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LETTER AND COMMENTS FROM U S EPA REGION I REGARDING DRAFT FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA OPERABLE UNIT 14 (OU 14) NAS SOUTH WEYMOUTH MA
10/07/2010
U S EPA REGION I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION I
5 Post Office Square, Suite 100
Boston, MA 02109-3912

October 7, 2010

Brian J. Helland, P.E.
BRAC Program Management Office NE
4911 South Broad Street
Philadelphia, PA 19112-1303

Re: Draft Feasibility Study Report for Site 11, Solvent Release Area (Operable Unit 14)

Dear Mr. Helland:

EPA reviewed the *Draft Feasibility Study Report* (FS) for Site 11, Solvent Release Area at the Naval Air Station South Weymouth, dated August 2010 in light of its general compliance with EPA's Remedial Investigation/Feasibility Study Guidance and for consistency, technical accuracy, and completeness. The FS summarizes the site history, remedial action objectives, and develops and evaluates remedial alternatives designed to remediate the site groundwater. Detailed comments are provided in Attachment A. As discussed with you today, EPA will be submitting its comments on the Applicable or Relevant and Appropriate Requirements separately at a later date.

The evaluations for the alternatives developed for this FS were based on data generated for the Remedial Investigation and selected data collected before the Remedial Investigation. Unfortunately, the available database is too sparse to support a conceptual remedial design. While the Navy has performed simulations using the Biochlor software program to evaluate the transformation of the chlorinated ethenes to determine when the remedial goals would be achieved for the various alternatives that rely on reductive dechlorination, credible site-specific values for first order decay coefficients for the various chlorinated ethenes cannot be determined from the available data and neither can source decay coefficients. These parameters are important components of the simulations. Multiple rounds of groundwater sampling through the plume centerline are necessary to generate the data needed for design. While this should be the focus of additional data collection, better characterization of the plume flanks should also be conducted. Finally, the concentrations of PCE detected in the plume core are high enough ($\geq$1% of solubility) that DNAPL could be present. If present and not accounted for in the design assumptions, the remedy would not perform as expected. As a result, the simulations performed do not provide an acceptable basis for a remedial design and cannot be relied upon to credibly select a remedy that is protective of human health and the environment.

The evaluation performed for all of the alternatives is not comprehensive enough to determine whether the alternatives are protective of human health and the environment. There is no discussion of the downgradient impacts to groundwater or surface water for any of the alternatives based on the simulations and proposals supporting the alternatives. It is apparent that the concentration of chlorinated ethenes impacting the East Mat Ditch and downgradient groundwater will continue to increase with time as the plume migrates south because none of the alternatives proposed will

prevent that. All the alternatives focus only on treatment of the plume core and do not address the contamination in the plume downgradient of the treated areas that will continue to migrate.

The simulations performed using the Biochlor software were not calibrated to the existing plume and therefore they likely do not accurately reflect how the contaminants are currently distributed throughout the plume or how the plume will change with time. (This can be demonstrated by using a one year time simulation and comparing the simulated contaminant distribution to the actual distribution based on available data.) The correct way to develop a reasonable approximation of the current plume configuration is to calibrate the software to the current concentrations. This requires that assumptions be made related to the time of the release and initial concentrations. Site-specific first order decay coefficients are estimated from the available plume data. Assumptions are modified as necessary to produce plume concentrations that reasonably represent the current plume concentrations (multiple solutions are possible). The result is a plume that simulates the current distribution of chlorinated ethenes along the length of the plume. From that point in time, the changes that will occur in the plume configuration can be simulated. In a solution developed using this methodology, the monitored natural attenuation alternative (Run #1 in Appendix F) would achieve MCLs within 86 years versus the 137 years for Run #1.

The FS should develop a range of alternatives that remediate the site over different time frames. All the alternatives evaluated, except G-6, will require 100 years or more to remediate the overburden groundwater (G-6 requires 60 to 70 years for overburden treatment; G-3 mistakenly estimated 45 years). EPA's FS guidance requires that the alternatives evaluated cover a range of remediation times to achieve cleanup. This can be accomplished by investing more resources initially to develop a more robust treatment system. While this will increase the capital cost it would be expected to also reduce the operation and maintenance costs. It should be noted that the true cost for all the alternatives evaluated in this report will be much greater than indicated because the cost evaluations have been limited to 30 years, whereas the time to cleanup will exceed 100 years in most cases. Therefore, a more aggressive treatment system that results in a much shorter time to cleanup could potentially cost less over the true life of the alternatives. The FS must be revised to include alternatives with a much shorter time to cleanup.

EPA is concerned that injection-based technologies and *in situ* enhanced bioremediation appear to be viewed more favorably than other alternatives. Unfortunately, the RI lacks data that would enable a more meaningful evaluation of the viability of these technologies at SRA. Consequently, additional information is needed to better constrain the type and number of potential remedial alternatives. As a first step, a limited pilot test should be considered in the high-concentration source area to assess the potential to recover DNAPL, particularly in bedrock. Hydraulic information should also be collected during this extraction effort so that pump test analyses can be used to design a subsequent hydraulic study that would better constrain the effectiveness of delivering amendments to the subsurface via controlled injection (*i.e.,* injection pilot test). EPA maintains that strong consideration should be given to removing the high-concentration soil source zone to shorten remedial time-frames and increase the chance of success for some of the other less aggressive remedial options under consideration.

The range of remedial alternatives considered in the FS should be expanded. Enhanced bioremediation is featured as all or part of Alternatives G-3, G-4, G-5, and G-6. While EPA agrees that bioremediation could successfully remediate this site, these processes are more effective in the dissolved phase portion of the plume. Their use in the high concentration source area, where

DNAPL is suspected, is somewhat uncertain and is therefore not appropriate in a rigorous comparison of alternatives, particularly for DNAPL source zone remediation, unless careful pilot testing is conducted and supports its consideration at SRA.

The FS makes appropriate distinctions between the high concentration source area and the down-gradient dissolved-phase plume areas, and also between the overburden and bedrock. The remedial alternatives are designed to address the high-concentration source area (overburden), the high-concentration source area (bedrock), dissolved plume (bedrock) and dissolved plume (overburden). In most cases, the emphasis for active remedial components appears to be directed toward the high-concentration source area. EPA believes that the relatively higher levels of dissolved phase contamination (*i.e.,* the area down-gradient from the highest concentration) may not be sufficiently treated in the alternatives currently under evaluation, and therefore could be problematic for long periods of time. The region affected by dissolved groundwater concentrations (lower than 10,000 ug/l and above 100 ug/l) may be more efficaciously treated with a different approach than that selected for the high-concentration source areas and dilute far-field down-gradient areas. In this context, it may be productive to reconfigure remedial alternatives into six general sub-categories as follows:

- High-concentration source zone (overburden)
- High-concentration source zone (bedrock)
- Moderately high concentration mid-plume region (overburden)
- Moderately high concentration mid-plume region (bedrock)
- Distal down-gradient dissolved-phase plume (overburden)
- Distal down-gradient dissolved-phase plume (bedrock)

While the precise division between these sub-categories will depend on the specific remedial components under consideration, the general concept should be applied to the development of particular combinations of remedial technologies. The remedial alternatives need to provide a higher level of treatment to the moderately high concentration mid-plume regions than is currently the case.

The elimination of extraction wells and all technologies that rely on them, including virtually all *ex* situ treatments, is inappropriate. EPA recognizes that groundwater extraction (*e.g.,* pump-and-treat) may not always be effective, but it has been implemented successfully at hundreds of sites. It is inappropriate to eliminate the technology because it may not achieve RGs. Table 3-1 notes that, "This technology may reduce groundwater contaminant levels, but could reach asymptotic level greater than PRGs." If correct, as demonstrated through an appropriate LTM program, a decision to revise the treatment train can be made at that time, if required.

Groundwater extraction has at least three additional functions in site remediation that may be important at SRA, and therefore support retaining the technology. Specifically, groundwater extraction is often essential to hydraulic containment and DNAPL recovery efforts. Groundwater extraction and/or injection may be useful in pilot testing and remedial design to evaluate the feasibility of injecting or extracting various remedial substances as well as developing specific injection or extraction strategies.

- Hydraulic containment: EPA expects a plume to be contained even where full remediation within a reasonable time frame may not be feasible. The relatively long remedial time estimates presented in the FS suggest that hydraulic containment may be necessary, and should therefore not be eliminated.

- DNAPL recovery: EPA recommends removing any mobile NAPL before attempting bioremediation in DNAPL Source Zones. Therefore, consideration should be given to interim actions, such as a focused pump-and-treat effort to remove any mobile NAPL, should it be present.

- Hydraulic Testing: There are many considerations for remedial actions that rely on fluid injection (or extraction). Since injection is required by most of the remedial alternatives in the FS, the range of potential pitfalls of injection-based remedial technologies (*e.g.,* injection pressure limitations; risk of induced uncontrolled fractures; potential for DNAPL mobilization; potential for groundwater and contaminant displacement; injection efficiency limitations due to hydrogeologic complexity) should be more fully examined.

To assess the impact of these factors with respect to injection-based remedial alternatives, *in situ* injection field testing as a stand-alone effort, before introduction of any additives, should be considered. Field tests can be used to collect data to assess the viability of injection as well as to finalize the full-scale design. Given the reliance on injection-based technologies, a robust assessment of injection feasibility is needed. EPA recommends that such testing is completed as an interim action. Factors to be assessed include: 1) evaluate the ability to deliver fluid to the subsurface; 2) develop an understanding of subsurface interconnectivity; 3) determine the volume-radius relationships, to better constrain injection well spacing; and 4) confirm groundwater flow rates, to determine the necessary injection frequency.

In Situ Bioremediation of Chlorinated Ethene – DNAPL Source Zones: While *in situ* bioremediation of chlorinated ethenes is well established in dissolved-phase plumes, the use of this emerging technology for DNAPL source zones is subject to a number of challenges, including:

- Geochemical conditions outside optimal range (*e.g.,* low or high pH)
- Bio-fouling
- Decreases in pH and ORP conditions during bioremediation may solubilize metals, particularly redox-sensitive metals (*e.g.,* arsenic, manganese, iron)
- Inhibition/toxicity of contaminants & of co-contaminants to dechlorinating microbes
- Adequacy of existing microbial populations
- Deliverability challenges because of geologic complexity
- Low aquifer permeability, heterogeneity and/or preferential pathways
- Long remedial time frames
- Monitoring and system maintenance considerations
- Large source zones may require additional treatment technologies

Many of these are of particular concern at SRA. The Weymouth area has high levels of manganese in native geologic materials. *In situ* bioremediation, particularly using procedures that add carbon-rich substrate to the subsurface, perturb the redox environment. At SRA, this may result in mobilization of redox-sensitive metals such as iron, arsenic, and manganese from their more stable oxidized phases to lower valence states that are mobile in groundwater. Manganese and iron have

shown this type of behavior at other sites (*e.g.*, RDA). EPA is concerned that full-scale application of enhanced bioremediation could result in a new dissolved manganese plume. Further, given the relatively short flow path distances to surface water discharge bodies, transfer of metals from groundwater to surface water and sediment may occur, and unforeseen risks could develop. Therefore, selection of bioremediation, particularly enhanced bioremediation, should be rigorously monitored to ensure that metals do not become problematic for down-gradient groundwater, surface water, or sediment. As a result, EPA believes that a manganese PRG should be developed for SRA for groundwater.

Biofouling could occur given the potential for metals mobilization. Remedial alternatives that rely on enhanced bioremediation need to fully consider potential for extensive maintenance and extra costs should biofouling become problematic.

Decreases in pH owing to geochemical changes attending ISB may result in inhibition or elimination of bacteria necessary to fully dechlorinate the CVOC. The degree to which the geochemical system at the SRA is self-buffered is not known. After the ability to inject is evaluated, further pilot testing of particular ISB processes should be considered to more thoroughly evaluate the potential for metals mobilization, unfavorable drops in pH, and biofouling. Such information will enable a better estimate of the time frame and cost of treatment using these types of technologies.

Excavation/Removal: EPA believes that excavation/removal was unfairly eliminated and should be retained in the detailed analysis of alternatives. Excavation/removal should be retained as a component for the high-concentration overburden source area because it could provide a meaningful cost estimate for comparison to the other technologies evaluated. Although dewatering and related efforts will increase costs, these operations are routinely applied at construction/remediation projects, and therefore cost estimates for excavation/removal may be subject to considerably less uncertainty than some of the other technologies.

Groundwater extraction in high-concentration bedrock source area: Groundwater extraction should be retained as a potential remedial component for the high-concentration bedrock source area because it could provide a meaningful cost estimate for comparison to the other technologies evaluated. Information and cost data for groundwater extraction/pump-and-treat is readily available and there is less uncertainty for this technology. For comparative purposes, at least one additional remedial alternative should be included in the detailed analysis that includes groundwater extraction/pump-and-treat in the high concentration bedrock source area and excavation/removal of the high-concentration overburden source material.

The document makes reference to Region 9 PRGs in the discussion of the Remedial Investigation Report (RI), presumably because significant progress had been made on the RI before the current Regional Screening Levels (RSLs) were issued. However, for subsequent documents that require screening evaluation, please plan to use the RSLs.

The report refers throughout to a 1:1 replacement ratio for disturbed wetlands as a typical requirement. However, because the success of wetland restoration cannot be guaranteed, the regulatory requirement is generally greater than 1:1 and in some cases much greater. The text acknowledges that the final ratio will be determined in conjunction with the regulators, therefore clarify in the FS that for the purposes of costing only a 1:1 replacement ratio has been used. The

text should also indicate that this may be underestimated. EPA has seen a wide range of compensation ratios used depending upon site-specific circumstances. The U.S. Army Corps of Engineers has issued guidelines for compensatory wetland mitigation that should be consulted when addressing wetland mitigation within the Feasibility Study (*see* http://www.nae.usace.army.mil/reg/2602_001.pdf).

Sustainability is not a CERCLA evaluation criterion. Please mention this at each reference to a sustainability evaluation. It is inappropriate to evaluate alternatives in light of criteria other than those specified in the NCP.

All the alternatives evaluated use the same technology to remediate bedrock groundwater. This is not appropriate and a range of alternatives should be reviewed that differ in the time to cleanup and in the type of technology applied.

The selected PRGs (*e.g.,* 5 ug/L for PCE) will result in cumulative human health risk greater than 1E-04 for the lifelong resident. The selected PRGs will also yield a cumulative HI greater than 1.0 for the resident. The FS should include an appendix showing human health risk calculations to demonstrate that the selected PRGs do not present unacceptable cumulative risk to potential future human receptors.

I look forward working with you and the Massachusetts Department of Environmental Protection to select a final remedy for the SRA site. Please contact me at (617) 918-1385 to arrange a meeting to discuss these comments.

Sincerely,

Kymberlee Keckler, Remedial Project Manager
Federal Facilities Superfund Section

Attachment

cc: Dave Barney, USN, South Weymouth, MA
Dave Chaffin, MADEP, Boston, MA
Kevin Donovan, SSTTDC, South Weymouth, MA
Rona Gregory, USEPA, Boston, MA
Phoebe Call, TTNUS, Wilmington, MA

ATTACHMENT A

Page	Comment
§1.1.1	The FS is affected by the uncertainties inherent in the RI data. The range of remedial alternatives under consideration should be expanded to include excavation/disposal and pump and treat.
§1.2.3	For AOC 35, please specify the *type* of contaminated soil.
§1.2.3	In the April 2003 – Groundwater sampling of Downgradient Overburden Well text, please specify the sample depth collected from MW10-302.
§1.2.3	In the September-October 2003 – Shallow Groundwater Sampling Program text, please specify the range of depth for the groundwater samples collected from the temporary wells. Please also confirm that these samples are all from the overburden. EPA has commented about the upgradient control that is partially supported by the NDs at the seven temporary well points located along Pidgeon Road. Additional upgradient control is needed before field pilot testing or remedial implementation efforts. Confidence in the characteristics of water entering the site from upgradient areas is essential to MNA analysis.
§1.2.3	October 2004 – Geophysical Survey/Refuse Removal: Although it is unlikely that waste materials were buried at depth, a limited soil removal action in the locus of the highest soil contamination areas will serve to remove significant contaminant mass and confirm whether waste material, such as buried drums, are present.
§1.3.1	Depending on the remedial approach selected, additional monitoring in the eastern half of the flow system may be needed because of the groundwater divide. EPA looks forward to working with you on this during the remedial design phase.
§1.3.4	While EPA recognizes that standard soil vapor sampling has been precluded by high water table conditions at the site, other approaches could improve the understanding of the potential for vapor intrusion (*i.e.,* passive vapor sampling approaches). EPA is willing to perform a small scale demonstration project of such technologies to determine whether such methods may inform the CSM and future remedial strategies.
§1.3.5	A limited soil removal action in the locus of the highest soil contamination areas will remove significant contaminant mass and also confirm whether waste materials, such as buried drums, are present. This could expedite the remedial action time.
p. 1-11, §1.3.5	The second paragraph speculates that the source of the groundwater contamination may be the disposal of small quantities of spent solvents.

	Based on the estimated mass in groundwater presented in Table 2-6, which only accounts for contaminants currently present above their MCL, approximately 200 gallons of solvent are currently present in the subsurface. Depending on when the release(s) occurred, this likely represents only a fraction of the total solvent volume released. Please delete the reference to a "small quantity."
p. 1-12, §1.3.6.1	The text at the top of the page states: "Potential unacceptable risks were identified for future residents (adult and child) primarily from use of groundwater as drinking water…" This statement does not completely describe the important pathways for future residents. Dermal exposure during showering and vapor intrusion are also significant risk pathways that should be included in this summary.
p. 1-13, §1.3.6.1	The last paragraph summarizes site COCs. The text notes that while unacceptable risk was identified for the construction worker exposed to VOCs in trench air, site conditions preclude the construction of such a trench. Section 1.3.6.3, however highlights this pathway as one posing potential unacceptable risk. If this scenario is one for which a COC is not identified, the FS should propose a LUC to ensure that workers are not exposed to trench air before remediation.
p. 1-13, §1.3.6.1	The last sentence, which discusses a depth to groundwater of 1-2 feet is not consistent with the text in the last sentence on page 1-9 which refers to a depth to groundwater of 0-6 feet. Please correct.
§1.3.6.2	While current data suggest that metals in sediment are not expected significantly impact invertebrates; this may change in the context of a full-scale remedial implementation that employs enhanced bioremediation. EPA therefore believes that PRGs for common redox sensitive metals (manganese, iron, arsenic) should be developed. A more robust coordinated monitoring scheme for surface water, sediment and groundwater will be necessary before future active phases of work, such as field pilot testing or remedial implementation efforts, particularly those employing enhanced bioremediation.
p. 1-13, §1.3.6.3	The concentration of chlorinated ethenes entering the East Mat Ditch and impacting surface water and sediment will significantly increase with time as the plume migrates south. None of the alternatives presented would prevent that.
Figure 1-4	Please correct the scale bar in the inset map.
p. 2-1, §2.1	Please correct the last sentence in this paragraph. Concentrations of chlorinated ethenes in surface soil exceed the current Regional Screening Levels (RSLs) for both risk-based and MCL-based values and concentrations of several metals exceed soil screening levels for leachability and polynuclear aromatic hydrocarbons also exceed the risk-based RSLs.

p. 2-1, §2.2	The penultimate sentence states that the maximum concentration of vinyl chloride does not exceed its MCL. The maximum vinyl chloride concentration was 3.3 µg/L, detected at CH108-MW-01 in 2006. Please correct.
p. 2-2, §2.3.1	A fourth remedial action objective is necessary to "Prevent the migration of contaminants to surface and sediment at concentrations that create excess risk to human health and ecological receptors."
p. 2-6, §2.4.4	The second sentence in the first paragraph exaggerates the protectiveness of the selected PRGs and should be deleted. Current remediation techniques and analyses can reasonably achieve lower contaminant concentrations than proposed and can therefore offer greater protection of human health and the environment.
p. 2-7, §2.4.4	The statement in the first paragraph that the MCLs are sufficiently protective has not been demonstrated to be correct because they result in risk to humans (*see* Table 2-3). Because multiple COCs are present, the MCLs are not protective, so in accordance with the third sentence in this paragraph, PRGs should be based on a 1×10^{-5} excess risk. If there is a risk-based justification for using the MCLs as PRGs, please provide it.
p. 2-8, §2.5.2	Generic action-specific ARARs should not be presented in this section. Action-specific ARARs should be presented and discussed in Section 4 because the action-specific ARARs vary for each alternative. Please delete Table 2-5 and the reference to it.
§2.6.1	As discussed on July 22, 2010, the plume may extend southward of the EMD, at least in deep overburden and/or shallow bedrock groundwater. The monitoring network needs to be improved in this southern part of the site during subsequent project phases.
p. 2-8, §2.6.1	Please revise the fourth sentence in the first paragraph to state: "Recent monitoring data suggest that the PCE plume extends to, but not beyond (*i.e.,* south of) the East Mat Ditch in overburden. However, the presence of elevated concentrations of chloride in overburden groundwater south of the East Mat Ditch suggests that a solvent plume older than the one currently identified may have migrated south past the East Mat Ditch.
p. 2-9, §2.6.1	To better clarify the extent of the bedrock PCE plume, please edit the first full paragraph to acknowledge that PCE was also detected south of the former pistol range on the East Mat at MW10-411D2 at a concentration of 6.3 µg/L which exceeds the MCL.

Section 2.4.4 — The text states that the VI PRGs based on residential exposure are in Appendix B. This is incorrect because the only PRGs in Appendix B are for construction workers. Please document the calculations for VI PRGs for residents in an Appendix and include them in a revised Table 2-3 so that all of the PRGs can be evaluated together.

Tables 2-1 & 2-3 — Please consider developing PRGs for the common redox sensitive metals (manganese, iron, arsenic), particularly if a remedy involving enhanced bioremediation is implemented or pilot tested.

Table 2-3 — a) Maximum Contaminant Levels (MCLs) were selected as PRGs that results in a human health risk greater than 1×10^{-4}. When ARARs are not sufficiently protective (*e.g.,* when multiple COCs are present), the NCP requires alternate remedial goals. Therefore, the MCLs need to be evaluated cumulatively for excess human health risk and cannot be used indiscriminately as PRGs. Please demonstrate that the selected PRGs are protective.

b) Please explain the rationale for selecting MCLs as PRGs given RAO #2 (page 2-2) that requires restoration of groundwater only to GW-2 and GW-3 criteria.

Table 2-3 — Please provide the calculation of the risk-based PRGs and show the toxicity values and exposure assumptions (RME or CTE) used for these calculations.

Table 2-3 — Please add a column to show the cancer and non-cancer risk associated with the selected PRG, equivalent to the table below:

EPA Calculation of Risks Associated with Selected Groundwater PRGs-Solvent Release Area

Contaminant of Concern	Units	Risk-Based PRG				Selected PRG	Selection Basis	Residential Risk Associated with Selected PRG	
		Resident		Construction Worker					
		CR= 10^{-5}	HI = 1	CR =10^{-5}	HI = 1			CR	HI
PCE	ug/L	0.53	44	449	1855	5	MCL	9E-05	0.1
cis-1,2-DCE	ug/L	NA	96	NA	NA	70	MCL	NA	0.7
TCE	ug/L	45	NA	NA	NA	5	MCL	1E-06	NA
VC	ug/L	0.39	15	NA	NA	2	MCL	5E-05	0.1
PCP	ug/L	4.7	310	NA	NA	1	MCL	2E-06	0.0
3,3'Dichlorobenzidine	ug/L	0.94	NA	NA	NA	0.94	Risk-Based PRG	1E-05	NA
Arsenic	ug/L	0.38	3.1	NA	NA	10	MCL	3E-04	3.2
Barium	ug/L	NA	2000	NA	NA	2000	MCL	NA	1.0
							Cumulative VOC Risks:	1E-04	1.0

This table shows that the cumulative risk of all the VOCs combined is a cancer risk of 1E-04 and a hazard index of 1. These risks are acceptable given that it is unlikely that hypothetical residential receptors would be exposed to all of the VOCs at the PRG concentration. The risks of the other chemicals, notably arsenic, are not considered problematic because of the low frequency of detection. Inclusion of a table and description such as this will support the PRG selection. It will also be useful in the ROD to demonstrate that the cumulative risks associated achievement of the PRGs will be protective.

Table 2-5

It is possible that excavated soil and or extracted groundwater from the highly contaminated source areas could be hazardous.

§3.2.2.4

It is not clear why Phytoremediation was eliminated. It could help remediate shallow (overburden) groundwater. If existing wetland vegetation is replaced with species favorable to phytoremediation, please clarify how this would affect the wetlands value of the area.

§3.2.3.1

Under Excavation, the volumes of contaminated soil and groundwater within the highly contaminated soil source area employing construction dewatering/treatment is routinely applied at contaminated sites. Owing to the likely effectiveness and benefits of such an action, EPA maintains excavation should be retained and included in detailed cost estimates for specific remedial alternatives that include excavation.

§3.2.4.1

EPA concurs that field pilot testing would be required to test the effectiveness of injection. The presumption that "injection into the bedrock via injection wells can be readily implemented and can provide accurate reagent delivery into target areas" needs confirmation. With regard to overburden injection feasibility, removal of highly contaminated source materials could facilitate replacement of that area with coarse material, such as gravel. Such coarse materials could be used very effectively as a means of delivering injected substrate in the subsurface in order to sweep/treat down-gradient area.

§3.2.4.2

Under Chemical Oxidation, ISCO should be retained, subject to a pilot study to determine injection effectiveness in the shallow and deep bedrock.

p. 3-14, §3.2.4.3

The discussion of permeable reactive barriers would benefit from a summary description of how the mulch and ZVI PRBs work to remediate the COCs. For example, the mulch acts as a source of carbon for aerobic microorganisms that use dissolved oxygen to metabolize the mulch, thus lowering the redox potential of the aquifer. This stimulates anaerobic degradation of organic matter releasing hydrogen and acetate that are used by other anaerobic microorganisms to complete reductive dechlorination of the chlorinated hydrocarbons. ZVI works by releasing electrons to the chlorine molecules on the hydrocarbons (PCE) allowing them to cleave from the hydrocarbons. Successive cleavages dechlorinate the hydrocarbons

ultimately resulting in the production of ethene. The reaction pathways may be very complex, but the net result is the dechlorination of the hydrocarbons.

§3.2.4.4 EPA disagrees with the basis for eliminating ERH for bedrock. Can this be better explained?

Table 3-1 Containment technologies need to be retained in the event that groundwater restoration proves to be impracticable. Combinations of vertical barriers in the overburden and groundwater extraction in bedrock have been effective at other sites. *Ex situ* treatment and disposal technologies would need to be reexamined and should not be eliminated.

Table 3-1 It is not clear why DUS is eliminated. Problems involving heterogeneity also negatively affect many of the other technologies that have been retained. Please clarify why this is a greater problem for DUS.

Table 3-1 The preliminary screening of alternatives, as summarized in Table 3-1, is somewhat uneven in its evaluation with respect to removal/groundwater extraction (eliminated) and in-site treatment/PRB (retained). While EPA agrees that groundwater extraction is often found to slow in its effectiveness as contaminant levels decline "asymptotically," and that the possible presence of DNAPL may also limit its effectiveness, it would seem that the same limitations may obtain for the PRB approach. In particular, it can be assumed that some large fraction of the PCE present in the shallow overburden aquifer is sorbed to the matrix, and will continue to supply groundwater with dissolved PCE for some time. Any residual DNAPL will also continue to supply dissolved PCE. These ongoing sources to groundwater present a challenge for both pump-and-treat and for PRB technologies, as they are both intended only to remove dissolved PCE at some location(s) downgradient of the source area. Only destruction of sorbed compound and/or DNAPL in the source area can obviate this problem. Please strive for internal consistency in the screening of alternatives, such that groundwater extraction is carried forward, or the PRB is eliminated for the same reasons, or some rationale is provided for different results for these two technologies.

Table 3-1 While EPA is not expressly encouraging groundwater extraction, the FS should present a factual and unbiased evaluation of potential remedial options.

a) Since an appropriate justification for eliminating groundwater extraction was not provided, this determination seems arbitrary. Please explain the elimination of groundwater extraction in greater detail.

b) Groundwater extraction would facilitate the implementation of injection technologies by lowering the groundwater table thus potentially enabling injection without having groundwater breach the ground surface. Extraction would also increase the local groundwater seepage velocity thus reducing the

time needed to distribute the reaction chemicals thus reducing the treatment time.

c) Groundwater extraction could also create a hydraulic barrier to minimize the discharge of contaminated groundwater to the East Mat Ditch.

p. 4-9, §4.2.2

a) Please review the first full paragraph. Contaminant migration is already occurring and is impacting the East Mat Ditch. This condition may get worse with time. Therefore, monitoring will track how far the contamination is migrating and will provide data to determine if additional remedial measures need to be implemented including the extension of the area covered by LUCs, if necessary. Please make this correction throughout the discussion of this alternative.

b) The second full paragraph refers to 36 existing monitoring wells, but 39 wells are identified in Table 4-2. Please correct.

§4.2.2.2

The restoration time frame analyses discussed are highly uncertain. Please consider an interim source action (*e.g.,* DNAPL recovery/soil excavation) after which restoration time frames could be revised.

p. 4-11, §4.2.2.2

Under *Short-Term Effectiveness*, it should be noted that this alternative would not prevent the off-site migration of contaminated groundwater or mitigate its movement into the surface water in the adjacent stormwater drainage ditch and beyond.

§4.2.3.1

The various remedial alternatives that rely on injection technologies reveal the uncertainty inherent in the site characterization. For example, Alternative G-3 specifies 56 new bedrock injection wells. This is more than the total number of monitoring wells present at the site and underscores the need to perform additional characterization including a carefully designed pilot test to determine the effectiveness of injection (*i.e.,* an injectability study).

p. 4-12, §4.2.3.1

The third paragraph states that "… two (mulch) barriers are required to allow the complete treatment of the plume in approximately 45 years." However, nothing in the FS supports this contention. Furthermore, it is not apparent that the statement is correct based on rough simulation of the time for the downgradient (untreated) portion of the plume to dissipate. Please provide the basis for this statement including Biochlor simulation results or other appropriate documentation. Note that based on the distance to the East Mat Ditch from the southern mulch barrier and considering the retardation factor used for PCE for the FS modeling, the expected PCE travel time to the ditch alone would approximate 100 years.

p. 4-13, §4.2.3.1

Please clarify the following statement in the second full paragraph: "Approximately half of the disturbed area can be restored and counted toward the 0.85 acre." Why would only half of the disturbed area be restored?

§4.2.3.2	EPA disagrees that enhanced bioremediation is a "relatively well established technology." Use of the technology in bedrock is not yet proven. Therefore, EPA recommends a pilot scale treatability study designed in light of the hydrogeologic environment present at the SRA site.
p. 4-15, §4.2.3.2	Under *Reduction of Toxicity, Mobility, or Volume through Treatment*, enhanced bioremediation is estimated to remove 1,900 pounds of PCE from groundwater. It is unlikely that this or any alternative would remove that amount of PCE which is essentially all the PCE in groundwater and soil within the defined plume area according to Table 2-6. PCE and daughter products will migrate beyond the site and dilution and dispersion will account for additional removal. Unless there are calculations to support the claimed PCE removal, the specific quantity should be deleted. This same comment applies to Alternatives G-4, G-5, and G-6.
p. 4-16, §4.2.3.2	Under *Short-Term Effectiveness*, it should be noted that this alternative would not prevent the off-site migration of downgradient contaminated groundwater or do much to mitigate its movement into the surface water in the adjacent stormwater drainage ditch and beyond. This same comment applies to Alternatives G-4, G-5, and G-6.
p. 4-17, §4.2.4.1	The second paragraph refers to a cover but no earlier mention of a cover has been made. Please edit the text to introduce the cover properly, explaining what it is and its purpose.
p. 4-21, §4.2.5	As noted previously, the PRB in the configuration described may be limited by the continued release of PCE to solution from mass sorbed on the overburden matrix material in the source area, as well from DNAPL, if residuals are present. These continuing sources may mean that the PRB will have to remain viable for many years until PCE in the source area is depleted. Section 4.2.5.1 refers to "...complete treatment of the plume in approximately 30 years...." How was this timeframe estimated? Please modify this remedial alternative to include some sort of treatment in the source area, in order to shorten the necessary time that the PRB must be maintained. Perhaps the enhanced bioremediation proposed for the downgradient bedrock portion of the plume could be extended to the source area?
§4.2.6.1	It is not clear why ERH is eliminated for bedrock. A variation of alternative G-6 should be evaluated that includes ERH for both bedrock and overburden. This could present cost advantages as the costs associated with getting power to the site, *etc.* will more effectively leveraged if ERH is expanded to include bedrock.

§4.2.6.1	The projected clean-up time frame (*i.e.,* 600 years) for using enhanced bioremediation in bedrock is quite long and EPA therefore believes that additional approaches should be considered. For alternative G-6, for example, a variation that replaces enhanced bioremediation in bedrock with ERH in both bedrock and overburden should be considered.
p. 4-28, §4.2.6.2	a) The viability of electrical resistance heating at this site is questionable given the high water table elevation that will make it difficult to operate a soil vapor extraction system to capture the mobilized contaminants. Further discussion of this situation is warranted in the description. b) Edit the last sentence to refer to *contaminated* GAC.
Table 5-1	a) On pages 1 and 2 of 2, for Alternative G-2, the reference to "several years" for *Overall Protection of Human Health and Environment* and the 15-year time frame discussed for *Short-term Effectiveness* and *Implementability* are not correct. b) There are several inappropriate statements that need to be corrected. For example, for G-3: contrary to the text in *Overall Protection of Human Health and Environment* the high PCE concentrations would persist for a very long time after the plume moves through the barriers because high PCE concentrations exist immediately downgradient of the southern barrier. Please review all the discussions in this table and make the appropriate corrections. None of these alternatives would remove the high PCE concentrations in a short time.
Appendix C	Bulk density of bedrock is said to be 206 pounds per cubic foot (3.3 g/cm3). That is not consistent with the value used in Appendix D in the substrate calculation sheets (2.6 g/cm3).
Appendix D	a) On page 2 of 2 for Mulch PRB: there is a typo at the bottom of the page in the penultimate line; 41,565 should be 44, 565. b) Table following page 2 of 2 for Mulch PRB: The retardation factors present here are significantly different from the ones used in the Biochlor simulations. Also, the note states that bedrock retardation is assumed to be similar to overburden; however, significantly greater retardation factors were used for bedrock in the Biochlor modeling. c) On page 2 of 2 for Bedrock Biobarrier, the third line in each paragraph should be deep bedrock, not shallow bedrock. d) The substrate calculation sheets would benefit from a discussion of the assumptions made to develop these calculations.

e) For all the substrate calculation sheets, please provide the source for the Koc values used. Note that the Koc values used in this appendix differ significantly from the values used in Appendix F for the Biochlor simulations.

Appendix F

a) On page 2 of 7: Please cite the literature source for the Koc values used.

b) On page 5 of 7: Regarding the assumption at the bottom of the page, the method discussed for determining the source degradation term Ks is not correct. The source degradation term needs to be determined by iterative sampling of a specific well located in the source area to measure the changes in the contaminant concentration in that source area well. Consequently, the value calculated by the method indicated will not be representative of source area degradation. No data has been collected to date that could be used to reasonably estimate source degradation, thereby creating a significant data gap for the Biochlor modeling.

c) In Figure C-4, the semi-log plot for overburden PCE concentrations with distance, it is not apparent what PCE concentrations were plotted because they do not coincide with any PCE concentration data points. Please clarify what PCE data was plotted.

d) Similarly for Figure C-5, the semi-log plot for bedrock TCE concentrations with distance, the values plotted do not appear to coincide with any TCE data points or even PCE data points if that was the intent. Please correct.

e) All the Biochlor modeling (overburden and bedrock) has mistakenly entered the Alpha y value for dispersion into the model rather than the ratio of the Alpha y to the Alpha x. This results in a more lateral dispersion of the plume than would actually occur. Consequently, achievement of the remedial goals would take longer than indicated in these modeling results.

f) The Biochlor modeling has overridden the retardation factor selected by the model and inserted a more conservative, larger retardation factor (one representative of PCE). This would extend the time it will take to achieve the remedial goals. For example, for Run 1, using the model-selected retardation factor and correcting the Alpha y value, the time to achieve the remediation goals becomes 116 years instead of 137 years.

g) Runs 3 and 4: Simulation of the effects of the permeable reactive barriers cannot be accurately performed in the manner attempted in these runs because these simulations do not account for the current status of the plume concentrations.

Appendix G

a) There are significant differences among the alternatives regarding the area of wetland that is disturbed and consequently requires restoration. The FS does not explain these significant differences nor do the figures provided for each alternative provide any rationale. Alternative G-3 disturbs only 0.4

acres, Alternative G-4 disturbs six acres, G-5 disturbs two acres, and G-6 disturbs 0.3 acres. Please clarify why these differences exist.