEMS Number: 82, SRNS-RP-2020-00566, Revision 0, September 2020 (the EMR) to address this issue.

   Response: Agree.

   SRS agrees the conditions favorable for reductive dechlorination are not as widespread as initially estimated. As noted in the *Protocol for In Situ Bioremediation of Chlorinated Solvents Using Edible Oil* (Air Force Center for Engineering and the Environmental, 2007), lag times to stimulate measurable increases in the rate of chlorinated ethene degradation may take 12 months or longer in initially aerobic aquifers.

   SRS plans to install 2 wells within the 2 oil injection zones in FY22 to determine if conditions near the injection zone remain conducive to reductive dichlorination, and downgradient effects may have a longer lag time than expected. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

2. The EMR indicates microbial counts, especially of anaerobic bacteria, are also expected to increase in the groundwater samples over the next 5 years. Additionally, the text in Section 5.0 (Summary) on Page 21 of 100 states "The QuantArray®-Chlor analyses of the BioTraps indicated an increase in anaerobic microbial activity at some wells." While it is noted an increase in anaerobic microbial activity occurred at some wells, it appears there are insufficient microbes to conduct RD, based on the BioTrap results presented in Table 4 for microbial results. Typically, microbial results should be in the range of 10^6 or 10^7 cells per milliliter (ml) at a minimum. However, the ranges of microbial results presented in Table 4 are several orders of magnitude lower than 10^6 or 10^7 cells/ml. It is possible the injected microbes may have been stressed or killed by exposure to oxygen (or to oxygenated water) during injection or the methanogens outcompeted microbes for all of the resources (carbon substrate, vitamins, etc.). One other possibility is that the pH was too low, or the ORP was not low enough or was strongly reducing. As such, it is unclear whether the anaerobic microbes will continue to increase in the future based on the current unfavorable geochemical aquifer conditions (i.e., high DO, positive ORP and low pH levels). Revise the EMR to address this issue.

   Response: Agree.

   SRS acknowledges that microbial populations are lower than optimal for RD conditions. Microbial activity will continue to be monitored per the sampling plan.

   SRS plans to install 2 wells within the 2 oil injection zones in FY 2022 to determine if conditions are conducive to reductive dichlorination, including sampling for microbial colonies. Section 5.0 of the 2021 EMR will be expanded to include greater interpretation of the microbial results in the context of overall RD conditions. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

3. The significance of the aerobic biodegradation pathway and its impact on cis-1,2-dichloroethylene (DCE) and VC were not discussed in the EMR. It is noted that the biodegradation of cis-1,2-DCE and VC can occur via the aerobic pathway and the BioTrap sampling indicted the presence of aerobic microbes and related enzymes. Currently, the CAGW OU NTC RA monitoring results indicate concentrations of cis-1,2-DCE and VC are virtually non-detect at all sampling locations. Revise the EMR to discuss the significance of aerobic biodegradation on reducing concentrations of cis-1,2-DCE and VC.

   Response: Agree.

   SRS recognizes there are several pathways for the degradation of chlorinated solvents, including aerobic cometabolic degradation of TCE and daughters as indicated in Figure 1-2 from the *Protocol for In Situ Bioremediation of Chlorinated Solvents Using Edible Oil* (Air Force Center for Engineering and the Environmental, 2007) (See attached). This

could be the reason why cis-1,2-DCE and VC are not detected, and could be supported by the presence of aerobic microbes and associated enzymes. However, significant reductions in TCE concentrations were not observed. Additional interpretative text will be added to the 2021 EMR to address this potential pathway.

No changes are proposed for the 2020 Effectiveness Monitoring Report.

Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

4. The EMR states methanogenesis indicates conditions favorable to the biodegradation of TCE by anaerobic bacteria. The EMR further indicates the presence of methane above background concentrations in areas with chlorinated solvents is an indication that the groundwater geochemical conditions are favorable for anaerobic reductive dechlorination. However, the presence of methane and methanogenesis does not provide evidence that complete reductive dechlorination is occurring, and ethane and ethene are better indicators. Methanogenic bacteria compete with reductive dechlorinating bacteria like *Dehalococcoides* sp. for free hydrogen and compete for fermentation substrates. The injected substrate is being used to produce methane. Methanogens double every hour, while it takes about 48 hours for reductive dechlorinators like *Dehalococcoides sp.* to reproduce. Revise the text to acknowledge that the presence of methane does not indicate that complete reductive dechlorination is occurring, that methanogens compete with anaerobic bacteria capable of complete reductive dechlorination, and that ethane and ethene are better indicators that reductive dechlorination is occurring.

Response: Agree.

The *Protocol for In Situ Bioremediation of Chlorinated Solvents Using Edible Oil* (Air Force Center for Engineering and the Environmental, 2007) indicates that *Methanogenesis is characterized by coupled enzymatic reactions which may result in TCE degradation through cometabolism, although the fastest and most complete reductive dechlorination of CAHs typically occurs under methanogenic conditions. However, measured ethylene concentrations to date are very low indicating minimal TCE degradation via the reductive dichlorination pathway.*"

SRS believes wells installed within the injection zones in FY22 will provide additional evidence to determine if reductive dichlorination is occurring in an anaerobic portion of the aquifer. Section 5.0 in the 2021 EMR will include additional discussion on aerobic (co)metabolism.

No changes are proposed for the 2020 Effectiveness Monitoring Report.

Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

SPECIFIC COMMENTS

1. **Figure 2. CAGW OU TCE Plume 2019, and Figure 3. CAGW OU NTC RA Area (Baseline Conditions), Pages 27 and 29 of 100:** The most current TCE sampling results for the monitoring stations (i.e., monitoring wells, seepline wells, surface water stations) are not presented in the figures. As such, it is difficult to assess results relative to the TCE maximum contaminant level (MCL) of 5 micrograms per liter (µg/L) since up to 2 orders of magnitude is represented in a single range of concentrations. For example, in Figures 2 and 3, the orange colored symbols indicate a TCE concentration range of 5.00 - 99.9 µg/L and 5.00 - 49.9 µg/L, respectively, representing two orders of magnitude. For clarity and completeness, revise the figures to include the most recent TCE data, and to split the concentration range of 5.00 - 99.9 µg/L and 5.00 - 49.9 µg/L into smaller increments, such as from 5.00 - 9.99 µg/L and 10.00 to 99.9 µg/L and 10 -49.99 µg/L, respectively.

   Response: Agree.

   Figures 2 and 3 will be revised in the 2021 report to show the most recent TCE concentrations, and smaller ranges will be used for the wells and plumes, similar to the revised Figures 2 and 3 attached to these responses. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

2. **Figure 6. CAGW OU Monitoring Stations, Page 35 of 100:** Castor Creek monitoring station CC-07 is not depicted in the figure. Revise the figure to illustrate the location of CC-07.

   Response: Agree.

   Figure 6 will be revised in the 2021 report to show the location of CC-07, similar to the revised Figure 6 attached to these responses. No changes are proposed for the 2020 Effectiveness Monitoring Report.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

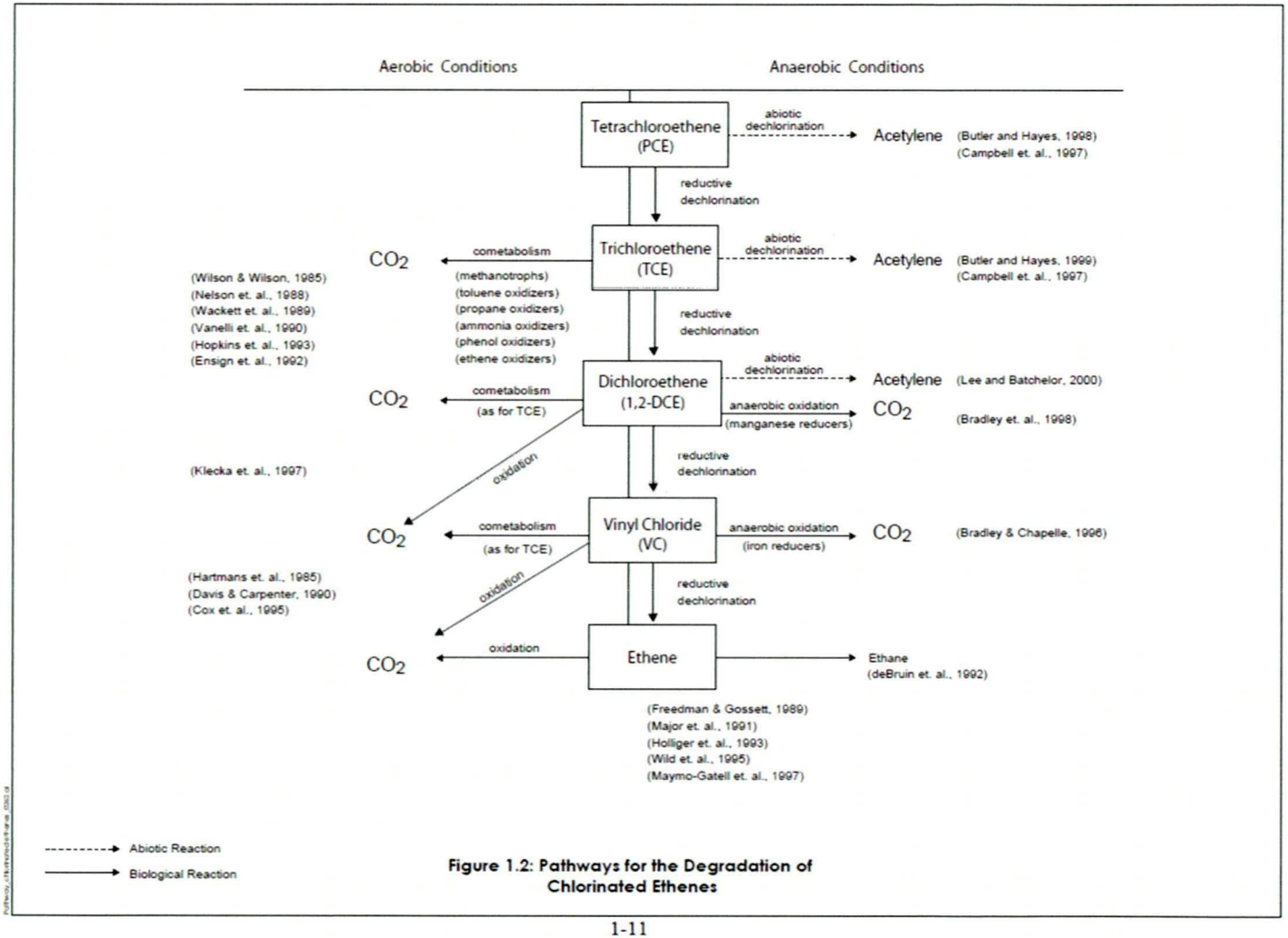

Figure 1.2: Pathways for the Degradation of Chlorinated Ethenes

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Figure 1-2 from the U.S. Air Force Protocol for In Situ Bioremediation of Chlorinated Solvents Using Edible Oil

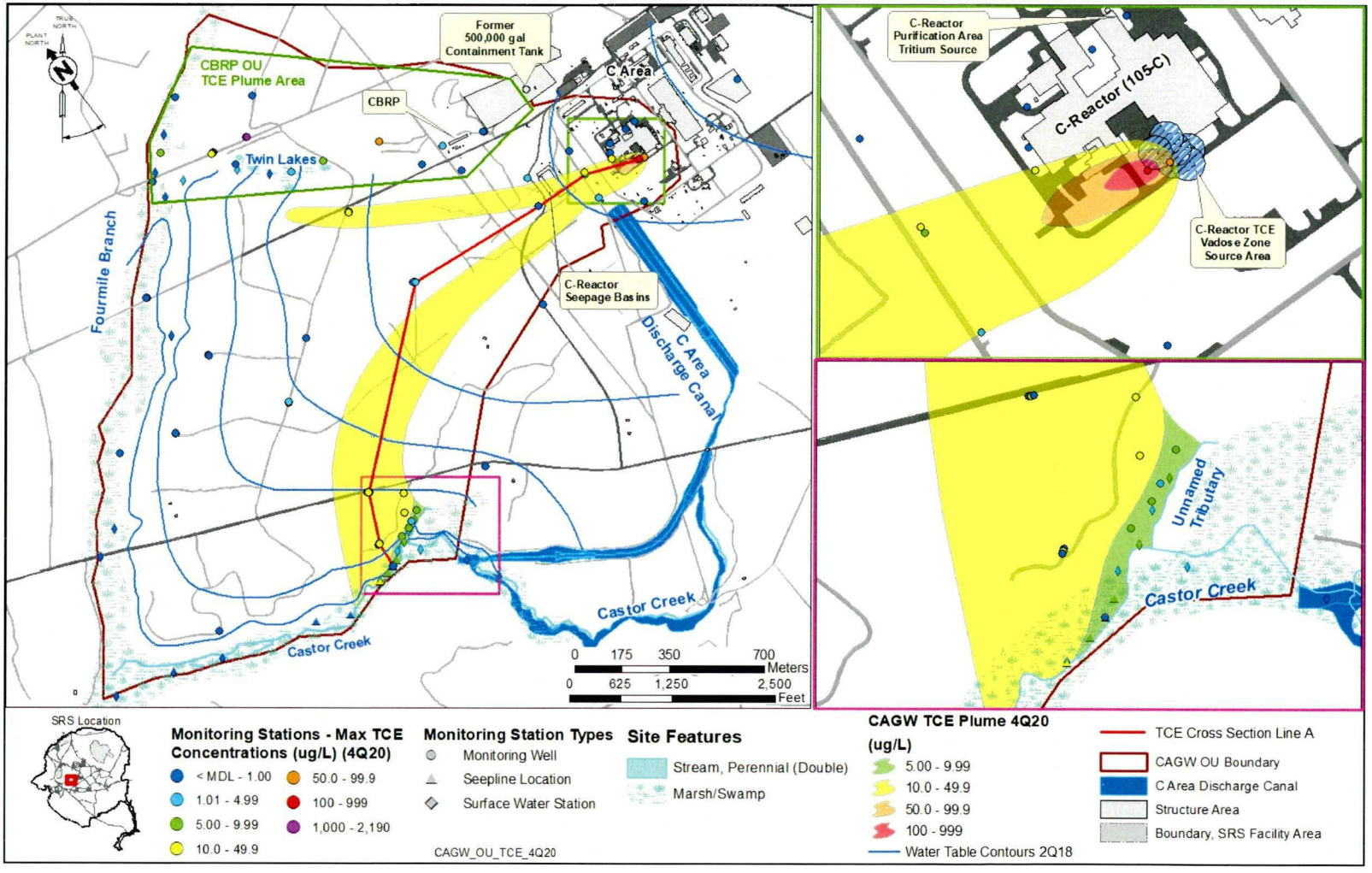

Figure 2 revised for inclusion in 2021 EMR

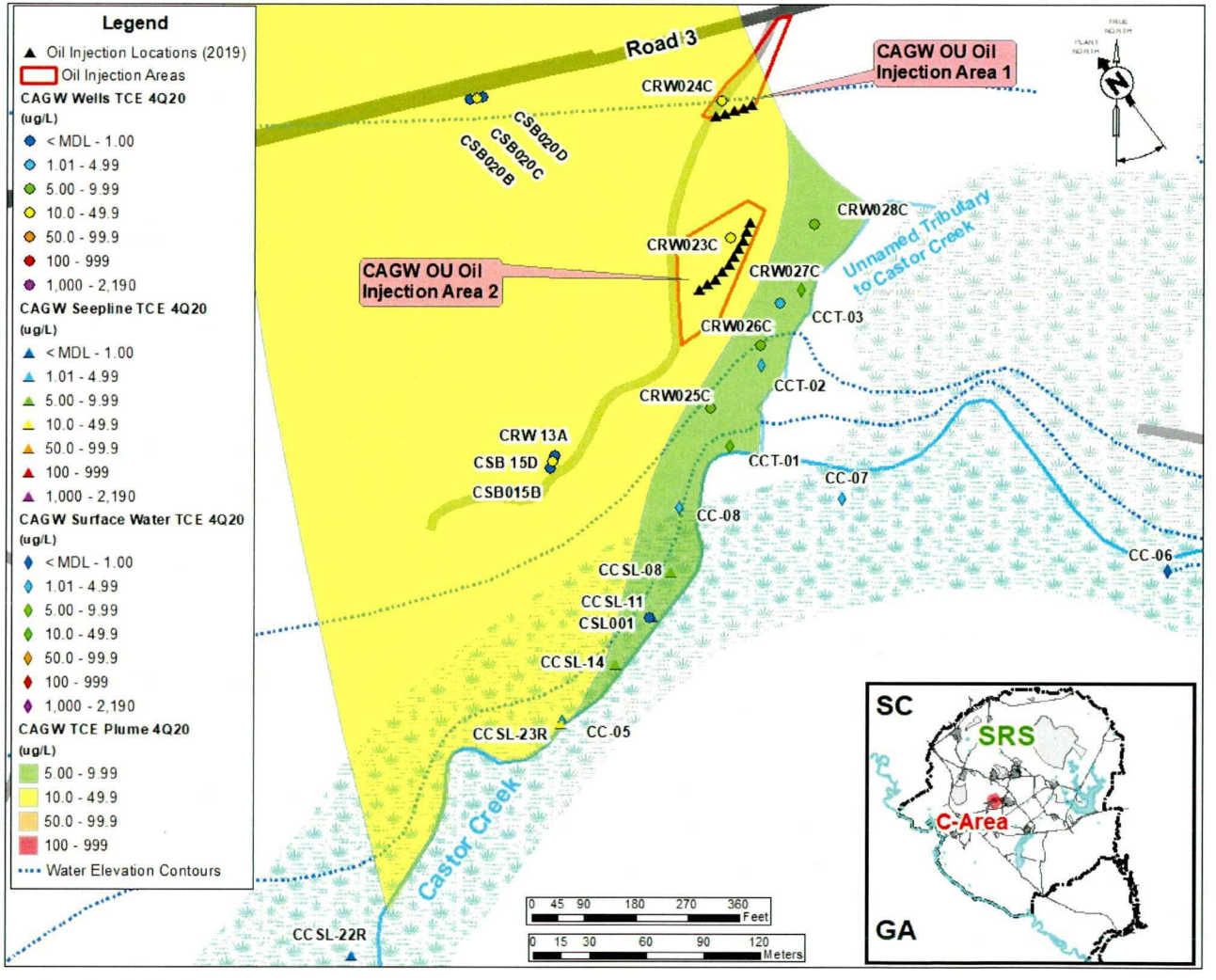

Figure 3 revised for inclusion in 2021 EMR

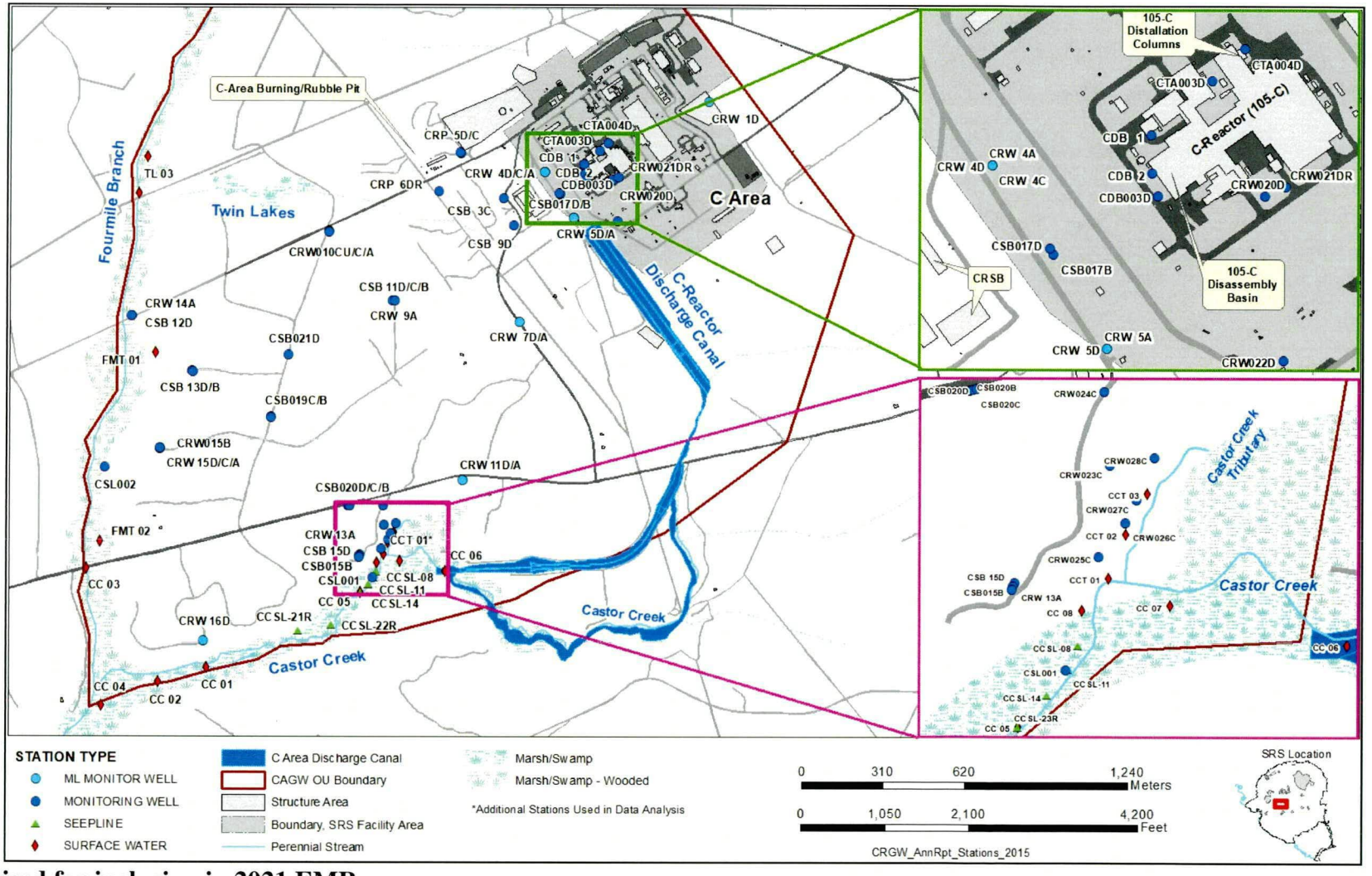

Figure 6 revised for inclusion in 2021 EMR