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Response to Comments on the IR Sites 4 and 5 DNAPL and Dissolved Source Draft Removal Action Work Plan Alameda Point, Alameda, California

Comments by: Melinda Trizinsky, SWDIV Remediation Specialist

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G1			There may be some serious issues associated with the SPH pilot studies and the full scale deployment of SPH that are proposed.	Comment noted.
G2			Six-phase heating is a patented technology that has been developed and marketed by Current Environmental Solutions (CES) and Battelle. CES is the only vendor of SPH. Yet it appears that CES is not involved with this project.	Six-phase heating is a patented application of electrical resistance heating that was developed by Batelle Laboratories at government expense. As such, the patent is majority owned by the federal government and the federal government has full and irrevocable rights to use the technology in any way it sees fit. Repeated attempts to contact CES prior to hiring a SPH subcontractor were unsuccessful, and TRS had experienced staff available, so they were hired.
G3			Six-Phase Heating™ is a patented technology that has been developed and marketed by Current Environmental Solutions (CES) in conjunction with Battelle.	1) Although CES claims a trademark on the the term "Six-Phase Heating", there does not appear to be a trademark registration for the term in the USPTO database. 2) CES's lawsuit filed 5/30/01 makes a claim for trademark infringement based on TRS's logo design, but makes no claim against TRS for the use of the term "Six-Phase Heating", in spite of the repeated claims to such trademark in their web-site.
G4			CES is the only vendor of SPH. Yet it appears that CES is not involved in this project.	CES is one vendor of Six Phase Heating, but not the only one. TRS is also a vendor of Six Phase Heating.
G5			If CES is not a subcontractor to IT on this project, then the remediation approach is not actually SPH. Both the EE/CA and the Action Memorandum for this project indicated that SPH was the preferred alternative. I am no legal expert, but it seems that the Navy could get itself into trouble if IT chooses a vendor other than CES.	Since CES does not appear to have a trademark registration on the term Six Phase Heating. Their participation is not essential to the successful performance of the removal action.

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G6			I strongly recommend that IT subcontract with CES for this project. In addition to having a thorough understanding of the technology and its application, CES has developed a number of innovations that maximize the effectiveness of SPH and minimize energy usage.	IT Corporation will, upon receipt of a formal instructions from the Navy, hire CES as a subcontractor. In the meantime, all references to TRS will be removed from the workplan and its associated documents. While CES may have developed a number of innovations, it is not clear at this time whether any of them are proprietary. If so, CES should have patents on those innovations. The staff of TRS has participated in the bulk of the work CES has done to date (all of TRS's staff were employees of CES until mid to late 2000). Thus, this project may access any non-proprietary innovations through either subcontractor. IT Corporation will inquire with CES as to any additional patents they may hold and will consider the value they may add to the project.
G7			The designs in this work plan suggest that the alternate vendor, Thermal Remediation Services (TRS), does not possess the same level of expertise as CES.	The staff of TRS has participated in the bulk of the work CES has done to date (all of TRS's staff were employees of CES until mid to late 2000). Thus, it is difficult to visualize how the level of expertise in CES could exceed the level of expertise at TRS (or vice-versa)
G8			There seem to be some serious design flaws in the "Typical Electrode Completion" given in Figure 23.	This comment is too general for a reasoned response.
G9			Given the current energy situation in California, CES is likely to deliver more cost effective remediation at Site 4 and 5 than TRS.	This may or may not be so, however, it is impossible to determine this at this time.

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G10			It is not clear from the work plan whether TRS is also involved in the pilot study using "energy saving modifications" or not, but the rationale for these modifications is not clear. Because the principles of operation for the modified system were not clearly explained, the technical merit of this approach could not be evaluated. Specific comments will address these issues.	The following text will be added to the sixth paragraph of section 1.2 (page 1-5), just before the last sentence: "The addition of a low-permeability barrier surrounding the treatment cell is expected to reduce power consumption by limiting the recharge of groundwater and air as the water initially contained within the pore volume is boiled away and the soil gas/steam mixture is recovered by the steam extraction wells. This should increase the vadose zone, allowing for higher mass-transfer rates that will reduce the total energy that will be required. The low-permeability barrier will also sharply reduce the infiltration of soil gas from surrounding areas, sharply reducing the size of the treatment systems for extracted steam. The spatial relationship of the steam extraction wells relative to the electrodes will be changed to limit short-circuiting that may occur under the "state of the art" design that will be piloted at plume 4-1."
G11			Regardless of who designed this modified SPH system, there might be similar issues if the six-phase heating system forms the core of the remediation approach.	See the responses to G1 through G10

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1		Section 1.2	This section mentions modifications to the pilot study that will be conducted at site 5-1. These modifications need to be discussed in more detail. It is not clear why hydraulic control is being used or how these modifications are expected to reduce energy consumption.	See general comments 10 and 11 above.
2.1		Section 1.2	The last three sentences of the paragraph discussing Phase III actually seem to be discussing Phase IV. Move these sentences into the next paragraph, which discusses Phase IV.	Agreed, will incorporate as indicated
2.2		Section 1.2	The discussion of Phase VI indicates that each of the 7 source areas will have its own power supply and effluent treatment system. Is this really necessary?	The seven source areas are separated from each other by hundreds of feet (in some cases, thousands). Some of the areas are within buildings and are separated by walls. Construction of wiring and piping systems to accommodate multiple plumes serviced by a single power supply or treatment systems would be expensive, inefficient and would significantly impair traffic. Under-grounding the cables and piping would be even more expensive, and running the cables and (hot) pipes above grade would present significant security and safety problems. The most cost-effective safe alternative is to limit the distance over which power must be transmitted and steam conveyed. This can be achieved by having the power supplies and treatment systems service one plume at a time, often servicing only a portion of the plume at any given time.
2.3		Section 1.2	Although there are 7 potential source areas identified, they are located on just 2 IR sites. I thought that there were only a limited number of units capable of converting normal 3-phase power into the Six-phase power required for this technology. Perhaps a phased approach using mobile power supplies and treatment systems needs to be considered.	There is, in fact a very limited number of power supply units. In fact, only one is available at this time. Staging a single power supply to remediate all seven plumes would extend the project schedule well beyond the timeline that is acceptable to the Navy and the BCT. The current plan is to have two new power supply units built, and to operate three systems simultaneously, thus allowing for completion of the full-scale application over a

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				period of eight months.
3.1		Section 1.3	A number of assumptions seem to have been made in this project. For example Section 1.0 assumes that the EE/CA will be approved by the regulatory agencies without significant modification, and this section assumes that the regulatory agencies are comfortable with fieldwork proceeding prior to their review of this work plan. Is there reason to believe that this is the case?	The comments to the EECA related only to ARARs. There is no impact to the technology choice.
3.2		Section 1.3	For example, has verbal approval been given for the data gap sampling effort? If so, maybe the discussion in this section should be qualified.	The additional design data collection scope was presented to the BCT during the April 17, 2001 meeting at Alameda Point. It was well received, and there have, been no further comments on this matter from the Agencies to date.
4		Section 1.4	Include the project documents mentioned here (QCPP, SAP, EPP, and HWMP) in the references given in Section 8.	Agreed, will incorporate as indicated
5		Sections 2.2.1 and 2.2.2	The "marsh crust" is never mentioned in these reviews of site geology and hydrogeology. If it does exist at Sites 4 or 5, the high organic content of the marsh crust may act as a sink for migrating CVOCs. Clarify whether the marsh crust may be present below either of these two sites.	The following language will be added to this section: Text added to first paragraph of Section 2.2.1: 'The "marsh crust", an identifiable subsurface horizon of organic peat layers containing preserved marsh grasses and other tidal features has organic peat layers two to six inches thick. Overlying, or instead of, the organic peat layers is a carbon rich layer composed of Refinery and Manufactured gas plant by-products that were deposited onto the former marsh and backwater areas. Both units are organic rich and can sorb contaminants. At Site 4 the marsh crust is anticipated to lie beneath the northern edge of Plume 4-1. Text added to first paragraph of Section 2.2.2: "At Site 5 the organic rich portion of the marsh crust is not anticipated to underlie the plumes . However it is possible that a thin organic rich Refinery and Manufactured gas plant by-product layer (as well as other industrial wastes) may have been distributed as far as Site 5." The layer beneath Site 5 has been referred to as the "Sub-tidal Area" in the Marsh

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				Crust ROD.
6		Sections 2.2.2	Clarify whether the statement, "Tidal fluctuations were not measured in the FWBZ…" indicates that tidal fluctuations were "non-detectable" or were "not investigated". The current phrasing could be interpreted either way.	Sentence will be changed to read "Tidal fluctuations were not investigated in the FWBZ…"
7.1		Section 3.3	Is the current monitoring well network adequate to define the potentiometric surface and establish flow direction?	The current monitoring well network is sufficient to define a general flow direction at each site. The following sentence added to first paragraph "Site 4 has enough existing wells screened in the FWBZ to allow rough definition of the potentiometric surface and to establish general flow direction. Site 5 has enough wells to allow rough definition of the potentiometric surfaces for the FWBZ and the SWBZ and to establish the general flow direction for each zone." Site 4 has 10 monitoring wells screened in the first water bearing zone: • 3 screened 3.5-13.5 feet bgs; • 4 screened 5-15 feet bgs; and • 3 screened in the 84-96 feet bgs interval-- 84-94; 86-96; and 86.5-96.5. Since three points define a plane, a minimum of three wells screened in the same water bearing zone are required to allow rough definition of the potentiometric surface and establish general flow direction. Site 5 has 14 monitoring wells screened in the first water bearing zone and 3 monitoring wells screened in the second water bearing zone. • 1 screened 3-13 feet bgs, FWBZL; • 1 screened 4-12 feet bgs, FWBZL; • 3 screened 4-14 feet bgs, FWBZL;

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				• 7 screened 5-15 feet bgs, FWBZL; • 1 screened 7-15 feet bgs, FWBZL; • 1 screened 7-17 feet bgs, FWBZL; • 2 screened 57-67 feet bgs, SWBZ; • 1 screened 60-70 feet bgs, SWBZ; Since three points define a plane, a minimum of three wells screened in the same water bearing zone are required to allow coarse definition of the potentiometric surface and establish a general flow direction.
7.2		Section 3.3	Clarify whether the FWBZ and SWBZ will be evaluated separately at Site 5.	The following sentence will be added before the last sentence in the first paragraph: "The data from the FWBZ will be used to define the potentiometric surface for the FWBZ. The data from the SWBZ will be used to define the potentiometric surface for the SWBZ. The local groundwater flow directions and hydraulic gradients will aid…"
8.1		Section 3.6	DNAPLs tend to collect at interfaces where permeability decreases with depth. Will changes in lithology factor into the CVOC sampling strategy?	Yes. Ground water samples (discussed in Section 3.7) will be collected from depths determined after consideration of the EE/CA, CPT, stratigraphy and chemical analytical data.
8.2		Section 3.6	There is no mention of evaluating the lithology for conductivity; CES usually evaluates the conductivity of lithologic layers within the contaminated zone to optimize electrode placement. Strategically placing the active surfaces of the electrodes helps to reduce energy usage and minimize treatment time. Given the current energy situation in California, this project should consider following CES's example.	Performing a site evaluation is generally advisable where no pilot study is planned prior to the design of a full-scale electrical resistance heating system. At the Alameda site, the pilot studies will provide high quality empirical data that will be used in conjunction with the data from the additional design data investigation to design full-scale electrical resistance heating systems for the remediation of the seven plume areas.
8.3		Section 3.6	Is there a compelling reason why CES is not being used as the subcontractor? Chances of a successful, cost-effective, and safe remedial design would probably be improved if CES were involved.	Repeated attempts to contact CES prior to hiring a SPH subcontractor were unsuccessful, and TRS had experienced staff available within a timeline that supported the production of the work plan in a timely manner, so they were hired. CES eventually responded, but, by that time,

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				the work plan preparation effort was well under way.
9		Section 3.7, Paragraph 3	In general, this approach looks good, but it might be wise to consider changing the decision criteria used to determine when the depth of contamination ahs been adequately characterized to something less than 10,000 ppb. Given the potentially heterogeneous subsurface lithology and the nature of DNAPLs, it might not be wise to discontinue sampling too soon. As much of the existing data demonstrates, it is quite possible for DNAPL concentrations to increase with depth. Zones of less than 10,000 ppb are frequently underlain by zones that exceed the 10,000 ppb criteria in the current data set; therefore, if this decision criteria had been applied previously, then significant contamination might not have been detected. The depth of most of the source zones has not been delineated by previous studies; let's not make the same mistakes again.	The CPT work will take place prior to groundwater sampling. The CPT data will be reviewed, and the initial sampling locations will be chosen with the stratigraphy data in mind. The decision criteria for subsequent sampling are not based solely on the reported concentration of the screening analytes being below 10,000 ppb. The determination that the vertical and lateral extent of plume contamination greater than 10,000 ppb has been reached will be a technical decision made by the Lead Geologist based on CPT, stratigraphic and analytical data. The following text will be added to paragraph 3 of Section 3.7: "Once the target contour has been located, the Lead Geologist will review the distribution of total SA and the surrounding lithology to determine the advisability of further sampling.
10.1		Section 4.0	It appears that both of these pilot tests intend to heat a continuous zone rather than targeting the resistance heating to the most conductive layers. Why?	There are very few data to define the stratigraphy and contaminant distribution at the seven source areas. The workplan was therefore based on the assumptions presented by the EE/CA, but sought to maintain flexibility in the likely event that the additional design data investigation proved one or more of the assumptions to be incorrect. The EE/CA described most of the source areas as vertically limited to within 20 feet of the surface. This would result in a 15-foot thick saturated zone to be treated, which does not typically require multiple-completion electrodes. The design presented does not ignore the differences in conductivity due to stratigraphy. Rather, it seeks to avoid over-complicating the design by taking advantage of electricity's proclivity to preferentially flow through the higher conductivity paths. By installing electrodes that extend over the full depth of

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				the treatment interval, we will apply a potential to all the horizons that might require remediation. More electrically conductive soil will initially draw the majority of the current flow and boil more vigorously, while the less conductive materials will initially draw less current. The amount of current flow to various parts of the treatment volume will naturally change as changing temperatures and moisture content create corresponding changes in the conductivity of the subsurface. As treatment progresses, the entire treatment volume will be uniformly heated. Should the additional design data investigation reveal that the contaminants extend significantly deeper than we have assumed for the preparation of the work plan, full consideration will be given to using multiple-completion electrodes to preferentially direct the flow of eletricity (and thus the generation of heat) in an optimal manner.
10.2		Section 4.0	Why are the pilot tests restricted to the upper 20 ft of the aquifer when the depth of the source zone appears to extend deeper and has not been defined for either plume 4-1 or 5-1? This relatively shallow zone will not provide performance data for all of the lithology that may need to be treated in by the full scale system.	The design is consistent with the assumptions of the EE/CA. Prior to installation of electrodes, an additional design data collection will be conducted using CPT and direct-push Hydropunch. The results of this effort will determine the total depth of each treatment zone and the depth of the electrodes will be established accordingly. Based on review of previous site sampling data, an original depth of treatment of 20 feet was selected. Should any of the plumes require deeper treatment depth, the conductive interval of the electrode will simply be extended so that the electrodes terminate approximately 2 feet below the targeted cleanup depth. Additionally, the effects of electrical resistive heating extend at least 2 feet below the depth of the electrodes. If the treatment depth increases to a point where the total

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				conductive interval exceeds 20 feet, the electrode design will be changed to a multi-element design. This design would split the conductive interval into two approximately equal parts, separated by a 6-inch thick non-conductive sand region. The electrodes would then have two conductive elements to allow independent monitoring and control of the energy input into the different depth zones.
10.3		Section 4.0	Could these shallow pilot tests create a situation where increasing temperatures decrease the viscosity of DNAPL trapped in lower permeability layers and allow the DNAPL to migrate downward?	Viscosity effects are not expected to be a problem with regard to re-mobilization of DNAPLs. The releases that occurred at the source areas are all relatively old, so DNAPL is spatially stable: migration is expected to be effectively zero at this time. Re-mobilization due to viscosity effects is very unlikely. Viscosity is a factor in DNAPL migration only during the early phase of a release. A low-viscosity DNAPL will flow faster than a high-viscosity DNAPL until it reaches an extent where the gravity forces that drive the movement come into equilibrium with the surface tension across the pore openings through which it must migrate. Once that point is reached, viscosity has no effect on migration: the only ways to cause further migration is to 1) increase the driving force (either by increasing the density of the DNAPL or reducing that of water or 2) enlarge the size of the pores through which the DNAPL can travel. None of these effects are expected
10.4		Section 4.0	Appendix B describes remediating an unconfined aquifer in Portland, OR; in that case, the vendors seemed to think it was necessary to create a thermal front below the contamination to drive contaminants towards the vadose zone. These shallow pilot tests may also require that the pilot test electrodes be replaced by deeper electrodes for full scale remediation. Justify the approach presented.	Mr. Michael Dodson and Mr. Greg Beyke, who are now employees of Thermal Remediation Services (formerly with CES), designed the electrical resistance heating system for the referenced site in Portland, OR. The Portland site presented unique remediation challenges not found at the Alameda site. Mssrs Dodson and Beyke chose the subject approach on the basis of site-specific conditions described by the EE/CA and expected to be found at Alameda Point.

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				Further information is available upon request.
11.1		Section 4.1.4 and Figure 23	This is not a normal SPH electrode design. Part of the efficiency of SPH is obtained by allowing steam (generated by the resistive heating) to migrate upwards through overlying contaminated layers and thus creating something akin to an in situ air sparging layer. The steam vent well proposed for installation with each of the electrodes would probably short circuit this process and reduce the efficiency of the SPH approach.	The first sentence of the third paragraph will be modified to read " Along-side the two electrodes...will be constructed to assist in maintaining electrode efficiency by venting any steam bubbles that might be trapped due to the heterogeneity of the soils." The vent wells are in no way meant to eliminate normal upward migration of steam flow through overlying contaminated layers. During startup and initial operations, the vent wells will not be placed on-line (the block valves at the vent well heads will be closed). The vent wells will only be purged as necessary (in the event that bubble formation around the electrode causes conductivity to degrade) to maintain the efficiency of the electrodes.
11.2		Section 4.1.4 and Figure 23	This design raises serious doubts about the subcontractor, Thermal Remediation Services and their ability to design and operate an efficient SPH system. See general comments for additional concerns.	TRS is a qualified vendor of electrical resistance heating services. TRS personnel are nationally recognized experts in electrical resistance heating and have extensive experience designing and deploying *in situ* electrical resistance heating systems. TRS's engineering and project management team's direct experience with electrical resistance heating began in 1997, during the transition of the technology from Battelle's laboratories to the commercial marketplace. The staff of TRS has over 16 years of combined project experience in the design, construction, operation, and maintenance of *in situ* electrical resistance heating systems for the remediation of chlorinated VOCs and fuel hydrocarbons, including NAPL cleanups. They have a proven track record of safe and timely performance on projects for DOE, DoD, and other public and private clients. Also, see the responses to comments No. 10.4, No. 26.1 and No. 26.2.
11.3		Section 4.1.4	Provide a brief mention of the importance of a relatively	A discussion of the importance of the surface seal is not

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		and Figure 23	impervious surface seal to improve SVE radius of influence and efficiency. Then direct reader to section 4.1.8.	relevant in this section, and belongs in section 4.1.8. A new sentence will be added after the first sentence of the first paragraph of section 4.1.8: "A competent surface seal is important because it will maximize the radius of influence of the VR wells.
12		Section 4.1.8	If utility line backfill is located in the vadose zone and has higher permeability than surrounding soils, consider installing SVE points in a central location in the backfill. I participated in a project where we utilized existing French drains as part of an SVE system under a landfill. We got excellent recoveries, maintained the integrity of the landfill, extended our effective treatment zone, and saved money on SVE installation costs. It might work here too if the conditions are right.	This approach is not appropriate for a pilot test, however, it may be advantageous for the full-scale application. A new paragraph will be inserted at the end of section 5.2.2: "Some of utility corridor back-fills may be of sufficiently high permeability to support its use as a steam recovery structure. If any such corridors are found, and the nature of the utility line permits it, a shallow VR well will be installed at an appropriate location within the back-fill to take advantage of the serendipitous situation."
13.1		Sections 4.1.11.1 and 4.2.12.1	Provide additional information about how power usage and removal efficiency will be evaluated.	A new paragraph will be inserted at the beginning of section 4.1.11.1: "Power application rates (in kW) and cumulative energy input values (in kW-hrs) will be tracked along with subsurface temperatures.The relation between power usage and temperature will be monitroed to track progress through the "heat-up" and "normal operating" periods. By comparing the concentrations of VOCs in the steam and condensate production rates to the power input, a direct correlation can also be made between power input and both CVOC and steam removal rates during the normal operations phase."
13.2		Sections 4.1.11.1 and 4.2.12.1	Initial heating is likely to require more energy than maintaining temperatures once the operating temperatures are reached.	During heatup, the energy will be used to raise the temperature of the soil and groundwater to the boiling point. During normal operations, the energy will be used to maintain that temperature, to overcome losses due to conduction, and to drive a phase change from liquid to gaseous states. The energy input rate will remain relatively

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				constant throughout the pilot study.
13.3		Sections 4.1.11.1 and 4.2.12.1	The efficiency of the CVOC removal will probably not be as good during the startup period either.	We are, in fact, not expecting any significant CVOC removal during the heat-up phase. All the CVOC removal is expected to occur during the normal operations phase.
13.4		Sections 4.1.11.1 and 4.2.12.1	Will the testing period be sufficiently long to monitor performance during both startup and normal operation?	Based upon existing site data, the testing period will be sufficient to monitor performance during both startup and normal operations. It should be noted that the purpose of the pilot test is obtain design scale-up data; not to achieve a removal end-point. Thus, all that is necessary is to determine how long and how much energy is needed to complete the heat-up phase, plus enough transient data to establish a CVOC removal trend. We expect that the heat-up phase will be completed during the first two weeks of the test. The following two weeks will establish a CVOC removal trend.
13.5		Sections 4.1.11.1 and 4.2.12.1	The two phases should be evaluated separately.	Agreed. Sufficient data will be collected as indicated in the response to comment 13.4 to evaluate both phases separately.
14		Section 4.1.11.2, 2nd paragraph	The discussion regarding the impact of elevated TOC levels suggests that it may be important to determine if the marsh crust is present at either of these sites.	It may be important to determine if the marsh crust is present at these sites. We will determine this during the installation of the treatment cells with the continuous coring performed at the central electrode location. If the marsh crust is encountered in the planned CVOC mass removal zone, the thickness of the layer will be measured and a sample will be taken. The physical characteristics of the layer will be logged in the field and the sample will be tested for hydrologic/geotechnical parameters. From these observations and analyses, adjustments to system design will be made and provisions will be made in the full-scale design application for the additional energy required to desorb COCs from this material.
15.1		Section 4.2	The purpose of the hydraulic barriers and groundwater extraction in	The purpose of the hydraulic barrier is to:

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			this pilot test are not clear. Justify the use of two forms of hydraulic control and explain how this approach is expected to save energy.	• Reduce the flow of non-condensibles (air and soil gas) to the treatment system • Limit the lateral loss of energy – the wall will focus the energy delivered within a containment area which will have the benefit of reducing the amount of energy required per cubic yard of soil treated. • Reduce the amount of steam that must be generated to achieve the removal objectives, thereby reducing costs in two ways: lower energy consumption and lower effluent treatment costs. • Increase the effectiveness of the vapor recovery system • Reduce the rate of groundwater recharge into the test zone, which will reduce the groundwater inventory within the test cell as water is removed through evaporation. The reduced groundwater inventory will expose some portion of the adsorbed CVOCs to shorter mass transfer paths, thus increasing the mass treansfer rates and reducing the duration of the mass removal (normal operations) phase. The purpose of the groundwater extraction wells is to: • Partially dewater the target zone. This should expose the CVOCs in the upper portions of the target removal zone to shortened diffusion paths. • Reduce the groundwater recharge into the target treatment zone, which will reduce the groundwater inventory within the test cell as water is removed through evaporation.
15.2		Section 4.2	Are there other modifications that are not discussed?	No other modifications..
15.3		Section 4.2	Is this effort aimed at dewatering/ lowering the water table within the test cell?	See response to comment 15.1.

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15.4		Section 4.2	How would these modifications be extended to the full-scale remediation system?	The following text will be added to the bottom of section 4.2: "This pilot test will be used to determine whether a number of potential modifications to the "state of the art" approach to SPH would be cost-effective. The addition of groundwater recovery wells within the treatment zone and of a low-permeability barrier surrounding said zone will be tested as a way to reduce energy consumption and effluent treatment costs." The modifications will only be applied to the full-scale removal system if they prove to be cost-effective. The full-scale design for some of the source zones would include hydraulic barriers and groundwater extraction wells only if the pilot test and additional design investigation data indicate that it would be cost-effective. The cost of treatment for each source area will be projected for the state of the art method (based on the data from the 4-1 pilot) and for the modified method (based on the data from site 5-1). If the 5-1 method results in sufficient energy cost savings and environmental benefits to justify its application, it will be implemented. Otherwise, full-scale mass removal will proceed according to the state of the art method.
15.5		Section 4.2	Would it be practical/cost effective to install hydraulic barriers if the source zone contamination turns out to be up to be deeper than 20 ft bgs?	The answer to this question cannot be determined at this time. However; once the two pilot tests are complete, the data required to answer it will be available. See the response to comment 15.4.
15.6		Section 4.2	Clarify the rationale for this pilot scale design. Explain the principles of operation for this modified design.	The purposes of the hydraulic barrier and groundwater extraction in this pilot scale design were discussed under Comment 15.1.
15.7		Section 4.2	It seems that some of the modification would hinder SPH efficiency in the full scale system. See general comments for other concerns	The modifications were reviewed in depth by IT's technical personnel, and we have the expectation that every

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			about this "SPH" pilot test.	modification will, in fact improve the SPH efficiency. In any event, the final arbiter of this issue will be an analysis of the data that will be generated by the two pilot tests.
16.1		Section 4.2.4.2	Why are so many SVE wells included in this small test cell?	The test cell size is being upgraded to allow 20-foot spacing of the electrodes. This will also increase the spacing between the SVE wells. The following text will be added at the end of section 4.2.4.2: "This VE extraction well array contains a larger number of wells than a typical "state of the art" pilot test installation in order to determine whether an increased VE well inventory can improve steam collection efficiency. This can be done by temporarily closing block-valves on some portion of the VE wells during normal operations and observing the effect on the operation." The water table at the site is shallow, which favors ultra low vacuum SVE operations. Given the shallow groundwater, it is highly desirable to build the system so that it can effectively collect spent steam and soil gas with relatively low applied vacuums, and correspondingly small ROIs. The large number of SVE wells supports the overlap of the SVE wells' ROI despite the small vacuum obtainable. The SVE wells are very inexpensive, since they are only four feet deep.
16.2		Section 4.2.4.2	Does Site 5 have very low permeability relative to Site 4?	Data relative to site permeability were not available in the EE/CA or in the data available to date, so the answer to this question is not known at this time. The additional design data investigation and the two pilot tests will provide some insight into this matter.
16.3		Section 4.2.4.2	The number and placement of SVE wells is generally dictated by site geology.	Agreed.. Hydrology characteristics (for example depth to water) are also a strong factor.

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17.1		Section 4.2.9	Clarify why hydraulic control is needed (desired) at Site 5.	It is desired to the extent that it can reduce lateral and vertical recharge within the treatment cell.
17.2		Section 4.2.9	Nothing in the site geohydrology indicated that high flow rates might be a problem.	Agreed.
17.3		Section 4.2.9	What is gained by using this approach?	See the responses to comments 15.1 and 17.1.
17.4		Section 4.2.9	Justify the added expense and additional waste handling requirements.	The possibility of achieving significant cost savings in the full-scale application justifies the testing of the various modifications that will be tested in the 5-1 pilot test.
18		Section 5.2.1	Issues related to the discharge of metal contaminated water raise more questions regarding the wisdom of using groundwater extraction in conjunction with SPH.	If metals contaminated water is encountered, IT will weigh the effectiveness of the modifications against the additional treatment costs. Only site 5-3 is suspected of containing dissolved metals. It is possible that the economic analysis of the full scale application at site 5-3 (in conjunction with the additional groundwater treatment needs that would be required by the method modifications) will indicate that the modifications are not cost-effective at this site.
19		Section 5.2.2	See previous comments regarding Section 4.1.8.	See the response to Comment 12.
20.1		Section 5.2.3	This section states "...the implementation of SPH beneath the building would require it to be evacuated." Why?	The TRS engineering and design team has successfully used electrical resistance heating to treat soil and groundwater beneath an active strip mall, an active manufacturing facility, beneath a public fire lane, and beneath an active public street. The electrodes can easily be designed for installation within subsurface well vaults, and the piping and electrical distribution cables can be installed within trenches. The evacuation of those buildings was not required. However; the target areas were evacuated during construction of the remedial systems. It should be noted that the building currently houses a high-tech business that may suffer significant interferences from both the installation and operation of the remedial systems.
20.2		Section 5.2.3	SPH has successfully been used to treat soil underlying an active	The remediation that was performed in the active shopping

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			shopping mall. Clarify why this building would present a problem for the technology.	mall did not involve active traffic areas. In fact, it occurred within a lease space that was not leased at the time the remediation ocurred. Thus, while remediation was going only a few feet from an active mall area, on the other side of a wall, no system components were anywhere within reach of the public or any non-remediation employees. The building in question at site 5 is a high-occupancy area, and the potential target removal zone may require installation of components under areas currently occupied by desks, file cabinets, etc.
21.1		Section 5.4	The discussion in this section seems to be off-target.	The section is intended to discuss the places where amendments to the groundcover are expected to be required; not as a discussion of SVE
21.2		Section 5.4	The underlying reason that the ground surface should be relatively impervious has more to do with increasing the ROI of the SVE wells located in close proximity to the ground surface.	The goal of this project is removal or contaminants and the prevention of their escape into the environment. The ROI is a tool for the achievement of the project goals, not an end in itself. The ground cover is aimed at preventing fugitive emissions. The ROI probably does increase as a result of a competent surface cover, but increasing ROI is not the goal of the application thereof.
21.3		Section 5.4	Shallow SVE wells can short circuit resulting in limited ROI per well.	Shallow SVE wells are unavoidable in this project, since the groundwater table is encountered at 5 feet below grade. Short-circuiting is not an issue if a good surface seal is available.
21.4		Section 5.4	Sealing the surface reduces the number of wells needed to capture the VOCs by increasing the effective ROI.	Agreed.
22		Section 5.9	Justify the need for separate effluent treatment trains and power supplies for the seven source areas.	See the responses to comments 2.2 and 2.3
23		Section 8	Provide references for other site specific documents that support this work plan (e.g. SAP, QCPP, EPP, and HWMP).	Agreed, will incorporate as indicated
24.1		Figure 11	It appears that most of these wells extend over both depth intervals,	This figure represents the EE/CA's interpretations of data

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			but they are not marked as such.	that we have obtained from reports published by a variety of consultants, and are intended to show the paucity of data upon which those interpretations were made. The MLS wells were special multi-level sampling wells with several discrete sampling depths within each of the ten-foot depth intervals. If the sampling interval of 10 feet bgs is used for both the 0-10 foot and the 10-20 foot depth intervals, then the same value is posted in both ten-foot depth intervals and marked as extending over two intervals. If however, the sampling interval at 10 feet bgs was chosen for the 0-10 foot depth interval and the sampling interval at 13 feet bgs was chosen for the 10-20 foot depth interval, then there are two different values posted and they are not marked as extending over two intervals.
24.2		Figure 11	What about the other treatability wells; were they monitored? Clarify.	There are no relevant data that can be shown on this map. The IES wells were sampled prior to the Treatability Study. The IES wells do not appear to have been sampled after the Treatability Study, and the concentrations must may have changed markedly during the Study. The IES wells and their pre-treatment Screening Analyte concentrations are listed on Table 9, but their values are not posted on Figure 11 because it would have given a skewed view of the data.
25		Figures 12-15	It is not clear from the legend or the text, what is the significance of the blue and brown coloring of the sample locations. Clarify.	The drawing's legend indicates that the blue locations, labeled "proposed" are CPT locations and will be sampled for groundwater. The brown locations, labeled "CPT locations, potential groundwater sample locations" are to be the sites of CPT test, to be sampled only as step-out locations in the event that all the adjacent blue locations prove to contain CVOC concentrations above the decision threshold. The following text will be inserted after the second sentence of the fourth paragraph of section 3.6: "The blue

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				locations will be tested with CPT and sampled for groundwater analysis. The brown locations will also be tested by CPT. These brown locations represent the first step-outs that might be taken if analysis of samples from adjacent (blue) locations reveals COCs above the decision threshold." The following text will be added to section
26.1		Appendix B	The most recent references given in this Appendix are two years old. This is a rapidly evolving technology. Is this review up to date?	The project references in Appendix B are up to date. The last electrical resistance system installation was in the spring and early summer of 2000 at the Portland, Oregon site. This installation was designed by the TRS personnel, who were at the time working for CES.
26.2		Appendix B	How many of the SPH deployments listed in Table 2 involve vendors other than CES?	Table 2 of Appendix B will be updated to identify the design engineers and project managers for each referenced site deployment. The first six of the 16 site deployments listed in the updated Table 2 were performed by Battelle personnel who are no longer involved with electrical resistance heating. These six sites represent the first pilot testing efforts performed between 1993 and 1997. The remaining ten site deployments referenced in Table 2 were performed byCES.
26.3		Appendix B	Does Thermal Remediation Services have previous experience with SPH?	Yes, see responses to comments No. 10.4, No. 11.2, and No. 26.2.