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September 15, 1998

Mr. Hubert Chan
Engineering Field Activity West
Naval Facilities Engineering Command
900 Commodore Drive, Building 208
San Bruno, California 94066-5006

**Subject: Naval Auxiliary Landing Field (NALF) Crows Landing
Feasibility Testing for IRP Site 17, UST Cluster 1, UST 117
CLEAN II Contract No. N62474-94-D-7609, Contract Task Order 219**

Dear Mr. Chan:

This letter summarizes the recommended approach for air sparging (AS) and biosparging field pilot tests to be conducted at Installation Restoration Program (IRP) Site 17, Underground Storage Tank (UST) Cluster 1, and UST 117 at Naval Auxiliary Landing Field (NALF) Crows Landing. A comprehensive testing approach has been developed to allow for the collection of data necessary for the detailed design of full-scale remediation systems at the referenced sites. As we discussed during a conference call involving Don Chuck, Keith Reamer, Steve Annecone, and me on August 28, this letter was prepared to provide the Navy an opportunity to review this approach before the field work plan is prepared and implemented.

Background

Based on the results of testing conducted by Tetra Tech EM Inc. (TtEMI) at IRP Site 17 during June 1997, it appears that AS may be a feasible technology to address the suspected source area of dissolved carbon tetrachloride (CT) detected in groundwater at IRP Site 17. The test results indicated that sparging to a depth of approximately 75 feet below ground surface (bgs) is feasible; however, successful sparging at depths of 100 to 150 feet bgs was not fully demonstrated. It is possible that heterogeneous soil conditions result in limited vertical transport of air from deeper sparge points. This possibility is suggested by the buildup of pressure in two monitoring points (17-MP-01B and 17-MP-02B) at 69 to 79 feet bgs during sparge tests at a medium (104 to 109 feet bgs) sparge depth, and pressure buildup at three (17-MP-01D, 17-MP-02D and 17-MP-03D) monitoring points at 148 to 158 feet bgs during sparge tests at deep (153 to 158 feet bgs) sparge wells. Based on site boring logs, similar heterogeneous soil stratigraphy exists within UST Cluster 1 and UST 117.

Before developing a full-scale system design, additional testing at IRP Site 17 is considered warranted. Due to the highly heterogeneous soil stratigraphy across NALF Crows Landing, air/biosparging tests are also recommended at UST Cluster 1 and UST 117.

In addition to air/biosparging tests, anaerobic biotreatment should be evaluated at IRP Site 17. This technology will be evaluated as a contingency in the event testing results indicate that air sparging is not a feasible approach for the entire concentrated (greater than 100 micrograms per liter) CT plume, also referred to as the source CT plume, at IRP Site 17. As described in the feasibility study, it appears that anaerobic biodegradation is a viable alternative for the IRP Site 17 CT plume source area, based on several literature references and on actual site data.

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IRP Site 17 Air Sparge Testing Approach

The test objectives for IRP Site 17 are:

- Evaluate the feasibility of achieving vertical air flow between the saturated and vadose zones via air sparge wells at sparge depths up to 170 feet bgs
- Evaluate the effectiveness of air sparging over an extended operating period (4 weeks) to reduce CT concentrations within the suspected CT plume source area.

The specific design parameters to be developed based on this testing include sparge well screen interval depths, sparge flow rate and pressure, and effective zone of influence. The test data will also allow for specifying an operating air sparging configuration, such as air sparge pulsing cycles. Several of these parameters were previously evaluated during the 1997 TtEMI air sparge testing at IRP Site 17; however, due to the depth of the sparging tests (as much as 100 feet below the water table) and the uncertainties arising from soil heterogeneities, more comprehensive tests are considered warranted for this site. The additional testing will provide a better understanding of whether air sparging is feasible with respect to achieving vertical air flow within the targeted soils, and whether sparging at depth (150 feet bgs) over an extended period of time will result in effective removal of CT from the targeted groundwater depths.

The testing at IRP Site 17 will be conducted in two phases. The initial phase of testing will focus on the ability to achieve vertical air flow within the targeted aquifer using existing sparge wells and monitoring points at multiple depths. Phase 1 testing will be similar to testing previously conducted by TtEMI; however, it will include the use of a helium tracer for further definition of air flow pathways, and the use of monitoring wells as test sparge injection wells. If it is determined that vertical air flow, and therefore air sparging, is achievable, a second phase of testing will be conducted.

The second phase of testing will include installation and use of additional sparge and monitoring points to evaluate sparging at multiple locations over an extended (1 to 2 months) duration. Phase 2 testing will be conducted to evaluate CT removal efficiency within the test area, and to collect data to develop AS well and system design specifications.

IRP Site 17 - Contingency Approach

The recommended contingency option involves an enhanced groundwater pump and treat approach. This alternative approach would be based on a combination of groundwater pumping with anaerobic degradation of CT. Based on an evaluation of existing site data and several technical literature references (Bouwer 1997; Jin and others 1997a and 1997b; Peyton and others 1995), anaerobic biodegradation of CT is a potentially viable cleanup option for this site. If technically feasible, the use of anaerobic biodegradation with groundwater pump and treat technology may shorten the duration of cleanup to approximately 2 to 4 years versus the estimated 11 to 15 years for groundwater pump and treat technology alone.

Existing groundwater analytical data indicate that concentrations of chloroform (CF) and methylene chloride (MC), byproducts of anaerobic CT biodegradation, are higher where reduced dissolved oxygen (DO) levels were also detected. These data are summarized in Figure 1. As presented in Figure 1, groundwater with reduced DO (less than 1 milligram per liter [mg/L]), including samples from monitoring wells 17-MP-01D and 17-MP-01B, also contained high concentrations of CF and MC relative to groundwater samples with higher DO (greater than 8 mg/L). These data suggest that biodegradation of CT is occurring in locations of reduced DO conditions.

Conditions favorable to the anaerobic degradation of CT may be achieved by injecting one or more chemical amendments into the targeted aquifer. The injected amendments may include alternative electron donors (lactate, acetate, or benzoate) and possibly electron acceptors. Based on background site data, it appears that the primary amendment requirement at the site will be an alternative electron donor. The electron donor would serve as a substrate (carbon source for cell growth and maintenance) and energy source to sustain an anaerobic microbial population capable of degrading CT. A groundwater pumping system would be developed to distribute the amendments throughout the CT source, while maintaining hydraulic control of the entire CT plume. The groundwater pumping configuration would be developed with consideration for incorporating it into full-scale remediation designs for UST Cluster 1 and UST 117.

The bio-enhanced groundwater pumping approach would be evaluated in two steps. The first step consists of a baseline characterization and bench-scale treatability study to confirm biochemical feasibility and to identify optimal amendment parameters (primarily electron donors and electron acceptors). If results of the bench-scale treatability study indicate that anaerobic biodegradation of CT is feasible, the next step will be an extended (approximately 3 to 6 month) field demonstration to evaluate hydraulic and chemical operating parameters. Results of the bench and field pilot tests would be used for the full-scale remedial design.

The contingency option will be evaluated on a bench scale in conjunction with the Phase 1 air sparge testing at IRP Site 17. It is recommended to proceed with the bench scale evaluation of the contingency option to avoid an extended (2 to 3 month) delay in the development of a full-scale remediation approach for IRP Site 17, which will also affect the approach for UST 117 and UST Cluster 1 in the event that air sparging is considered infeasible. If the Phase 1 air sparge testing indicates that air sparging is not appropriate for addressing the CT plume source area at IRP Site 17, Phase 2 air sparge testing will not be conducted at IRP Site 17. If the bench scale bio-evaluation suggests that the contingency option is viable and Phase 1 air sparge testing indicates that air sparging is not appropriate for IRP Site 17, the contingency option will be further evaluated.

To more efficiently control costs associated with collection of groundwater and soil samples for the bench-scale evaluation, drilling and sampling for the bio-evaluation will be conducted in conjunction with installation of groundwater monitoring wells currently planned for CT plume delineation in the mid-deep (170-180 feet bgs) and deep (270 feet bgs) aquifer zones at IRP Site 17.

UST Cluster 1 and UST 117 Testing Approach

The testing objectives for UST Cluster 1 and UST 117 are as follows:

- Evaluate the feasibility of achieving vertical air flow between the saturated and vadose zones via air sparge wells at multiple sparge depths
- Evaluate the ability to increase dissolved oxygen levels within the hydrocarbon plume by injection of air or oxygen via biosparging wells
- Evaluate the effective zone of influence at multiple injection flow rates and depths.

As with IRP Site 17, testing at UST Cluster 1 and UST 117 will be conducted in two phases. Phase 1 testing will focus on the ability to achieve vertical air flow within the targeted aquifer using existing monitoring points as test and monitoring wells. Phase 2 testing will consist of extended air or oxygen injection to evaluate the ability to create conditions favorable for aerobic degradation of hydrocarbons. If Phase 1 results suggest that testing in UST Cluster 1 will provide data sufficient for the design of a full scale system at UST 117, Phase 2 testing will be limited to UST Cluster 1. In an effort to control project costs, it is assumed that the Phase 1 and Phase 2 testing at UST Cluster 1 and UST 117 would be conducted during the IRP Site 17 Phase 1 and Phase 2 testing events.

Summary

TtEMI will prepare a more detailed internal work plan over the next several weeks. It is anticipated that this document will be completed by October 9, 1998. This document will be submitted to the Navy for review before field work begins. Please call Jon Polonsky (303-295-1101 ext. 7817) or Steve Annecone (303-312-8886) with any questions or comments about this letter.

Sincerely,

Jon Polonsky
Project Engineer

Enclosures

cc: Ray Lecler, DTSC
Don Chuck, Moffett Federal Airfield
Robert Reeves, RWQCB
Steve Annecone, Tetra Tech EM Inc.

REFERENCES

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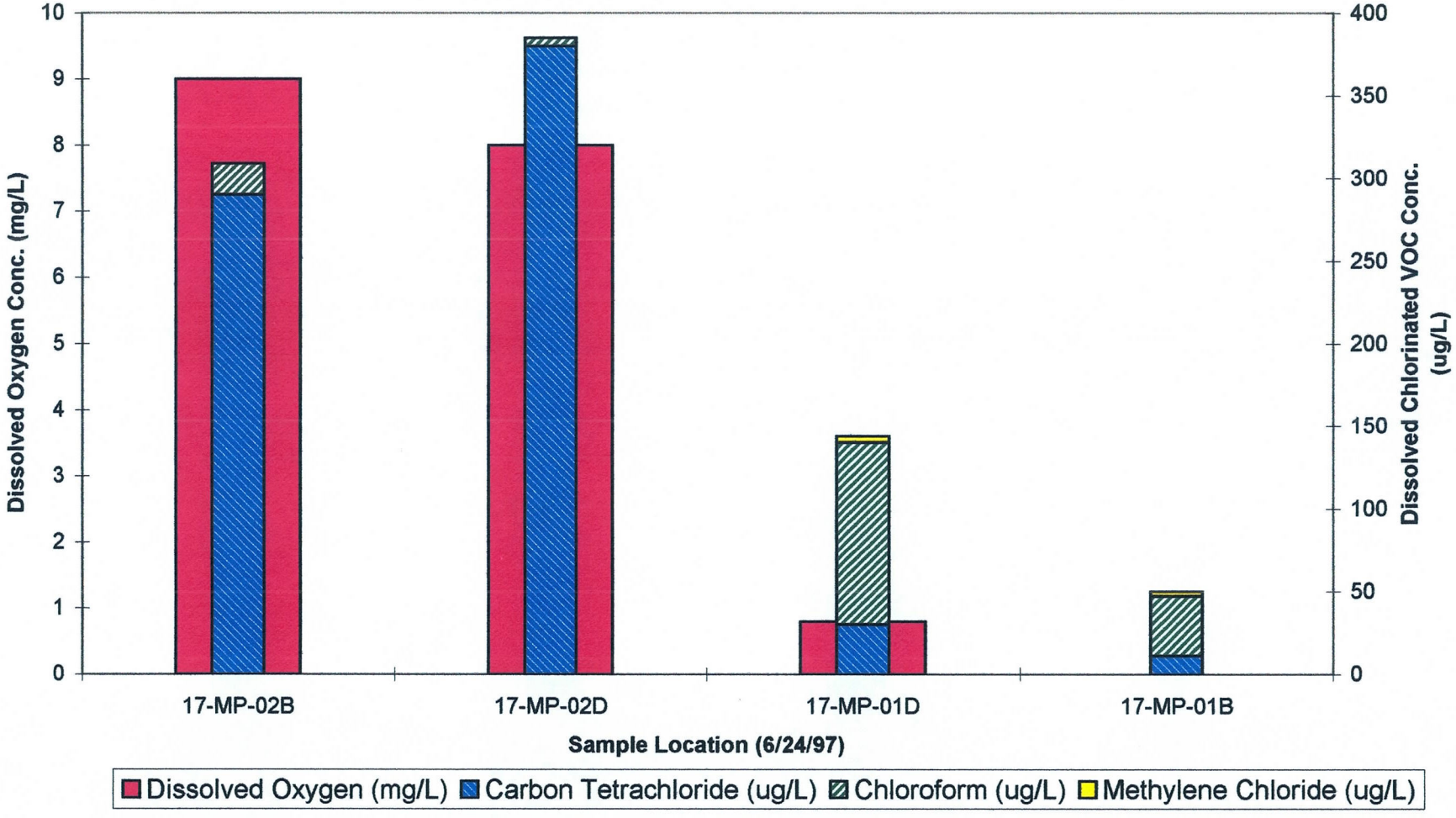
FIGURE 1
DISSOLVED OXYGEN VS. DISSOLVED VOC
NALF CROWS LANDING - IRP 17
ANAEROBIC BIODEGRADATION STUDY