RESPONSE TO COMMENTS
DRAFT FEASIBILITY STUDY REPORT
INSTALLATION RESTORATION PROGRAM SITES 11 AND 17
NAVAL AUXILIARY LANDING FIELD (NALF) CROWS LANDING

1.0 INTRODUCTION

Comments on the draft feasibility study (FS) report for NALF Crows Landing dated December 5, 1997 and prepared by Tetra Tech EM Inc. (TtEMI), were received from the U.S. Navy, the California Regional Water Quality Control Board (RWQCB), the California Department of Toxic Substances Control (DTSC), and the National Aeronautics and Space Administration (NASA). Responses to Navy comments dated March 9, 1998 are presented in Section 2.0, responses to RWQCB comments dated April 8, 1998 are presented in Section 3.0, responses to DTSC comments dated May 4, 1998 are presented in Section 4.0, and responses to NASA comments dated January 21, 1998 are presented in Section 5.0. The draft final FS report has been revised to reflect changes suggested by the comments, as noted in the responses.

2.0 RESPONSES TO COMMENTS FROM THE U.S. NAVY

Comment 1: **Sect. 3.0 Par. 3 Pg. 3-1**

Provide the equations used to calculate the hazard index in the text.

Response: The equation for the hazard index calculation has been added to the text.

Comment 2: **Sect. 3.2.2 Par. 4 6th Sent. Pg. 3-7**

The sentence states that Plate 1 shows the lateral distribution of carbon tetrachloride in the wells at Site 17. There is no Plate 1 in the document. Perhaps the reference should be to Fig. 3-5? Please correct.

Response: The text now refers to Figure 3-3 (which was formerly Figure 3-5).

Comment 3: **Sect. 4.1.1 Par. 2 2nd Sent. Pg. 4-2**

The range of vacuums is given as 47 to 104 inches of water. The highest vacuum given in Table 4-1 is 101 inches. Please provide the correct number in this sentence or in the table.

Response: Vacuums at the wellhead ranged up to 104 inches of water, as stated in the text. However, the stable vacuum measured at the wellhead near the end of run 3, as listed in Table 4-1, was 101 inches of water. Only final, stable vacuum levels are listed in Table 4-1 as indicated in the text and in note 2 of the table. It is common during soil vapor extraction (SVE) testing for wellhead vacuums to decrease over time as air flow pathways are developed throughout soil pores in the vadose zone. To improve clarity,

the note in Table 4-1 has been revised to explicitly state that both vent vacuums and monitoring well vacuum responses listed are the stable values measured near the end of the test runs. In addition, the vacuum range has been changed to 47 to 101 inches of water.

Comment 4: **Sect. 4.1.1 Par. 2 Pg. 4-2**

Figures should be added to show the monitoring points with their corresponding responses. The data should also be contoured to help demonstrate the zone of influence of the SVE system at the various flow rates.

Response: A new figure (Figure 4-2) has been added to show vacuum responses at monitoring points for all test runs and contours of the estimated zone of influence for the third test run.

Comment 5: **Sect. 4.1.1 Par. 3 Pg. 4-2**

This paragraph discusses contaminant concentrations found in extracted vapors using both FID [flame ionization detector] and Summa canisters. The results of both sampling methods should be provided in a table. Additionally, a graph of concentration vs. time for each test should be included. This information will help show the effectiveness of the SVE system.

Response: A new table (Table 4-2) showing sampling results of extracted off-gases for all three Summa canisters is included in the draft final report. However, as stated in the draft report, FID equipment calibration problems were experienced during the early stage of testing, which included most of the SVE testing. In all cases, the FID results were much higher (as much as 30 times higher) than, and not consistent with, laboratory results. Therefore, confidence in the validity of these FID results is low and the results are not included in Table 4-2. Since the laboratory Summa canister sample results are all essentially unchanged during testing (the results were 4.0, 4.0, and 3.9 parts per million by volume [ppmv]), the data were not graphed.

Comment 6: **Sect. 4.1.2 "Shallow Sparge Testing" Par. 1 Pg. 4-3**

Provide graphs showing pressure vs. time for each monitoring point to illustrate the change of pressure as the test proceeds. At a minimum, the test data should be provided as an appendix to the document.

Response: A complete set of all pressure data collected in the field over time is now included in Appendix A. Plots of these data are also included in Appendix A.

Comment 7: **Sect. 4.1.2 "Shallow Sparge Testing" Par. 2 Last Sent Pg. 4-3**

The sentence concludes that good vertical and lateral distribution indicated a potential success for air sparging. What was the zone of influence? Provide a figure showing this.

Response: The text has been modified to include estimates of the zone of influence (ZOI) for each of the sparge tests. The ZOIs ranged from approximately 10 to 40 feet (or more) outward for all tests at the depths measured. An additional figure (Figure 4-5) has also been added to show the estimated zone of influence for each of the sparge tests.

Comment 8: **Sect. 4.1.2 "Middle Sparge Testing" Par. 3 4th Sent. Pg. 4-4**

It is probably better to use the term zone of influence instead of ROI. *Radius* implies a two-dimensional area while *zone* gives a third dimension to the influence.

Response: Although the industry's standard has been the term "radius of influence" (ROI) when describing sparge and SVE performance, TtEMI concurs that the term "zone of influence" (ZOI) is more appropriate and accurate. ZOI is preferable due not only to the three-dimensional distribution of injected or extracted gases during sparge or SVE operation, but also because zones of influence are not necessarily radial or circular in a two-dimensional plane. Therefore, all references to ROI have been changed to ZOI throughout the draft final report.

Comment 9: **Sect. 4.1.2 "Deep Sparge Testing" Par. 3 3rd Sent. Pg. 4-5**

The sentence states that "pressure increased ... after air injection stopped." Provide data tables or graphs to show this.

Response: As indicated in the response to comment 6, Appendix A now includes pressure data over time for all sparge tests.

Comment 10: **Sect. 4.1.2 "Deep Sparge Testing" Par. 3 Pg. 4-5**

Based on the data provided in Table 4-4, I'm not sure that the conclusion that air sparging at deep levels is justified. The data presented show that some C wells did not respond to sparging from the deep point. Additionally, the data in Table 4-4 seem to indicate that air moved in a mostly horizontal direction, note that pressure response in the D wells were 150+ inches of water. This response could imply that deep air sparging could cause the plume to spread horizontally. Was atmospheric pressure monitored during the test? Some of the pressure responses in Table 4-4 are very small (such as 0.18" [inches] H_2O which equals approximately 0.007 psi [pounds per square inch]). Could diurnal change of atmospheric pressure also result in some of the pressure results seen in the test?

Response: Based on the limited extent of testing and the available data, TtEMI concurs that deep sparging results do not necessarily demonstrate that sparging at those depths was successful during testing. The testing conducted by TtEMI at the deepest depth was limited or constrained by two primary factors: (1) the aquifer was responding more slowly to air injection than expected, requiring more time than was budgeted for testing at this depth; and (2) the leased air compressor was cycling frequently during testing, resulting in variable injection pressures over time and making it difficult to evaluate steady-state conditions. The compressor cycling was likely because the air compressor was running near its maximum capability during the deep sparge testing. However, it appeared to be the best compressor available on a leased basis (the specific application was unique) and was the only one the vendors claimed could meet our specifications. TtEMI still believes that, based on the available data, successful deep sparging implementation was "likely." However, this point is subject to various interpretations, and therefore the text has been modified to better reflect the uncertainty involved in projecting potential success at sparging at this depth.

The comment on atmospheric pressure variations should be considered further. Atmospheric pressure data were collected frequently throughout the sparge tests during

monitoring of passive bioventing performance at underground storage tank (UST) 109. However, as noted in the UST corrective action plan (TtEMI 1998), diurnal barometric changes were slight during the testing period, typically ranging only up to 0.03 inches of mercury throughout the day or approximately 0.40 inches of water. Furthermore, pressure gauges used for monitoring were reset to zero values daily and within the day to compensate for and screen out this diurnal effect. Even so, any pressure or vacuum value less than approximately 0.1 inch of water is slight and should not be conclusively used to demonstrate that a particular point is within a ZOI. However, diurnal changes could affect pressure results slightly, even though Magnehelic gauges were recalibrated frequently in the field.

Comment 11: Table 4-7 Pg. 4-17

Several of the concentrations given for 17-ST-01A are based on the assumption of a linear reduction in concentration at the pump outlet. How valid is such an assumption? Why weren't samples taken from the pump outlet at the time indicated and the results analyzed for better data? This could have been done by placing a sample port in the line from the pump outlet.

Response: The assumption of a linear reduction in carbon tetrachloride concentration at the pump outlet was included for illustrative purposes only. The intent of the pilot test was to provide simple, inexpensive, means to evaluate the effect of spray irrigation on contaminant reduction. While it is true that collection of additional samples may have resulted in better data, the goals of the test were accomplished without the cost of numerous additional samples. The test showed that significant reductions in contaminant concentrations could be achieved by spray irrigation, even at a scale smaller than would actually be employed. However, to avoid confusion, Table 4-7 has been revised to omit the assumption of a linear reduction in contaminant reduction at sampling point 17-ST-01A. In addition, the following statements have been added to the fourth paragraph in Section 4.3:

> The carbon tetrachloride concentration in the sample from the pump outlet at test startup time was 330 micrograms per liter (μg/L). Analysis of the first samples collected from sampling points 17-ST-02 and 17-ST-03 show that carbon tetrachloride concentrations decreased by approximately 92 percent (17-ST-02) and 94 percent (17-ST-03) through a lateral spray distance of 25 feet. On conclusion of the test, analytical results indicate that contaminant reductions of approximately 98 percent were realized at both these sampling points.

Comment 12: Figure 4-1

Add cross-section lines to the figure.

Response: Cross section lines have been added to Figure 4-1 in the draft final report.

Comment 13: Figure 4-3

The four wells on the right-hand side of the figure are incorrectly labeled. They are labeled as Sparge Wells 17-SP-02A,B,C. They should be labeled as Monitor Wells 17-MP-02A,B,C,D. Please correct. Both this figure and the preceding are excellent

at portraying the concept of the air sparging process. The one major drawback is that they imply an isotropic, homogeneous geology which is not reflective of the actual site. This should be noted.

Response: Both Figures 4-3 and 4-4 have been revised to include notes stating that actual air flow distributions were not necessarily uniform as suggested by the figures.

Comment 14: Sect. 5.5 Par. 4 Pg. 5-7

It is stated that "... no contamination was identified in the groundwater at Site 11 ..." This appears to contradict Sect. 3.1.2 which states that TPH-e [extractable total petroleum hydrocarbons] and other fuel-related compounds were found in the groundwater at Site 11. While the levels were low and posed no risks, it should be so stated.

Response: The statement has been removed from the text. Furthermore, Section 5.0 has been revised based on suggestions from RWQCB.

Comment 15: Sect. 6.1 1st Sent. Pg. 6-1

The sentence lists Sect. 6.1 as identifying the RAOs [remedial action objectives]. RAOs are given in Sect. 5.1.

Response: The sentence has been corrected in the draft final report.

Comment 16: Sect. 6.1.1 "Institutional Controls" Pg. 6-2

While institutional controls alone may not satisfy ARARs [applicable or relevant and appropriate requirements], won't some institutional controls be needed if Site 11 is capped to prevent access to the site and prohibit any future development on the cap?

Response: While institutional controls can be a component of other general response actions (GRAs), they do not comply with all ARARs by themselves. Therefore, this GRA will be eliminated from further consideration. If a final cover were installed at Site 11, access to the site could be controlled institutionally through the use of signs, fences, or other barriers to traffic.

Comment 17: Sect. 6.2 Par. 1 2nd Sent. Pg. 6-4

GRAs are discussed in Sect. 6.1, not Sect. 6.2 as stated here.

Response: The reference has been corrected in the draft final report. Furthermore, the section on GRAs has now been moved to Section 5.0 as suggested by RWQCB.

Comment 18: Sect. 6.2.1 "Physical Treatment" Par. 3 5th Sent. Pg. 6-6

The use of sprayed water for irrigation is given here as a point of discharge. Where is water discharged during the periods when irrigation is not needed?

Response: Without temporarily halting the extraction pumps, water will be produced regardless of water demand. It is therefore crucial to select secondary discharge options. Sprayed

process water could be beneficially used to irrigate agricultural crops during the growing season and, as with other pump and treat alternatives, discharged to surface waters, to groundwater by injection or percolation, or to storage during periods of low water demand. The report has been amended to include this discussion.

Comment 19: Sect. 6.2.1 "Physical Treatment" Par. 5 Pg. 6-7

Aeration was removed due to the need of constructing holding ponds or lagoons. Will storage ponds be required for the spray irrigation treatment to store water until called for in the irrigation process? Another possible drawback to aeration ponds is the storage of untreated water above ground which can be accessed by wildlife attracted to the water pond/lagoon. This could also apply to storage of spray irrigation water in a pond while awaiting use. The water would be untreated until sprayed.

Response: The amount of storage needed to match the temporal nature of irrigation demand could approach 35 acre-feet per month for up to 3 months. It is infeasible to construct such large holding facilities, especially because the value of this potential irrigation water is less than $100 per acre-foot. Other discharge options such as surface discharge or injection or percolation to groundwater could be considered. Aeration ponds would not store water, but would act as needed for daily operational storage during periods of irrigation or other demand. Controls can be implemented to prevent wildlife attraction to the aeration pond such as fencing, tenting, water jets, or decoys. The text has been amended as discussed here.

Comment 20: Sect. 6.2.1 "Chemical Treatment" Pg. 6-7

Chemical treatment options are not considered further. What about consideration of the advanced oxidation process under construction at Moffett Field?

Response: The advanced oxidation process (AOP) under construction at Moffett Federal Airfield (MFA) was chosen because this system destroys contaminants (instead of transferring them to the vapor phase), eliminating the need for expensive offgas treatment that would have been required for the air stripper effluent. The resulting reduction in operation and maintenance (O&M) expenses quickly offsets the high capital cost of the AOP. However, at Site 17 the air stripper offgas would not have to be treated, thereby removing the primary advantage of an AOP system.

Comment 21: Sect. 6.2.1 "Groundwater Disposal Options" Par. 5 Pg. 6-8

Discharge to the Delta Mendota Canal is dismissed due to high costs of routing water to it. It should also be noted that water discharged to the canal would probably have to meet certain quality criteria before being accepted. Have similar discharges been used elsewhere? Would a NPDES [National Pollutant Discharge Elimination System] permit also be required for such a discharge? In spite of the cost, this discharge option should be kept for consideration if the canal district was willing to accept the water. This would be a beneficial use of the discharge.

Response: The Delta Mendota Canal represents a discharge option similar to the Bell Road stormwater ditch and Little Salado Creek except that discharge into the Delta Mendota Canal would require piping and pumping the effluent approximately 1 mile. It is likely that RWQCB would issue Waste Discharge Requirements (WDRs) for this discharge

through the regulatory requirements of the Bureau of Reclamation, the Central Valley Project, or the Del Puerto and Oak Flat Water Districts. Although it is possible to sell water to the canal, the value of irrigation water (currently approximately $35 per acre-foot) compared to the capital costs of constructing a pipeline, operating costs of pumping, and relatively low sellable flows, is minimal. Conversations with the Del Puerto and Oak Flat Water Districts revealed the infeasibility of selling water to the canal due to various regulatory restrictions. They recommended instead selling the water directly to the farmers who lease land on or near the base. The report has been amended to include this discussion.

Comment 22: Sect. 6.2.2 "Air Sparging/SVE" Par. 1 4th Sent. Pg. 6-9

What is meant by *relatively* permeable soils? The permeability range of the soils at Crows Landing should be listed along with the range of permeabilities suitable to this treatment technique.

Response: The term "relatively permeable soils" was meant to imply that soils at NALF Crows Landing are conducive to air flow. While no absolute rules exist regarding the range of permeabilities that is conducive to air flow in soils, site-specific testing has demonstrated that technologies based on moving air through soils may be technically feasible and cost-effective at Crows Landing. Although hydraulic permeabilities are often estimated for soils based on pump test results, soil air permeabilities are less commonly used and have not been measured or calculated. However, if this information continues to be of interest to the Navy, TtEMI can use existing SVE results and the HyperVentilate modeling software to estimate a range of soil permeabilities for air.

Comment 23: Sect. 6.2.2 "Air Sparging/SVE" Par. 2 Pg. 6-9

I'm not sure that I can agree with some of the conclusions presented in this paragraph. It was not clearly shown that the deep sparging was effective. Little or no response was shown in the C wells during the tests. I also don't feel that it was shown that injected air was well distributed throughout the aquifer for the deep test. Instead, it appeared that the air in the deep test was spread horizontally in a greater fashion than vertically. It should also be noted that the injection point for the deep test was at 158 ft. below the surface. Carbon tetrachloride is known to be 250 ft. deep. That depth appears to be beyond the technology of air sparging. While sparging worked well at Cluster 2, the contamination at Cluster 2 is not nearly as deep.

I agree that SVE works well at Crows Landing as shown at UST Site 117, but without the air sparging, I don't think it will be as effective at addressing the contamination at Site 17.

Response: As indicated in the response to comment 10 above, TtEMI concurs with the Navy that deep sparging effectiveness was not clearly demonstrated. Although further, longer-term deep sparge testing may indicate that air injection is effective at these depths, it may also reveal potential problems. Although the data presented in the draft report seemed to indicate primarily horizontal flow with minimal upward flow, pressure data collected after the end of air injection showed slow pressure increases at the shallower monitoring points over time with pressure dissipating in the deeper points, indicating that air was eventually flowing upward. As stated above, all pressure data collected are now included in Appendix A of the draft final report. However, the point that contamination

exists at depths greater than sparge testing depths is valid and is now stated more explicitly in the draft final report. Although this point was discussed in the detailed analysis in Section 7.0, it is now explicitly stated in all sections of the draft final report that discuss the potential effectiveness of sparging as a full-scale remedy. How sparging would perform at 230 or 250 feet below ground surface (bgs) is unknown. Deep sparge testing conducted at IRP Site 17 has supported recommending biosparging for UST Sites Cluster 1 and 117, particularly since air flow from deeper plume depths to the vadose zone is not required or necessarily intended in many biosparging applications.

Comment 24: Sect. 6.2.2 "Bioremediation" Pg. 6-10

1. **Anaerobic biodegration is proposed as a possible technology for Site 17. As described here, the degradation products are chloroform and methylene chloride. What are the allowable concentrations of these compounds in the groundwater? Has it been shown that these compounds will also degrade? Will some other technology be needed to dispose of these compounds?**

2. **It is also stated here that it appears that in situ biodegradation is going on at the site based on the low levels of dissolved oxygen (DO) seen at some of the wells. As noted in the text, these zones of lower DO correspond to areas of Site 17 where there is commingling of petroleum contamination from UST Site 117. It seems more likely that the lower DO levels are due to aerobic degradation of the fuel products than the petroleum compounds providing an electron source for the anaerobic degradation. Please comment.**

3. **The recommended corrective action for UST Site 117 is biosparging. As I understand it, biosparging provides an aerobic environment. Won't this conflict with the proposing anaerobic degradation for Site 17? Coordination for the cleanup of both sites is essential.**

Response: (1) Although maximum contaminant levels (MCLs) for chloroform and methylene chloride are 100 and 5 µg/L, respectively, the detection limit for these volatile organic compounds (VOCs) is 0.5 µg/L. Both chloroform and methylene chloride have been show to be biodegradable via the same process (anaerobic dehalogenation) suggested for carbon tetrachloride (CT) and appear to be amenable to degradation under a wider range of environmental conditions. For example, chloroform may also be cometabolically biodegraded under aerobic conditions, and methylene chloride has been shown to be degraded under a wide range of conditions including direct biodegradation as a primary substrate. In addition, chloroform degrades abiotically via hydrolysis reactions, though half-life estimates vary significantly in the literature. Methylene chloride has been detected at Site 17 only at very low levels near detection limits, suggesting that chloroform resists degradation under the current environmental conditions or that methylene chloride rapidly biodegrades whenever produced from CT or chloroform degradation. Therefore, processes targeting CT degradation should also result in chloroform and methylene chloride degradation and no other special technology modifications should be necessary.

(2) Low levels of dissolved oxygen in the petroleum plumes are most likely due to prior aerobic degradation. However, once oxygen is sufficiently depleted in these areas, microbes capable of biodegrading the petroleum compounds using alternate electron acceptors may be stimulated. Both CT and chloroform may serve as this electron acceptor for anaerobic degradation of petroleum compounds under both denitrifying and

sulfate-reducing conditions. The draft final text has been clarified to state that low DO areas are due to the aerobic degradation of petroleum hydrocarbons, which then results in conditions suitable for anaerobic degradation.

(3) Biosparging at UST 117 would result in aerobic conditions that may conflict with an anaerobic system at Site 17 in the region of plume overlap. However, in the unlikely event that in situ bioremediation is the selected alternative for Site 17, the two remedial options are not necessarily incompatible and would be coordinated to optimize cleanup rates for both sites. For example, groundwater extracted from the overlap regions and amended with acetate would not likely be re-injected near any sparge wells since that would defeat the purpose of adding acetate. Another option would be to use only sparging, for example, in the overlap zone to remove chlorinated VOCs as well as degrade petroleum compounds. Many combined approaches are possible in these overlap regions and specific implementations can be coordinated and evaluated in more detail once alternatives for each site are selected.

Comment 25: Sect. 6.2.2 "Passive Barriers" Pg. 6-11

I agree that passive barriers such as the "iron curtain" are technically impractical for Site 17 due to the depth of the contamination and the groundwater flow. What about using iron to treat the discharge of a pump and treat system?

Response: The use of granular iron in a pump and treat system for chlorinated hydrocarbons is generally impractical due to the long residence times required for destruction of chlorinated hydrocarbons. For example, the pilot-scale barrier at MFA has a retention time of about 12 days. Carbon tetrachloride is easily degraded by zero-valent iron, with a half life ranging from 0.31 to 0.85 hours. However, carbon tetrachloride degrades to chloroform and methylene chloride. Chloroform is also effectively degraded by zero-valent iron (with a half-life of about 4.8 hours), but methylene chloride does not appreciably degrade in the presence of zero-valent iron, creating a new contaminant problem (Gillham 1996). Methylene chloride generation aside, treating carbon tetrachloride in a pump-and-treat system would require an impracticably large system. Treating carbon tetrachloride from 400 to 0.5 μg/L (the MCL) would require a retention time of about 8.2 hours (using an 0.85-hour half life). Assuming the porosity of the iron to be 0.4, a 100-gallon per minute (gpm) treatment system would require a 123,000-gallon iron-filled reaction tank.

Comment 26: Table 6-1

1. **Only two chemical treatments are discussed in the text. What about an advanced oxidation process as proposed for Moffett Field?**

2. **Air sparging does not seem to be well proven at the depths of the contamination at Site 17 (see earlier comments).**

Response: (1) As discussed in the response to comment 20 above, AOP systems are generally cost effective only when regulations require treatment of offgas, which would not be the case at Site 17.

(2) While not proven at the deepest depths, the highest concentrations of CT are within depths where sparging appeared to be effective. It is also possible that sparging would be effective at the deeper depths, and only low levels of CT (6 μg/L or less) have been

found below 160 feet bgs. Therefore, this technology is "potentially applicable," as stated in Table 6-1 and is worth consideration at this stage of the screening process. However, later analysis of the sparging alternative indicates that it may not be as cost-effective as other remedial options.

Comment 27: Sect. 7.1.1 "Compliance with ARARs" Pg. 7-5

1. **The paragraph states that CCR [California Code of Regulations] Title 17 requires caps to prevent human contact with the waste, reduce leachate generation, and prevent off-site migration of the waste. The paragraph goes on to seemingly show that the no action alternative meets these three criteria. Yet the conclusion is that the no action alternative does not meet the ARAR. In what way or ways does this alternative not meet the ARAR. Please be more specific.**

2. **In the last sentence of this section, it is stated that CCR Title 17 is discussed in Sect. 5.1 as an ARAR for Site 11. Sect. 5.1 discusses RAOs for Site 11. ARARs are discussed in Sect. 5.5. Please correct.**

Response: (1) The text has been modified to clarify that the soil covering does not reduce leachate generation or prevent migration and, for this reason, does not meet ARARs.

(2) The correction noted has been made to the report.

Comment 28: Sect. 7.1.2 "Alternative Description" Par. 2 1st Sent. Pg. 7-7

The sentence states that quarterly groundwater monitoring will be required for 30 years. Can the frequency be reduced after an initial period of time instead of quarterly for the entire 30 year period?

Response: The assumed monitoring frequency has been reduced to quarterly monitoring for the first year, semi-annual monitoring for years two through five, and annual monitoring thereafter. The cost estimate and text for Alternative 2 have been revised to reflect these changes. Additionally, a list of potential analytes is presented in the response to DTSCs specific comment 20.

Comment 29: Sect. 7.1.2 "Compliance with ARARs" Par. 1 Last Sent. Pg. 7-7

Discussion of capping ARARs is in Sect. 5.5, not 5.1 as stated. Sect. 5.1 discussed RAOs.

Response: Section 5.1 in the draft final report now discusses ARARs.

Comment 30: Sect. 7.2.1 "Implementability" Pg. 7-15

Air sparging may not be feasible at the depths of contamination at Site 17. As noted in the section on long-term effectiveness, further testing at deeper depths will be required to show that sparging can work. Please add a statement concerning the ability of air sparging to work at the depths at Site 17.

Response: The text in this section of the draft final report has been amended to state concerns regarding sparging implementability at depths not previously tested.

Comment 31 **Sect. 7.2.2 "Implementability" Pg. 7-19**

Will anaerobic degradation of Site 17 interfere with aerobic degradation of UST Site 117? Biosparging is one of the alternatives being considered for Site 117 in the corrective action plan (CAP).

Response: See the response to comment 24 above.

Comment 32: **Sect. 7.2.2 "Community Acceptance" Pg. 7-20**

There may be objections from the community to the injection of the acetate into the groundwater.

Response: The text has been modified to remove the statement regarding potential community acceptance.

Comment 33: **Sect. 7.2.3 "Alternative Description" Par. 1 Pg. 7-20**

The paragraph notes that the effectiveness of the pump and treat alternative is dependent on uniform extraction of groundwater: preferential paths can cause more water to be extracted from some parts of the plume and not from other locations. It should be noted that the alternatives previously mentioned will also be affected by preferential pathways. Preferential pathways could be developed for air sparging which results in some areas being volatilized more than others. Since a certain amount of pumping and re-injection is required for anaerobic degradation, it also could be affected in a manner similar to the pump and treat alternative. This portion of this paragraph should either be removed or changed to note such effects for all alternatives.

Response: TtEMI concurs that performance of all remedial alternatives discussed for Site 17 will depend on preferential pathways that would likely develop during system operation. However, since air permeability through a soil matrix is higher than hydraulic permeability, systems based on air injection may result in better distribution of air through the same lithologies than will systems based on liquids transport, even with the same relative degree of channeling. Nonetheless, the text has been modified to indicate that system effectiveness for the other alternatives may also be reduced by preferential pathways.

Comment 34: **Sect. 7.2.3 "Treated Groundwater Discharge" Pg. 7-23**

1. **In the 3rd paragraph, re-injection is considered as a discharge alternative. Has consideration been given to discharging the water to percolation ponds to allow the groundwater to seep back into the aquifer? Water from the ponds could also be used for irrigation water.**

2. **Discharge to surface water, especially to the ditch on Bell Road or Little Salado Creek, is proposed for pump and treat. These two "streams" are normally dry. Care should be given to the possibility that turning these dry streams into year round flow could involve creation of a new habitat that may need to be kept after pumping is no longer needed. It would be important to check with the California Department of Fish and Game concerning this issue.**

Response: Some soils on base are highly porous and are good candidates for an efficient percolation pond operation. Percolation ponds are a low-maintenance and flexible form of discharge, using gravity to recharge groundwater and serving as operational storage to equalize variations in flow. Typically, percolation ponds are 2 to 4 feet deep with a surface area commensurate with the desired discharge rate. Periodically, the soil pores in the bottom surface of the pond become filled with sediment, detritus, or other fines, and raking is required to restore a satisfactory percolation rate. Raking is the only significant operation and maintenance cost. A percolation pond is both cost-effective and returns the treated groundwater to beneficial use. To comply with the substantive requirements of applicable state regulations, this, as with all pump and treat discharge options, would require the Navy to submit a Report of Waste Discharge. RWQCB would then issue waste discharge requirements (WDRs) under an NPDES permit. Permit requirements would include regular discharge water sampling and monitoring to ensure that WDRs were being met. In addition, the design and operation of the treatment and disposal system may be affected by the potential or eventual establishment of new wildlife habitat. A wildlife study may be conducted in coordination with California Department of Fish and Game to provide this information.

Comment 35 **Sect. 7.2.4 Par. 3 1st Sent. Pg. 7-27**

1. **The sentence states that the treatment system described in alternative 3B would include tanks to store *pretreated* process water. What pretreatment is being referred to here? The main goal of 3B is to use the irrigation pipes and spray nozzles to treat the water. It makes no sense to store treated water in a tank; sprayed water should fall on the ground and crops. Storing process/pretreated water in a tank for later irrigation seems to be more applicable to alternative 3A.**

2. **In the last two sentences, it is suggested that water be sprayed onto the runways or other nonagricultural areas and to allow the water to become runoff. Wouldn't this require an NPDES permit, especially if runoff were to make its way into storm drainage ditches? Also, the runways may not be available for this purpose if the future use of Crows Landing is as an airport.**

Response: As correctly pointed out, the spray system would not store water treated to any degree; it would store only raw water. The treatment system would consist of a spray irrigation network of pipes and spray nozzles, pumps, and water tanks or wet wells to store raw water. The spray system would be sized to effectively treat the groundwater under most atmospheric conditions. When crop spraying has been temporarily discontinued (seasonally or daily), level switches in the storage tanks or wet wells would be used to automatically operate valves to spray excess water onto other areas designated for land application, or over a percolation pond if needed. The percolation pond would serve as operational storage and a point discharge that would maximize beneficial uses and reduce stormwater releases and evaporative losses. During the rainy season when most crops are not being irrigated, process water could be routinely sprayed onto runways or other nonagricultural areas. The treated groundwater would either evaporate or infiltrate into soils. Proper management of the system would minimize surface runoff due to overirrigation of crops or land application areas and would be addressed in the base's Storm Water Pollution Prevention Plan (SWPPP). As pointed out, runways are not good candidates for land application discharge. The runways should be maintained usable and as an impermeable surface, runoff can be produced more readily. There are three main mechanisms to dispose of the treated groundwater–crop irrigation and associated

agricultural runoff; evaporation; and percolation. A combination of these three mechanisms would address (1) returning treated groundwater to a beneficial use, (2) disposal of treated groundwater during periods of low water demand, and (3) reducing the complexity of facilities compared with other treatment/disposal alternatives.

Comment 36: Sect. 7.2.5 "Overall Protection...Environment" Pg. 7-30

In addition to the placing of drinking water wells at Site 17, the no action alternative would not be protective if future pumping patterns change and cause the aquifer to acquire a preferred direction. This could cause the plume to then migrate.

Response: The text has been revised to include a brief discussion regarding the potential for future plume migration and the corresponding reduction of protectiveness with the no action option.

Comment 37: Sect. 7.2.5 "Reduction in Toxicity..." Pg. 7-31

It should also be noted that the carbon tetrachloride probably resulted from activities at the base during World War II, more than 50 years ago, and the CT is still present at unacceptable levels in the groundwater. A no action alternative would probably still not show any real reduction for at least that long.

Response: The draft final report text has been amended as suggested.

Comment 38: Sect. 7.3.1 "Long-term Effectiveness..." Pg. 7-33

Capping would require 30 years of monitoring. Would any monitoring be expected after excavation? Site 2 at Moffett Field was excavated and removed and the regulatory agencies still required a 3-year monitoring period for the site.

Response: Groundwater monitoring should not be required after excavation. According to CCR Title 27, monitoring would not be relevant and appropriate once source soils have been removed from the site. Furthermore, the eight quarterly sampling events that have already been conducted at Site 11 suggest no groundwater impact at the site.

Comment 39: Sect. 7.3.2 "Overall Protection..." Pg. 7-34

This paragraph states that while all four alternatives are considered protective of human health and the environment, Alternatives 1, 3A, and 3B will release VOCs to ambient air, and Alternatives 3A and 3B discharge water may have trace amounts of VOCs. The paragraph goes on to conclude that since Alternative 2 treats contaminants in the subsurface and does not have any discharges to air or surface water, it is more protective than the other three. What about the chloroform and methylene chloride degradation products produced by Alternative 2? Unless it can be shown that these by products are not a problem, then this paragraph should be rewritten to reflect that all four alternatives are protective of the environment without the qualifying material concerning Alternatives 1, 3A, and 3B.

Response: As discussed in the response to comment 24 above, both chloroform and methylene chloride are expected to be biodegraded along with CT under Alternative 2.

Furthermore, even if CT or other by products were to remain, Alternative 2 does not entail any discharges to air or surface waters and is thereby inherently more protective.

Comment 40: Sect. 7.3.2 "Long-term Effectiveness..." Par. 1 2nd Sent. Pg. 7-35

This sentence states that Alternatives 1 and 2 would result in lower final concentrations than pump and treat thus minimizing the later increases in groundwater concentrations. This seems to contradict what is stated in paragraph 2 under "Long-term effectiveness..." on page 7-14. There it states that "...sparging systems are commonly known to result in a 'rebound effect' ... a few months after system shutdown." Please reconcile these two statements.

Response: Since sparge systems are known to result in some rebound, it is common to monitor rebound and be prepared to restart the system, as indicated in Section 7.2.1. Typically, the system would be operated for a few more months to address any rebound in contaminant concentrations, which are potentially low if site conditions are amenable to sparging and the sparge system is properly implemented. Likewise, Alternative 2 would result in the direct biodegradation of sorbed contaminants in addition to dissolved phase contamination, thereby potentially resulting in lower groundwater concentrations in shorter periods of time. However, pump and treat alternatives commonly leave more significant amounts of contamination sorbed to soils once groundwater concentrations reach their lowest levels, and widespread increase in concentrations throughout the plume is to be expected. Attempting to address this residual contamination may require more years of pump and treat operation, if even technically feasible. This is largely due to slow desorption rates from soils and the large volumes of clean groundwater needed to flush soils to attain cleanup. Therefore, TtEMI believes that Alternatives 1 and 2 would result in better long-term effectiveness and permanence (assuming they perform as designed) than the pump and treat options.

3.0 RESPONSES TO COMMENTS FROM RWQCB

<u>General Comments</u>

Comment 1: The overall organization of the Report should be revised to provide more clarity and a basis for selecting state requirements (ARARs), remedial action objectives and appropriate remedial alternatives. Specifically, the Report should provide information developed during the Remedial Investigation that was used to evaluate if these sites threaten groundwater and its beneficial uses (i.e. water quality assessments).

Response: The information and conclusions developed during the remedial investigation (RI) and other investigations are discussed in detail in the final RI report (PRC 1997). This information included evaluation of soil, soil gas, and groundwater sample analytical data, as well as water quality assessments and human health and ecological risk assessments. Conclusions reached as a result of all investigations at NALF Crows Landing served as the basis for evaluation of remedial alternatives in the FS. The FS also summarizes the conclusions regarding cleanup at IRP Sites 11 and 17. Recommendations for remedial actions, based on those conclusions, are presented in Section 7.0 of the RI report. Although it is inappropriate to include a complete discussion of the remedial investigation in the FS, Sections 3.0 and 5.0 have been

revised to more clearly state the media and contaminants of concern that form the basis for cleanup actions and ARAR selection at the facility.

Comment 2: **No Further Action (NFA) Determination for Sites 10, 12, 13, 14, 16 and 18.**

It appears that many of the sites were investigated in the RI were not further evaluated in the FS. It is not clear how the Navy has made the decision to no longer carry these sites to the FS stage. Each site identified in the RI should be evaluated and if the Navy proposes NFA status for a site, such justification, as described under our Section 3.0 comments, should be provided. Briefly, the Report should include site summaries with field investigation findings. All groundwater monitoring data related to these sites should be provided in summary tables and indicate all analytes evaluated. Any recommendations for further actions (such as continued groundwater monitoring) should be discussed. Additionally, the Report should include a summary of the water quality assessments, human health and ecological risk assessments that were conducted at these sites.

Response: Each IRP site identified at NALF Crows Landing was evaluated through a series of field investigations, including eight quarters of groundwater monitoring at IRP Sites 11 and 17. Results from these investigations (including site summaries) are discussed in the final RI report submitted in July 1997. Results from the groundwater monitoring program, including all analytical data, are contained in the quarterly and annual groundwater monitoring reports. Furthermore, Section 7.0 of the final RI report summarizes soil, soil gas, and groundwater sample analytical data, water quality assessments, and human health and ecological risk assessments. Based on evaluation of the field investigation results, Section 7.0 also includes recommendations for further actions at each IRP site. No further actions (NFA) were recommended for IRP Sites 10, 12, 13, 14, 16, and 18. No further action was recommended for soil at IRP Site 17. A feasibility study was recommended for soil at IRP Site 11 and for groundwater at IRP Site 17. RWQCB approved the RI report for finalization in a letter dated October 2, 1997. DTSC concurred with the NFA designations in the draft final RI report comments. In order to maintain the focus of the FS on only those sites requiring remedial action, the purpose and scope of the FS are restricted to evaluating remedial technologies at IRP Sites 11 and 17. Site histories, site characterizations, and summaries of site human health and ecological risks for Sites 11 and 17 are provided in the FS. Site histories, site characterizations, and summaries of site human health and ecological risks for the NFA sites are presented in the draft NFA remedial action plan (RAP)/record of decision (ROD) submitted March 31, 1998. Section 1.0 of the draft FS will continue to include a reference to the complete evaluation of all IRP sites contained in the final RI report.

Site 17 Data Gaps

Comment 3: **We have several comments that are related to the remedial investigation that was conducted for Site 17. As discussed in our specific comments, we are concerned that the Navy has not adequately characterized the VOC groundwater plume at Site 17. We believe that additional pre-design investigations are necessary before remedial action at this site can be initiated. Further, we believe the site represents an "old" vadose zone source area for VOCs as suggested by the Navy. However, it appears the contaminant concentrations detected in the vadose zone warrants soil**

cleanup activities which should be focused on removing as much contamination from the vadose zone as possible. Regardless of which transport mechanisms are associated with the distribution of contaminants detected at Site 17, it is generally much less costly to conduct cleanup of VOCs in the vadose zone than from groundwater.

Response: In a remedial project managers (RPM) meeting held February 15, 1996, the Navy proposed installation of several deep and mid-deep wells to evaluate the vertical and lateral extent of carbon tetrachloride (CT) in groundwater at IRP Site 17. During that meeting, all participants agreed to an alternative approach to evaluating the extent of contamination. It was agreed that one mid-deep well and one deep well would be installed at IRP Site 17 adjacent to existing wells 17-MW-02 and 17-MW-03. The agreement was documented in a March 4, 1996 TtEMI (PRC) letter outlining field work recommendations.

On March 7, 1996, a conference call was held to further discuss the field work recommendations outlined in the March 4, 1996 letter. An April 5, 1996 letter from DTSC summarized the conference call conclusions, and confirmed that the state concurred with recommendations in the March 4, 1996 letter. The summary letter also stated that additional evaluation of the lateral and vertical extent of groundwater contamination, if necessary, could be incorporated into the remedial design or remedial action phases.

On April 25, 1996, an RPM meeting was held. Meeting participants discussed the need to end RI field work and move on to the FS phase and cleanup. All participants also agreed that additional field investigations may be necessary if significant data gaps were identified during the RI report writing or FS process. However, it was reconfirmed that any remaining data gaps could be addressed during the remedial design or remedial action phases.

The Navy believes that the groundwater contaminant plume at IRP Site 17 is adequately characterized to proceed to the remedial design phase. In accordance with previous agreements with state agencies, any further characterization of the plume will be coordinated with optimizing the design, construction, and performance of the remedial system.

The Navy has evaluated the presence of CT in soil gas at IRP Site 17. Specifically, a computer model was used to evaluate whether concentrations of CT in soil gas are high enough to degrade water quality as precipitation percolates through the soil gas plume. Results from the model indicate that cleanup actions directed toward removal of soil gas are not required. Since the ultimate goal is to achieve groundwater (and soil, where appropriate) cleanup as expeditiously and economically as possible, the Navy will progress toward groundwater cleanup. Since groundwater is the likely source of the CT in soil gas, it is also likely that cleaning groundwater will result in cleanup of both media. Removal of CT in the vadose zone will be addressed as part of any technology evaluation that includes air sparging and SVE.

Site 11 Data Gaps

Comment 4: **We have reviewed the RI Report, quarterly groundwater reports and the *First Final Annual Groundwater Monitoring Report*, submitted 10 April 1996, to evaluate if any VOC's were detected in monitoring wells 11-MW-01 and 11-MW-02. Based on our review of the FS Report and the Annual Monitoring Reports it appears that these wells have been dry for an extended period of time. The Navy should provide information summarizing all groundwater analytical data obtained from these monitoring wells. We may have additional comments related to the presence or absence of VOCs at Site 11 after our review of this information.**

Response: Monitoring wells 11-MW-01 and 11-MW-02 were installed in August 1991. By September 1994, these wells had gone dry due to a declining regional water table. All groundwater sample analytical results, including VOCs, based on samples collected from wells 11-MW-01 and 11-MW-02 are contained in Appendix C of the final RI report. Quarterly groundwater monitoring has been conducted at the site since May 1996. Quarterly groundwater monitoring data are contained in the quarterly and annual groundwater monitoring reports. Other than the common laboratory contaminant methylene chloride, no VOCs have been detected from any of the monitoring wells, including wells 11-MW-03 and 11-MW-04, which were installed as replacement wells for wells 11-MW-01 and 11-MW-02. The presence of VOCs in any media has never been an issue at IRP Site 11. The primary objective of the investigation at IRP Site 11 was to evaluate the extent and potential source areas for TPH-e contamination in groundwater. Combined investigation results confirmed the existence of a disposal pit at the location of an elongated surface depression that is the most likely source of TPH-e detections in groundwater. The FS evaluates technologies related to excavation or capping of the suspected landfill to eliminate it as a source area.

Although the FS is an inappropriate forum for discussion of site investigation (SI) groundwater analytical results, the Navy recognizes the importance of evaluating all available analytical data. This information will therefore be provided for regulatory review as an attachment to these comment responses.

<u>Specific Comments</u>

Section 3.0 Site Characterization

Comment 1: **The Report should include brief descriptions of the investigation results, water quality assessments, and ecological and human health risk assessments that were conducted during the remedial investigation. A summary for the NFA sites 10, 12, 13, 14, 16 and 18, and the FS sites 11 and 17, should include site location maps with monitoring well, groundwater and soil sampling locations, any geologic and hydrogeologic cross sections that were prepared to evaluate the extent of contamination at these sites and summary tables indicating contaminants of concern that were evaluated.**

Response: See the response to general comment 2.

Comment 2: **Section 3.0 or a separate section should include an analysis of the data and justification showing if remedial actions are necessary at an IRP site. In other words, the screening criteria that were used to determine a site would not be further analyzed in the FS should be presented. Specifically, the Navy should discuss how the water quality site assessment and human health risk assessment were used to screen out sites.**

Response: See the response to general comment #2.

Comment 3: **Section 3.2 IRP Site 17 Characterization**

a. **Field investigations and site history records indicate that this area was used during the 1940's and 1950's as a maintenance area. This suggests that spills or disposal of solvents in this area would represent an "old" source area for the observed VOC groundwater plume emanating from the area. The Navy has provided extensive soil, soil gas and groundwater investigations which indicate that this site should be remediated. We concur that the groundwater should be remediated. However, we also believe that these field results indicate that soil remediation (Soil Vapor Extraction) is warranted especially considering that mass removal of VOCs from the vadose zone is generally much less costly than from groundwater. Soil gas data indicate carbon tetrachloride concentrations ranging from 85 to 18,750 ppbv [parts per billion by volume]. These soil gas concentrations suggest that the vadose zone may contain a significant mass of VOCs.**

Response: The total mass of VOCs in the vadose zone has been estimated at approximately 2.6 pounds. Also see the response to general comment 3 and specific comment 8.

b. **The soil gas concentration profiles provide a good assessment of the contaminant distribution suggesting that contaminant concentrations increase with depth. We believe that the Navy's interpretation that volatilization is occurring from water table is valid. However, the contaminant distribution may also indicate that the area represents an old source area (40 years) where contaminants have had the opportunity to migrate to greater depths. Similar sites (Mather AFB [Air Force Base] and Sacramento Army Depot) that have experienced more recent spills of VOCs in the vadose zone have been evaluated using vadose zone computer models (VLEACH). These evaluations suggest that the predicted VOC concentrations would increase with depth over time (and would indicate a soil gas profile similar to Site 17) if these contaminants had not been remediated. Therefore, regardless of how the VOCs arrived near the water table, the mass of VOCs that is suggested by this site characterization appears to be sufficient to warrant soil cleanup.**

Response: See the response to general comment 3 and specific comments 3a and 8.

c. **The groundwater investigations conducted at Site 17 indicate carbon tetrachloride concentrations as high as 390 ppb [parts per billion] (17-MW-03) and benzene (2400 ppb). The Navy has indicated that the BTEX [benzene, toluene, ethylbenzene, xylenes] contamination observed at Site 17 is related to adjacent sites UST 117 and UST Cluster 1. The contaminant distribution for carbon tetrachloride indicates that the highest**

concentrations extend into the mid-shallow zone (approximately 50 feet below the water table). We believe that the groundwater investigation for Site 17 has been adequate to determine the vertical extent of contamination extending into the mid-shallow zone. However, the Navy appears not to have provided an adequate characterization to determine the lateral extent of contamination in the mid deep (approximately 125 feet below water table) and deep zones (200 to 250 feet below the water table to the Corcoran Clay), as discussed below.

Response:. The Navy believes that the groundwater contaminant plume at IRP Site 17 has been adequately characterized to proceed to the remedial design phase. As discussed in the response to general comment 3, any data gaps will be addressed as part of the remedial design phase. Further characterization of the contaminant plume may also be coordinated with enhancements to the performance of the groundwater remediation system.

d. Based on Cross Section B-B' (Figure 3-3) it appears the northern and southern extent of the plume has not been identified in the mid-deep and deep zones. Monitoring wells 17-MW-14 and 17-MW-15 are the only monitoring wells that provide information on the lateral extent of contamination (presumably beneath the source area). Cross section A-A' (Figure 3-4) suggests that the eastern extent of the VOC plume has better defined by monitoring wells 17-MW-14 and 17-MW-06 for the mid-deep zone. However, the Navy must still determine the full extent of VOC plume (at a minimum to the MCL for carbon tetrachloride - 0.5 ppb) in the mid deep and deep zones. The western extent of the VOC plume has not been identified in the mid-deep and deep zones. The Navy should provide additional monitoring wells in order to characterize the carbon tetrachloride plume the mid deep and deep aquifer zones.

Response:. See the response to specific comment 3c.

Comment 4: Section 5.0 Site Cleanup Objectives

This section discusses the remedial action objectives (RAOs) and the federal and state requirements to address cleanup actions at IRP sites 11 and 17. This section is not clear in its approach on how federal and state requirements, risk assessments and contaminant fate and transport evaluation results are used to identify RAOs. This section should indicate proposed numerical cleanup levels and how these cleanup levels are derived. The Navy should, at a minimum, identify cleanup levels that are based on levels that are protective of water quality and ecological and human health risks. We recommend that Section 5.0 is rewritten and discusses the following (in this order): potential state and federal requirements (or ARARs), Remedial Action Objectives and General Response Actions. The federal and state requirements discussion should be a separate discussion that should be referenced or repeated as necessary during a separate discussion of the general response actions that are those actions that will satisfy the remedial action objectives.

Response: The Navy has reorganized Section 5.0 as follows. First, an overview of the ARARs process is included in Section 5.1; potential state and federal requirements that may influence the development of remedial action objectives (RAO) (for example, chemical-

specific ARARs) are presented in Sections 5.1.1 and 5.1.2. The RAOs, including cleanup goals, are then discussed in Section 5.2. In the RAO section, the report provides further rationale for the RAOs developed. The action-specific ARARs have been removed from Section 5.0 and are instead presented in the detailed analysis of alternatives in Sections 7.1 and 7.2. The GRA section follows the RAO section in Section 5.3.

State Requirements

Comment 5: **The state and federal requirements discussion (Section 5.2) should be revised as follows and should indicate the state and federal requirements that were developed to address cleanup at Sites 11 and 17. The Navy should indicate that these sites are considered further in the FS because of remedial investigation results on the nature and extent of contamination and risk assessment.**

a. **Section 5.2 should have the title *Identification of Potential Federal and State Requirements*. The text in Section 5.2 (page 5-4) should be revised and indicate that this FS has identified potential state and federal requirements that apply to Site 11 and 17. Also, the Report should indicate that the Record of Decision (ROD) will provide the final determination of state and federal requirements for these sites.**

Response: It is unclear why the title of this section should be changed from "Applicable or Relevant and Appropriate Requirements" to "Identification of Potential Federal and State Requirements," since the Navy's obligation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is to identify ARARs. However, the Navy has changed the title of the section, and explains in Section 5.0 that potential federal and state requirements being identified are only those requirements that meet the criteria for inclusion as an ARAR. The text in Section 5.0 has been updated to explain that the ROD will contain the final selection of federal and state requirements. The Navy has included tables listing relevant federal and state ARARs as supplied by RWQCB in Appendix C.

b: **Section 5.2 should include tables which list all potential requirements for both Site 11 and 17. We have provided several tables, submitted in our letter dated 31 March 1998, which should be included and referenced in the discussion of federal and state requirements that would apply to the soil remediation at Site 11 and the groundwater and soil remediation for Site 17.**

Response: The discussion of ARARs, or potential state and federal requirements, is presented as follows in the FS. In Section 5.1, chemical- and location-specific requirements are presented before the discussion of RAOs. Action-specific ARARs are presented in Section 7.1 and 7.2 as part of the description of each alternative. Next, Appendix C has been added and includes all the requirements in a series of tables. For action-specific ARARs, the tables identify the requirements that are applicable to each alternative. In the state ARARs tables, the Navy lists all the requirements cited by RWQCB as potential ARARs in its March 31, 1998 tables and the Navy's determination as to whether those requirements are ARARs.

c. **Soil Remediation at Site 11 and Groundwater Remediation at Site 17. Section 5.2 should include a brief narrative discussion of the state requirements that apply to the soil remediation at Site 11 and the**

groundwater remediation at Site 17 which should be based on the ARARs (state and federal requirements) tables we provided in our letter, dated 31 March 1998. (Porter-Cologne Water Quality Control Act, Water Quality Control Plan [Basin Plan], State Board Resolutions 68-16, 92-49 and 88-63, Designated Level Methodology (DLM) for Waste Classification and Cleanup Level Determination, A Compilation of Water Quality Goals, applicable sections of Title 27 and Title 23 California Code of Regulations).

Response: The Navy has evaluated the potential ARARs provided by RWQCB and, as discussed above, included its determination as to whether those requirements are ARARs for the sites in Appendix C.

d. Soil Remediation at Site 17. Section 5.2 should include a brief discussion of state requirements that would apply to soil remediation at Site 17. As discussed in our comments on Section 3.2, soil remediation appears to be warranted at this site. The state requirements that would apply to this site are listed in the table *Site Specific ARARs for Soil Remediation at Sites 11 and 17 (dated 31 March 1998)*. Section 5.2 should also include a brief narrative discussion of state requirements that would apply to soil remediation at Site 17.

Response: Based on the data collected during the RI, the Navy does not agree that soil remediation is required at Site 17. As discussed in response to general comment 3, removal of CT in the vadose zone will be addressed as part of any technology evaluation that includes air sparging and SVE. ARARs related to soil remediation at IRP Site 17 have not been included in the FS.

Comment 6: Section 5.5, Action-Specific ARARs - IRP Site 17, should include discussion of State Board Resolution 68-16, 92-49, specific provisions of Title 27 and Title 23 CCR and the Basin Plan for the Central Valley Region.

Response: As explained in response to Specific Comments 4 and 5b, the Navy has moved the discussion of action-specific ARARs to Sections 7.1 and 7.2. The Navy presented its analysis of the requirements cited by RWQCB in Appendix C of the FS report.

Section 6.0 Development and Screening of Remedial Alternatives

Comment 7: Generally Section 6.0, *Development and Screening of Remedial Alternatives,* should be rewritten to incorporate soil and groundwater cleanup levels for Site 17 and soil cleanup levels for Site 11. These soil and groundwater cleanup levels should be numerical levels that are protective of water quality and human health and should be discussed in a sub-section, *Remedial Action Objectives,* of Section 6.0. The basis for developing these cleanup levels should be provided in the discussion on the Remedial Action Objectives. After this, the FS Report should include a sub-section, *General Response Actions,* which should discuss which remedial actions would satisfy the remedial action objectives.

Response: As explained in response to specific comment 4, Section 5.0 of the FS report has been reorganized so that certain state and federal requirements precede the RAOs. The GRAs immediately follow the RAOs in Section 5.3. Based on this the ordering of the material, the Navy does not believe it is necessary to include a detailed discussion of cleanup goals

in Section 6.0 or a subsection titled "Remedial Action Objectives" as this information will appear in the immediately preceding section of the report.

Comment 8: **The Navy should develop VOC cleanup levels for soil and groundwater at IRP Site 17. We have provided the attached recommended narrative cleanup standards for the vadose zone which have been used at similar sites in the Central Valley (DDRW Tracy, Mather AFB, McClellan AFB). We recommend that the narrative cleanup standards are included verbatim into the sub-section, *Remedial Action Objectives*. It should be noted that the narrative cleanup standards include a numerical cleanup level that is based on achieving soil vapor concentrations that would prevent the concentration in liquid phase from exceeding the water quality objective. In this case, the soil vapor concentration for carbon tetrachloride is 94 ppbv (assuming a cleanup level that is based on the MCL for carbon tetrachloride-0.5 μg/L). This approach also includes the development of model-based cleanup levels (see Item 2a in *Narrative Cleanup Standard)* which would represent the maximum allowable residual total soil concentrations which could remain at the site so that groundwater concentrations do not exceed numerical beneficial use limits in the future. These model-based soil cleanup levels could be used to provide a benchmark concentration to evaluate the technical and economic feasibility of providing soil cleanup.**

Response: The Navy has developed groundwater cleanup levels for VOCs at IRP Site 17. As discussed in response to general comment 3, removal of CT in the vadose zone will be addressed as part of any technology evaluation that includes air sparging and SVE. Cleanup goals related to soil remediation at IRP Site 17 will not be included in the FS.

Comment 9: **The General Response Action section (Section 6.1) should include discussions on which remedial technologies could be applied to provide cleanup of the VOC contamination in the vadose zone at Site 17 (i.e., soil vapor extraction, dual phase extraction). The narrative soil cleanup standard for VOCs in the vadose zone, discussed above, is applicable to sites where SVE is proposed for remediation.**

Response: See response to general comment 3 and specific comment 5d.

Comment 10: **Section 6.2, Screening of IRP Site 17 Remedial Alternatives, should include groundwater cleanup levels that are protective of beneficial uses. In developing groundwater cleanup levels, the Navy should conduct an evaluation to determine the technological and economical feasibility of achieving "background" (i.e., detection limits for VOCs) for contaminants of concern in groundwater. The basis for performing this analysis, to determine if background levels are achievable, is provided in State Board Resolution 92-49, Section III G. Analysis to determine if remediation of groundwater is possible to detection limits could be conducted by performing 3-D groundwater flow and contaminant transport modeling. Remediation times and O&M costs should be evaluated for this scenario and other scenarios (i.e., remediation to MCLs for carbon tetrachloride). As a practical matter, the cost to provide remediation of the benzene plume from UST site 117, could also be included in this evaluation, since this plume appears to have commingled with the carbon tetrachloride plume from Site 17.**

Response: Groundwater cleanup goals for Site 17 are discussed as part of the development of RAOs in Section 5.0. During this analysis, the Navy considered Resolution 92-49. As a practical matter, a cleanup goal of the MCL for carbon tetrachloride is the same as a

cleanup goal of "background." The MCL is 0.5 parts per billion, which is the detection limit for carbon tetrachloride. Regardless of the cleanup goal selected, the FS report includes a discussion of the feasibility of achieving that goal.

Section 7.0 Detailed Analysis of Alternatives

Comment 11: **Generally, Section 7.0, must be modified to include remediation of the vadose zone at Site 17. The alternatives to be evaluated for Site 17 could include, as an example, a combination of SVE and, groundwater extraction and treatment.**

Response: See response to general comment 3 and specific comment 5d.

Comment 12: **Section 7.2, Detailed Analysis of Alternatives for Site 17, should indicate that groundwater must be remediated to background unless it can be demonstrated that achieving background concentrations is technically and economically infeasible.**

Response: See response to specific comment 10. An explanation of the basis for the groundwater cleanup goal at Site 17 has been added to Section 5.0 and briefly summarized in Section 7.2.

Comment 14: **Section 7.2, Long-term Effectiveness and Permanence, states that air sparging may be ineffective at depths in excess of 60 to 80 feet below the water table. Because the Navy has not demonstrated that air sparging can be effective at depth, the Navy should consider a combination of alternatives that have been listed as separate alternatives (i.e. pump and treat and air sparging). The Report should be revised to indicate that a combination of pump and treat and air sparging may be necessary to remediate all aquifer zones that are contaminated above aquifer cleanup levels.**

Response: The Navy has evaluated a combined system that includes air sparging and SVE and pump and treat. The combined system is evaluated as remedial alternative 4.

Comment 15: **Section 7.2.4, Alternative 3B-Pump and Treat, Spray Stripping, Discharge, indicates that the Navy will consider spraying VOC contaminated water on crop lands during the irrigation season and during the rainy season will spray water onto runways or other nonagricultural areas. Although the pilot test results appear to indicate that this treatment option may be successful at Site 17, the Navy would have to demonstrate that all contaminated water is remediated to concentrations below aquifer cleanup levels. The Navy would have to provide a detailed proposal on how the system would be monitored to meet the discharge limits.**

Response: The Navy has proposed a monitoring system for meeting discharge limits. The proposed monitoring system is discussed in Section 7.2.4 of the draft final FS.

4.0 RESPONSES TO COMMENTS FROM DTSC

General Comments

Comment 1: **The report should avoid qualitative words such as low or high when referring to concentrations of chemicals to avoid confusion. In addition, the use of random should be restricted to situations when data is truly random and not simply where lack of data make interpretation difficult.**

Response: The comment has been noted, and attempts will be made to avoid the use of qualitative words when referring to chemical concentrations and use of the word "random" when referring to nonrandom events.

Comment 2: **At Site 11, Beryllium is referred to as ubiquitous and unrelated to site activities. Additional explanation is necessary before this chemical is eliminated from consideration. If the levels of Beryllium found at the site are associated with background, then this needs to be stated and documented.**

Response: Beryllium was detected in all soil samples collected from background locations in the zone from 0 to 5 feet bgs. In addition, beryllium was detected in almost all soil samples in the zone from 0 to 5 feet bgs at every IRP site. There is no documented or known evidence of any operations at the installation, past or present, that would have contributed beryllium to the environment. Information supporting this conclusion is found in the final RI report. The referenced statement is found in Section 3.1.3 of the FS. For clarification, and to refer the reader to the appropriate documentation, the third sentence in the first paragraph of Section 3.1.3 has been revised to state:

However, beryllium is widely distributed in background soil and is not attributable to known site activities.

Comment 3: **At Site 17 Carbon Tetrachloride (CT) was found in the vadose zone above groundwater. There seems to be three possible explanations:**

1) **There is a source of CT in the deeper vadose zone associated with an old vadose zone discharge.**

2) **It is volatilizing from the contaminated groundwater, as stated in the Report or;**

3) **The vadose zone is contaminated from groundwater as the water table has dropped over time (smear).**

The Report should consider all three possibilities unless there is strong evidence to eliminate alternate possibilities. In any case, the potential for the contamination to impact present and future remediated groundwater should be considered.

Response: All three of the scenarios outlined above have been considered. However, regardless of the source of contamination in the vadose zone, the approximate extent and magnitude of the VOC contamination above the water table is known and the total mass has been estimated at 2.6 pounds. Furthermore, the potential impact of this vadose zone contamination on groundwater quality has been evaluated using the VLEACH numerical

model and a detailed analytical model using the fugacity approach. Both modeling approaches produced similar results that suggest CT groundwater impacts below 0.5 µg/L, as discussed in the April 1998 conference call with Navy, the regulatory agencies, and TtEMI.

Comment 4: **Evaluation of contamination and hydraulic gradients in the deeper aquifer zone will be necessary before a remedial design could be completed at site 17.**

Response: As agreed to in recent meetings between the Navy and the regulatory agencies, the deeper aquifer zone at Site 17 will be characterized further as part of predesign activities once the Site 17 remediation alternative is selected.

Comment 5: **Groundwater elevation contour maps should be provided at Site 17. In addition, estimated groundwater flow maps are needed for each alternative.**

Response: Since groundwater gradients at Site 17 are very shallow and not consistent in direction, they do not appear to result in any significant contaminant migration over time, and were therefore not presented in the FS. However, groundwater contour maps for Site 17 (and other sites) have been included in the quarterly sampling reports for the last 2 years. The most recent quarterly report, which includes sampling results and groundwater contour maps for the first quarter of 1998, was issued in June 1998.

Comment 6: **This site is not listed as an NPL [National Priorities List] site under Federal Superfund. As such, the site remediation must meet both state and local requirements.**

Response: Although not a listed NPL site, under Section 120(a) of CERCLA, federal facilities are subject to, both procedurally and substantively, the requirements of CERCLA. In Executive Order 12580, the President delegates CERCLA authority for releases and threatened releases on and from Department of Defense (DoD) property to DoD. Under CERCLA, remedial actions must meet federal and more stringent state laws that are determined to be ARARs. At NALF Crows Landing, the Navy is evaluating requirements identified by the state as possible ARARs; a discussion of those requirements is contained in Appendix C of the draft final FS report. However, as local laws do not meet the criteria for an ARAR, they are not included in the FS. Although not required to do so under CERCLA, the Navy will consider whether particular local requirements, if identified by the state in a timely manner, should be considered in carrying out the remedial actions ultimately selected.

Comment 7: **The evaluation of remedial alternatives should include a discussion of the track record for each treatment technology. This should include: how widespread the use of the technology is for site conditions and a description of successes and failures. In addition, references should be included for discussions of innovative technologies.**

Response: References are included on sites that have used in situ bioremediation of carbon tetrachloride, and additional references on bioremediation and air sparging case studies have been added to the draft final report. As indicated in the report, although at least two pilot-scale CT bioremediation systems (Hanford and MFA) and numerous chlorinated-VOC bioremediation systems have been demonstrated in the field, the Navy is not aware of any full-scale applications of in situ bioremediation of CT. Most of these pilot-scale systems have been successful at reducing VOC concentrations, although a

presentation of the site-specific data and results of these systems is beyond the scope of this FS. Please refer to the references noted in the report for further information on these bioremediation systems.

Air sparging technology has been widely used since about 1985 to remediate volatile groundwater contaminants, including chlorinated VOCs. Many case studies indicate that air sparging has achieved a substantial and permanent reduction in contaminant concentrations in groundwater (Suthersan 1997). Table 1 lists some representative air sparging case studies and includes performance results. As with the bioremediation case studies, an in-depth discussion or presentation of results at other sites is beyond the scope of this FS. Please refer to Johnson et al. (1993), Marley et al. (1995), Loden (1992), Bass and Brown (1995), and Bass and Brown (1997) for further information on air sparging performance.

Comment 8: **Air sparging in the deep saturated zone is a very innovative technology at this time. The Report should describe that additional pilot testing may be required before this remedy could be selected as a final remedial action for Site 17.**

Response: The Navy concurs that air sparging in the deeper portions of the Site 17 plume is to be considered innovative. It is already stated in numerous places throughout the FS that deep sparging is innovative and not fully tested, and that additional pilot testing would be required before implementation as a full-scale alternative. However, additional discussion regarding the innovativeness of sparging at depth has been added to the draft final FS report.

Specific Comments

SITE 17 PILOT TEST

Air Sparging

Comment 1: **The general and specific goals of the test should be included in the introduction of this section including individual design parameters sought. Additionally, the introduction section should describe where this technology is being used successfully and under what conditions it has failed to achieve desired results.**

Response: The general and specific goals of the sparge pilot testing are now presented in Section 4.1 of the draft final FS. Additionally, Section 6.2.2 has been amended to include a brief discussion and references on the use of air sparging at similar sites.

Comment 2: **A conclusion section is needed and should include an estimation of important design parameters and how the test compared to other sites that have used air sparging in similar conditions. Effectiveness of this treatment in the deeper aquifer should be discussed in detail.**

Response: Conclusions relating to air sparging performance were presented throughout Section 4.1.2 near the end of each subsection, and near the end of Section 4.1.3 of the draft FS. However, additional conclusions have been presented in the draft final FS in a separate section (Section 4.1.4).

Comment 3: **Section 4.1.2 should describe the dissolved oxygen results in more detail, including conclusions, if any. Was mounding significant in any of the tests?**

Response: Section 4.1.2 has been augmented to more fully describe DO results, and a table presenting all DO results is now included in the draft final FS. Potential water table mounding was not monitored during sparge testing, although it was likely small, if measurable, due to the relatively low pressure and rates of air injection during testing. Mounding was evaluated during sparge testing at Cluster 2, although few wells showed any rise in water elevation and the maximum rise was 0.22 feet at a well 7 feet away from the sparge well. Results of the Cluster 2 sparge testing are described and presented in the UST corrective action plan.

Comment 4: **The figures should illustrate which sections of the aquifer are considered A, B, C, and D.**

Response: Figures 4-2 and 4-3 have been amended to indicate wells that are A-, B-, C-, and D-level monitoring wells and wells that are A-, B-, and C-level sparge wells. As described in the report, the A- and B-level monitoring wells and 17-MW-02 were used to monitor sparging at shallow sparge well 17-SP -01A, the A-, B-, and C-level wells and 17-MW-03 were used to monitor sparging during injection at middle sparge well 17-SP-01B, and all wells in the test area, including the D-level monitoring wells, were used to evaluate deep sparging at 17-SP-01C.

Comment 5: **Was the vadose zone monitored to determine the area influenced by volatilization of the deeper sparging? This will impact the area capture the Soil Vapor Extraction (SVE) system must achieve.**

Response: All A-level monitoring wells and well 17-MW-02 were used throughout all SVE and air sparge testing to evaluate pressure and vacuum responses at these wells. Screens in these wells span the lower vadose zone and the upper saturated zone, and can therefore monitor both of these zones. As noted in the report, only small pressure responses were measured in these shallow wells due to deep sparging, probably caused by low air injection flow rates (5 to 7.5 standard cubic feet per minute [scfm]) distributed over a very large three-dimensional volume of the aquifer. If SVE and air sparging are to be implemented, the SVE system would be designed and operated with a ZOI that would extend beyond the sparging ZOI.

Comment 6: **Isopressure maps might be useful in analyzing subsurface heterogeneity.**

Response: The Navy concurs that any available data should be used to evaluate subsurface heterogeneities. However, there was not a sufficient number of monitoring wells nor significant enough differences in pressure responses to create isopressure contour maps that would provide meaningful information on heterogeneities. However, a figure has been added to Section 4.0 that includes an estimated 0.1 inch of water pressure contour line due to sparging. Analysis of borehole logs may be useful to evaluate heterogeneity in more detail during a design phase, although as stated in the report, aquifer materials change significantly within small lateral distances and continuous lateral layers are rarely present.

<u>Aquifer Tests</u>

Comment 8: **The estimated zone of capture should be determined for this test.**

Response: Based on capture zone modeling using the U.S. Environmental Protection Agency (EPA) WHPA version 2.2 software, an aquifer transmissivity of 870 square feet per day, and a

pumping rate of 15 gallons per minute (gpm), a capture zone of 100 feet away from the pumping well in all directions was estimated after 1 year. After 5 years of pumping, a capture zone of at least 150 feet away in all directions is estimated. These estimates are based on pump test results and simplified assumptions about aquifer conditions. A more sophisticated evaluation and groundwater modeling effort would be conducted as part of the remedial design. The text has been augmented to include these capture zone estimates.

Spray Irrigation Test

Comment 9: **The Section on spray irrigation failed to discuss one of the most important factors in this type of technology: seasonal and daily weather variations.**

Response: Without temporarily halting the extraction pumps, water will be produced regardless of water demand. It is therefore crucial to have secondary discharge options. Sprayed process water could be beneficially used to irrigate agricultural crops during the growing season and, as with other pump and treat alternatives, discharged to surface waters, to groundwater by injection or percolation, or to storage during periods of low water demand. The spray system would be sized to effectively treat the groundwater under most atmospheric conditions. When crop spraying has been temporarily discontinued (seasonally or daily), level switches in the storage tanks or wet wells would be used to automatically operate valves to spray excess water onto other areas designated for land application or over a percolation pond if needed. The percolation pond would serve as operational storage and a point discharge that would maximize beneficial uses and reduce stormwater releases and evaporative losses. Proper management of the system would minimize surface runoff due to overirrigation of crops or land application areas but would be addressed in the base's SWPPP. The report has been revised to include some of the discussion presented here.

Comment 10: **The effectiveness of groundwater treatment should be compared to remediation goals as defined by state requirements.**

Response: The effectiveness of the technology relative to remediation goals is discussed in Section 7.2, the detailed analysis of alternatives.

Comment 11: **What does sampling point 17-SF-01 represent?**

Response: The reference to sampling point 17-SF-01 is not found in Section 4.3, which describes the spray irrigation test. It is assumed that this reference is a typographical error in either the DTSC version of the FS or the comment text, and that the reference should actually be sampling point 17-ST-01, which was the stainless steel bowl that was filled with groundwater at the start of the test. Periodically throughout the test, samples of water were collected from this bowl to measure decreases in contaminant concentrations over time for comparison with reductions associated with sprayed water. For clarification, the second sentence in paragraph three, Section 4.3 has been changed. The sentence now states:

An 8-quart stainless steel bowl, designated sampling point 17-ST-01, was filled with groundwater at the start of the test. Periodically throughout the test, samples of water

were collected from this bowl to measure decreases in contaminant concentrations over time for comparison with reductions associated with sprayed water.

Site Cleanup Objectives

Comment 12: Land use restrictions should be discussed in this section.

Response: Section 5.0, entitled "Site Cleanup Objectives" in the draft FS report, contains a discussion of RAOs and ARARs. Land use restrictions do not appear to be relevant to the discussion of RAOs and ARARs. To respond to comments received from RWQCB, this section will be expanded to include the discussion of GRAs, formerly in Section 6.0 of the report; institutional controls are discussed as one of the GRAs.

Comment 13: Chapter 6.8 of the California Health and Safety Code should be cited here as the law that governs remediation of hazardous waste sites.

Response: While the Navy recognizes that the Hazardous Substances Account Act in Chapter 6.8 of the Health and Safety Code is the state's "Superfund" law, as explained in response to Comment 6 above, the Navy is undertaking investigation and remediation at NALF Crows Landing pursuant to Section 120 of CERCLA. As such, state requirements will be considered as part of the ARARs process. Because the Hazardous Substances Account Act does not contain any substantive requirements, it is not considered an ARAR.

Comment 14: Preliminary Remediation Goals published by Region IX of the Federal Environmental Protection Agency should be described in this section.

Response: EPA Region IX preliminary remediation goals (PRGs) will be discussed in connection with the discussion of ARARs for Site 17. However, they do not meet the definition of an ARAR, but rather would be classified as "to be considered" (TBCs), which are not enforceable. The Navy has determined that the MCL for carbon tetrachloride is the pertinent standard, and not the PRG.

Development and Screening of Remedial Alternatives

Comment 15: The alternative called "Institution Controls" should be retained for further analysis. It was screened from consideration in the Report because it did not comply with State Regulations. This alternative may meet State Regulations under some limited conditions.

Response: It is unclear whether this comment relates to IRP Site 11 or IRP Site 17. At IRP Site 11, Title 27 closure requirements apply. For this reason, it does not appear that institutional controls alone would be appropriate for IRP Site 11. At IRP Site 17, while institutional controls coupled with natural attenuation could ultimately achieve the RAOs, given the long time that would be necessary to meet the goals, the Navy concluded that institutional controls alone would not be appropriate for IRP Site 17.

Comment 16: On page 6-3, the Report states that Site 11 contaminants are not leaching into the groundwater. The data supporting this conclusion should be included in the site characterization section.

Response: The following information has been added to the third paragraph of Section 3.1.2 of the site characterization section:

> Selected soil samples from IRP Site 11 were analyzed for the presence of VOCs using the toxicity characteristic leaching procedure (TCLP) method and for semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), metals, and TPH-E using the deionized water waste extraction test (DI-WET) method. These methods are used to evaluate the potential for groundwater degradation attributable to leachable fractions of contaminants detected in soil. No contaminants were detected in the IRP Site 11 leachate analyses (PRC 1997).

Comment 17: On page 6-9 the Report states that injected air was well distributed throughout the aquifer. This statement should be supported by data included in the pilot test section.

Response: The statement in question is supported by data and discussion presented in Section 4.1.2 of the report. Furthermore, all pilot test pressure data are now included in Appendix A and a table summarizing DO results has been added to Section 4.1.2. The pressure and DO data suggest that the sparging tests distributed air throughout relatively large portions of the aquifer in the area of testing.

Comment 18: On page 6-10 the Report states that biodegradation appears to be occurring naturally at the site. This statement should be supported by data included in the site characterization section.

Response: In the regions where the CT plume overlaps with the UST 117 and Cluster 1 plumes, DO is relatively low due to the prior aerobic degradation of petroleum compounds and CT to chloroform ratios are the lowest, suggesting that CT is being degraded to chloroform in these areas. In central regions of the CT plume with higher levels of DO and no petroleum compounds, CT to chloroform ratios are high, suggesting that less degradation has occurred in these areas. Section 3.0 has been augmented to include additional data in support of intrinsic bioremediation of CT at Site 17.

<u>Detailed Analysis of Alternatives</u>

Comment 19: A detailed matrix should be developed to summarize this section.

Response: It is not clear from the comment what sort of matrix would be used to summarize the section, or what additional information is being sought. If a specific presentation of information is suggested, perhaps this matrix can be discussed at the next RPM meeting and included in the final FS.

Comment 20: The cost for Alternative 2 at site 11 should include the likelihood that groundwater monitoring will occur less frequently over time and include less analytes.

Response: The cost estimate for Site 11 Alternative 2 has been revised to assume less frequent groundwater monitoring over a 30-year timeframe. The new estimate assumes routine monitoring and 5-year monitoring based on CCR Title 27 Section 20420. Routine monitoring would be conducted quarterly for the first year, biannually for the second

through fifth years, and annually for the sixth through 30th years, and would include analysis for TPH-purgeable, TPH-extractable, polynuclear aromatic hydrocarbons (PAHs), and VOCs. Monitoring to be conducted at 5-year intervals would include, in addition to the parameters above, analysis of SVOCs, chemical oxygen demand, metals, pesticides and polychlorinated biphenyls, total dissolved solids, ammonia, and anions.

Comment 21: On page 7-12, an estimated design flow rate for SVE is used in describing Alternative 1. Design parameters supporting this estimate should have been summarized in the pilot test section.

Response: The pilot test section describes the range of flows (19 to 41 standard cubic feet per minute [scfm]) that were used during SVE testing, and 30 scfm falls within this range. However, detailed analysis of optimum design parameters has not been performed and the 30 scfm estimate was used primarily for cost estimating purposes. It may have been premature to state that approximately 30 scfm "would likely" be used without a closer analysis, and the text has been modified slightly as a result.

Comment 22: Specific time estimates for remedial actions should be included for the alternatives at Site 17.

Response: Specific time estimates were included in the cost estimate summaries in Appendix B of the draft FS and in most of the detailed analyses of alternatives. The draft final FS now presents remedial time estimates in Section 7.0 for all technologies evaluated.

Comment 23: The limitations for seasonal and daily weather variation should be described in detail for Alternative 3B. Alternative treatment or storage should be included in this alternative.

Response: The report has been amended to include discussion on seasonal and daily weather fluctuations and additional storage for Alternative 3B. Also see the response to comment 9.

<u>Comparative Analysis</u>

Comment 24: The uncertainty of each technology to achieve remedial goals in a reasonable time period should be included in this comparison.

Response: Section 7.3, the comparison of remedial alternatives, has been revised to include more discussion of remedial timeframes and the uncertainties involved in predicting these timeframes.

Comment 25: On page 7-35 Alternatives 1 and 2 are described as favorable for long-term effectiveness and permanence. This needs to be supported by site specific data or specific reference.

Response: As indicated in the response to general comment 7, discussion and references have been added to Section 6.0 that better describe performance and effectiveness of air sparging and in situ bioremediation at other sites.

Appendix B

Comment 26: **Site 11, Alternative 2. The analytical suite should be described for quarterly monitoring. Is the 30 year monitoring considered as a present worth value?**

Response: The assumed analytical suite for groundwater monitoring is described in the response to comment 20 above. The costs for 30-year monitoring are estimated by assuming a net present worth cost, as was done for all cost estimates. In general, net present worth estimates tend to make long-term O&M appear less expensive than if it were to be funded incrementally throughout the period of operation or monitoring.

5.0 RESPONSES TO COMMENTS FROM NASA

Comment 1: **REF: Page 3-2, para. 1. Sent. 2**

Recommend rewording sentence to say: "The risk assessment regards an HI [hazard index] of 1.0 *or less* for noncarcinogens as protective of human health."

Response: The report text has been modified as suggested.

Comment 2: **REF: Page 3-7, para. 1, sent. 4**

"Plate 1" is referenced in the text. However, there is no "Plate 1". Should this reference be Figure 3-5?

Response: The text was corrected to refer to Figure 3-3 (formerly Figure 3-5).

Comment 3: **REF: Page 4-2, para. 2, sent 1**

Table 4-1 should be referenced rather than 4-2. Also, there is a discrepancy between the vacuum range of 47-104 in. Noted in the text and the range of 47-101 in. noted in Table 4-1.

Response: The text has been revised as suggested. Also see the response to Navy comment 3.

Comment: **REF: Page 5-6, Action Specific ARARs - IRP Site 11, sentence 1;**
REF: Page 7-28, Long-term Effectiveness and Permanence, sentence 1.
Check grammar.

Response: The text has been changed as requested.

References

Bass, D.H. and R.A. Brown. 1995. Performance of Air Sparging Systems - A review of case studies. Presented at the Superfund 1995 Conference, Hazardous Materials Control Research Institute, Washington, DC. November

Bass, D.H. and R.A. Brown. 1997. Performance of Air Sparging Systems - A review of case studies. Presented at the Fourth International In Situ and On-Site Bioremediation Symposium, New Orleans. April.

Gilham, R.W. 1996. In Situ Treatment of Groundwater: Metal-Enhanced Degradation of Chlorinated Organic Contaminants. Advances in Groundwater Pollution Control and Remediation, pp. 249-274. Netherlands, Kluwer Academic Publishers.

Johnson, R.L et al. 1993. An Overview of In Situ Air Sparging. Groundwater Monitoring and Remediation. Fall.

Loden, Mary E. 1992. A Technology Assessment of Soil Vapor Extraction and Air Sparging, EPA/600/R-92/173.

Marley, M.C. et al. 1995. Air Sparging Technology: A Practice Update. Presented at the Third International In Situ and On-Site Bioremediation Symposium, San Diego. April.

PRC Environmental Management, Inc. 1997. Final Remedial Investigation Report, Installation Restoration Program Sites 10, 11, 12, 13, 14, 16, 17, and 18. July 31.

Suthersan, Suthan S. 1997. Remediation Engineering Design Concepts. CRC Press, Inc.

Tetra Tech EM Inc. 1998. Naval Auxiliary Landing Field Crows Landing. Draft Final Corrective Action Plan. UST Sites Cluster 1, Cluster 2, 109, and 117. February 27.

TABLE 1

NALF CROWS LANDING
RESPONSE TO COMMENTS ON THE DRAFT FEASIBILITY STUDY
REPRESENTATIVE SPARGING SITES

Site	Citation	Contaminants	Soil Type	Clean up Time (months)	Number of Sparge Points	Depth to Groundwater (ft)	Intial Groundwater Concentration (ppm)	Final Groundwater Concentration (ppm)	Notes
Retail Gasoline Station, Massachusetts	Marley, 1992	Gasoline, BTEX	Fine-coarse sand, gravel	2	7 shallow 8 deep	15.5 - 16	Total BTEX - 21	Total BTEX < 1	Full Scale
Savannah River, South Carolina	Looney, 1991	TCE, PCE	Sand, silt, clay	3	1 horizontal	135	TCE 0.5 - 1.81 PCE 0.085 - 0.184	TCE 0.010 - 1.031 PCE 0.003 - 0.124	Field Demonstration. Air sparging was used as a supplement to pump and treat.
Chemical Manufacturer	Middleton, 1990	Halogenated Hydrocarbon	Sandy gravel Aquitard-clay	9	8	8	THH 1.9 - 5.417	THH 0.185 - 0.320	
Dry Cleaning Facility	Brown, 1991	PCE, TCE, DCE, TPH	Coarse sand Natural clay barrier	4	7	13	Total VOCs - 41	Total VOCs - 0.897	

Sources:

1. Loden, Mary E. A Technology Assessment of Soil Vapor Extraction and Air Sparging, EPA Publications, 1992, EPA/600/R-92/173, page 15-61.
2. Marley et al. The Application of In Situ Air Sparging as an Innovative Soils and Ground Water Remediation Technology, Spring 1992 Groundwater Monitoring and Remediation, page 137-144.
3. Looney et al. "Field Demonstration of Environmental Restoration Using Horizontal Wells," Presented at: Third Forum on Innovative Hazardous Waste Treatment Technologies; Domestic and International, June 11-13, 1991, Dallas, Texas.
4. Middleton et al. "In situ Aeration of Groundwater - A Technology Overview," Presented at A Conference on Prevention and Treatment of Soil and Groundwater Contamination in the Petroleum Refining and Distribution Industry, Montreal, Quebec, October 16-17, 1990.
5. Brown et al. "Extending Volatilization to Contaminated Aquifers," Prepublication Draft presented at the Symposium on Soil Venting, Robert S. Kerr Environmental Research Laboratory, Houston, Texas, April 29 - May 1, 1991.

Notes:

BTEX	Benzene, toluene, ethylbenzene and xylenes
TPH	Total petroleum hydrocarbons
DCE	Dichloroethene
TCE	Trichloroethene
PCE	Perchloroethene
THH	Total halogenated hydrocarbons
VOCs	Volatile organic compounds
ppm	part per million
ft	feet