UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

August 8, 2000

Mr John Burleson
BRAC Environmental Coordinator
Stratford Army Engine Plant
550 Main Street
Stratford, CT 06497

Re Pilot-Scale Treatability Study Report for the Chromium and VOC Groundwater Operable Unit (OU) 2 EE/CA
Stratford Army Engine Plant
Stratford, CT

Dear Mr. Burleson:

The United States Environmental Protection Agency (EPA) has reviewed the document entitled "Pilot-Scale Treatability Study Report for the Chromium and VOC Groundwater Operable Unit (OU) 2 EE/CA, Stratford Army Engine Plant, Stratford, CT". The document is dated June 2000.

EPA's review of this document focused on the technical accuracy of the information presented, completeness of the discussion of the results, and identification of apparent inconsistencies within the document discovered during the review EPA's comments on the above-referenced document are provided in Attachment I to this letter.

If you have any questions regarding these comments, please contact me at (617)918-1387

Sincerely,

Meghan F Cassidy

Meghan F Cassidy
Remedial Project Manager

Enclosure

cc Ken Feathers/CT DEP
Michelle Brock/US Army Corps of Engineers
Peter Golonka/Gannett-Fleming
RAB Members

Toll Free • 1-888-372-7341
Internet Address (URL) • http //www epa gov/region1
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on Recycled Paper (Minimum 30% Postco

ATTACHMENT I

The following are the Environmental Protection Agency's comments regarding the document entitled "Pilot-Scale Treatability Study Report for the Chromium and VOC Groundwater Operable Unit (OU) 2 EE/CA, Stratford Army Engine Plant, Stratford, CT". The document is dated June 2000.

GENERAL COMMENTS

1 The document is principally a data report, whose purpose is to archive results of the pilot test on in-situ Cr(VI) reduction and TCE oxidation. Comparisons of observations to pre-test predictions are presented (e.g., stoichiometric ratios of injectate to contaminant required to achieve attenuation, trends in pH, conductivity, etc.), and limited interpretation of deviations between expectations and actual results are offered. The interpretations are generally well founded. While the report includes a number of explicit recommendations for improvements that could be implemented in a full-scale remediation, it does not present an overall assessment of the approach as a potential remedy based on what was learned from the pilot test. While the pilot test demonstrated some success in reducing Cr(VI) and oxidizing TCE, it also revealed some limitations, including the need for more injectate than anticipated, a slower response time than anticipated, apparent oxidation of Cr(III) to Cr(VI) in the TCE treatment area, and fouling of the $FeSO_4$ injection wells. All of these phenomena clearly entail increased costs in full-scale implementation. What are the implications for full scale-up?

2. It is suggested that the ultimate assessment of remedial alternatives for the site weigh a simple extraction scheme for the chromium against the in situ reduction scheme. While the in situ oxidation scheme for TCE offers a clear advantage over simply extracting contaminated groundwater, the parallel for the Cr(VI) reduction is not as obvious. In particular, it is recognized that a large fraction of the TCE present in the subsurface is sorbed onto the solid phase, and that the desorption rate may severely limit cleanup by simple pump-and-treat methods In-situ oxidation offers the attractive possibility of destroying the sorbed fraction in a relatively fast treatment Although there apparently is "sorbed" chromium present in the form of Cr(III), as evidenced by the increase in Cr(VI) accompanying the oxidation of TCE (see sec 4 4), this is relatively immobile in its reduced state, and, presumably, will not be a source of "rebound" as will sorbed TCE It appears from the results obtained in the untreated lobe of the Cr(VI) test that the simple flush with clean water is quite effective in reducing Cr(VI) concentrations Figure 4-1 suggests that the rebound observed in PZ-99-06 (the untreated lobe) between the two phases of the test is more severe than in the treated lobes, however, the simple extraction seems to reduce Cr(VI) quite readily Is it possible that the rebound in the treated lobes is suppressed by residual $FeSO_4$ following the first phase of injection that continues to reduce Cr(VI) that is transported back into the test area by dispersion? The untreated lobe obviously would not enjoy this advantage If this is possible, then the efficacy of in situ reduction versus simple extraction should be evaluated with full consideration of the

transport processes that tend to drive contaminants back into treated areas from surrounding, untreated areas. That is, site-wide treatment of the "hot" zone could mitigate the rebound, even following a simple "flush" scheme, as the remaining contaminants outside the treatment zone would be at much lower concentrations, and the length scale over which rebound driven by transport would be much larger. The obvious advantages of a pump-and-treat approach to the chromium remediation are that it may be less costly (e.g., no injected chemicals, no maintenance problems caused by fouling due to oxidation of large masses of iron, etc.), and it removes the contaminant from the subsurface, rather than simply changing its redox state and its mobility. It is noted, too, that extraction following the oxidation of TCE could also remove additional chromium that is presently in a reduced state, as suggested by the rise in Cr(VI) observed at EW-99-02 A disadvantage that is suggested by the results of the pilot test is that a simple extraction scheme may encounter difficulty in accessing contaminants that have invaded the lower-conductivity portions of the subsurface. Of course, this will limit the in-situ reduction scheme, as well.

3. The report does not discuss the potential impact of normal groundwater movement on the observed concentrations of trichloroethylene (TCE) and hexavalent chromium [Cr (VI)] in the study areas. Rebound, for example, may be due to normal groundwater flow bringing contamination from upgradient locations. This effect may not be relevant in a full scale hot spot removal project but may appear significant in this pilot test if not discussed in this report. It seems important to know if the rebound effect is from contamination moving into the study area or from contamination in the study area that has not been adequately treated or detected.

4. This report would benefit from a statistical analysis of the test results. For example, "Are the changes in concentrations observed within and between the lobes statistically significant?" and "What proportion of the change in concentrations can be attributed to flushing alone?". Please consider using statistical analysis to evaluate the benefits of in situ chemical treatment. The benefits are not obvious from the report as currently presented.

5 Based on the dosing requirements for each lobe compared to the pre-test contaminant mass present in each lobe, it appears that the injected chemicals may not all be impacting the target areas but perhaps are being dispersed to areas not being monitored or circuiting to adjacent lobes and providing inaccurate test results For example, test results show that wells above and below the target depth have been impacted Also, it has not been clearly demonstrated by water level measurements that the draw down at the extraction wells extends as far as the injection wells The report needs to demonstrate more clearly to the reader how the validity of the groundwater model has been confirmed by the pilot test results

6. The text does not appear to discuss initial setting and maintenance of the chemical feed pumps. Each pump was set to a different flow rate. The pumping rates were apparently initially set by calibrating the chemical feed pumps. Subsequent monitoring of the chemical feed pumps is not discussed but presumably periodic checks of the pumping rates were made. Please edit the text to include a discussion of the initial, on going, and final calibration checks for the chemical feed pumps.

SPECIFIC COMMENTS

1. **Page 2-1, §2.1** In the first bullet, add to the end of the last sentence "... and distribution of $KMnO_4$ to locations where it was not originally planned to go." It appears from the data that areas outside of the planned 10-foot thickness have been impacted during the treatability study.

2. **Page 2-2, §2.2** For the discussion in the second bullet, please note that a prior EPA comment pointed out that MnO_2 has been shown to oxidize Cr (III) to Cr (VI), which may raise concern with this plan.

3. **Page 3-3, §3.2.2, Paragraph 3** The report notes that, "A key measure of success of the treatment will be the ability to meet [target] concentrations and maintain them." While maintaining the groundwater below remediation goals is certainly an important objective of the full-scale remedy, this assessment of "success" cannot be uncoupled from the transport processes that drive "rebound." One such process is certainly transport from untreated, low-permeability domains back into adjacent treated zones. It should also be noted that, at a larger scale, there is also transport from surrounding untreated areas into the treatment zone. This is particularly significant for the pilot test, which treated a small spot within a large domain of contaminated groundwater. Presumably, an effective full-scale remediation is less prone to this source of rebound, as the in-situ reduction scheme would be aimed at concentrations down to some maximum tolerable value, and rebound would not be as severe as that observed in the pilot test It is noted that a credible assessment of the predominant transport processes at the site may need to consider dispersion due to tidally driven fluctuations in groundwater movement. At this site, with very small mean groundwater flux toward the estuary, dispersion associated with the mean flow (as represented in the widely used, classical model for dispersion) may be much smaller than that driven by tidal fluctuations.

4 **Page 3-3, §3.2.3** As was done for Section 3 2.2, add a sentence presenting the amount of $KMnO_4$ required based on the bench scale test results and the stoichiometric requirement

5 **Page 3-6, §3.6.2** In the second last sentence, edit the text to state "Variations between and within lobes " because the data indicates this to be true and this variation is also noteworthy

6. **Page 4-2, §4.1.2** The fourth sentence in the second paragraph states that the referenced lobes may contain significantly different initial masses of TCE. In fact the data can be evaluated grossly to prove that is true. By taking the average of three concentrations from each lobe (at the injection well, one piezometer, and the extraction well) an average initial mass in each lobe can be calculated. Such a calculation (from data in Table 3-6) shows that the lobe injected with the smallest $KMnO_4$ concentration initially contained 1.28 kg of TCE (soil and groundwater), the lobe injected with the mid-range $KMnO_4$ concentration initially contained 4.37 kg of TCE, and the lobe injected with the greatest $KMnO_4$ concentration initially contained 3.46 kg of TCE. The mass of $KMnO_4$ required to demonstrate treatment at the referenced piezometers, as stated in the second sentence of the second paragraph of this section, is way out of proportion to the mass of TCE initially in each lobe. This seems to suggest that the $KMnO_4$ is dispersing to areas of the subsurface other than the target area.

7. **Page 4-2, §4.1.2** Contrary to the statement in the fourth sentence in the third paragraph, the data in the third sentence do not appear to indicate an advantage to injection at higher concentrations over a short time period. PZ-99-10 is on the lobe receiving the highest $FeSO_4$ concentration but required more than 50% more $FeSO_4$ to achieve treatment than PZ-99-08, which is in the lobe receiving the lowest $FeSO_4$ concentration. PZ-99-10 is only slightly farther from its injection well than PZ-99-08 is. Also, PZ-99-09 is in the lobe receiving the mid-range $FeSO_4$ concentration, yet it required more than five time more $FeSO_4$ to achieve treatment than PZ-99-08. This suggests that the character of the subsurface may have the most significant impact on the performance of the in situ chemical treatment. Chemical injected into a particular target area may be dispersing outside that area in significant quantities.

8. **Page 4-2, §4.1.2** The report acknowledges clearly that much greater masses of $FeSO_4$ and $KMnO_4$ were required than anticipated, and offers some speculation on possible reasons for this (e.g , higher contaminant mass than estimated, higher organic carbon in the soil that consumed oxidant, etc.). In view of the magnitude of this discrepancy, it would be useful to provide a summary of the actual masses injected in the text. It is noted that Table 3-7 does provide this information in terms of planned versus actual mass injected An additional column in the table showing the actual molar ratio injected (i.e., moles of oxidant or reductant actually injected divided by the estimated moles of contaminant in the treatment area) would provide another useful measure of the modifications required These figures will fold back into cost estimates for scale-up, as it appears that four to eight times the anticipated injectate was required to meet the pilot test objectives

9 **Page 4-3, §4.1.3** Can the difference between field observations and the original groundwater model be attributed to a reduction in the extraction rate compared to the modeled rate, or was the model deficient because the geology of the study area is so variable, or is there another explanation? Please suggest how the model and the field result can be brought into better synchronization

10. **Page 4-5, §4.2.6** The text could clarify this discussion by stating: At the acidic pH levels present in the subsurface when chemicals are being introduced through the injection wells, the low pH will inhibit the oxygen in the dilution water from oxidizing the Fe (II). When chemical injection stops, the pH will rise allowing the residual oxygen to slowly oxidize the surplus Fe (II).

11. **Page 4-7, §4.5** Please reconcile the apparent discrepancy between the last sentence in the first (partial) paragraph on this page with the last sentence in the second paragraph on this page in regard to chemical reactions continuing to occur in the sample bottles. Also, please explain whether or not the reaction rates are concentration dependent. If they are, then the holding times will affect samples from the different lobes differently.

12. **Figure 4-1** This figure appears to show that PZ-99-1C was impacted by the pilot test even though this well is located outside the target depth of the study. Was this expected? Was the impact from flushing or chemical treatment?

13. **Figure 4-5** Is there an explanation for the significant drop then rise in the TCE concentration from November 18, 1999 to November 30, 1999 to December 1, 1999? Is there any reason to question the November 30, 1999 analytical result?

14. **Figure 4-13** This figure appears to show that PZ-99-2A and PZ-99-2C were impacted by the pilot test even though these wells are located outside the target depth of the study. Was this expected? Was the impact from flushing or chemical treatment?

15. **Figure 4-27 to 4-30** The temperature effects cannot be viewed on photocopied versions of this report, presumably because of the color used. Is this result consistent with the groundwater flow model?

16 **Table 4-1** For well EW-02, two samples are shown for 1/24/00 08 00AM and both have the same ID number but different analytical results for manganese Please review and correct as required.