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Responses to Regulatory Agency Comments on the

TIME-CRITICAL LANDFILL GAS REMOVAL ACTION PROJECT WORK PLAN AND THE FINAL PARCEL E LANDFILL GAS TIME-CRITICAL REMOVAL ACTION ACTION MEMORANDUM

Hunters Point Shipyard, San Francisco, California

June 25, 2003

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

Prepared by

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June 25, 2003

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Dear BCT Members:

Enclosure (1) is the Responses to Regulatory Agency Comments on the Time-Critical Landfill Gas Removal Action Project Work Plan and the Final Parcel E Landfill Gas Time-Critical Removal Action Action Memorandum, Hunters Point Shipyard.

Should you have any concerns with this matter, please contact the undersigned at (619) 532-0913.

Sincerely,

KEITH FORMAN
BRAC Environmental Coordinator
By direction of the Commander

Enclosure: (1) Responses to Regulatory Agency Comments on the Time-Critical Landfill Gas Removal Action Work Plan and the Final Parcel E Landfill Gas Time-Critical Removal Action Action Memorandum, Hunters Point Shipyard, June 25, 2003

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RESPONSES TO REGULATORY AGENCY COMMENTS ON THE TIME-CRITICAL LANDFILL GAS REMOVAL ACTION PROJECT WORK PLAN AND THE FINAL PARCEL E LANDFILL GAS TIME-CRITICAL REMOVAL ACTION ACTION MEMORANDUM HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

This document presents the U.S. Department of the Navy's (Navy) responses to comments (RTC) from regulatory agencies on the "Time-Critical Landfill Gas Removal Action Project Work Plan [WP], Parcel E Industrial Landfill, Hunters Point Shipyard [HPS], San Francisco, California," dated October 2002 and the "Final Parcel E Landfill Gas Time-Critical Removal Action [TCRA], Action Memorandum [AM]," dated September 23, 2002. The comments addressed below were received from the U.S. Environmental Protection Agency (EPA) on October 24, 2002; the Department of Toxic Substances Control (DTSC) on November 19, 2002, which included comments from the California Integrated Waste Management Board (CIWMB), dated October 15, 2002; and the Regional Water Quality Control Board (RWQCB) on November 22, 2002.

RESPONSES TO COMMENTS FROM EPA

General Comments on the WP

1. **Comment:** **The work plan does not address how the sealant material between adjacent HDPE panels was to be hydrated, or for that matter, whether the panels were to be sealed. In the event that the barrier wall does not function as designed, consideration should be given to trying to hydrate the joints of the panels, which means that the joints should have been located and flagged before the area around the barrier wall was backfilled. Please specify whether the panels were to be sealed and discuss whether the sealant material was hydrated. If not, please suggest procedures for hydrating the seals if the barrier wall does not function as designed.**

Response: It should be noted that, while the preference and goal is a sealed wall, it is not necessary for the wall to be completely sealed to function properly. It is only necessary for the wall system to be less permeable than the vent trench system. The gas will flow through the most preferential pathway to escape, and the granular trench and pipe were installed on the landfill side of the wall to provide this preferential pathway.

The curtain wall panels were installed with an interlocking seal and hydrophilic eslastomer profile that is capable of swelling to three times its volume in water within 72 hours. The seal was attached to the bottom of the female interlock and fed into the opening from the bottom. The seal was monitored during installation to ensure that its rate of insertion was the same as the curtain wall panel. The elastomeric seal makes contact with both sides of the joint and provides a seal, even in its unhydrated state. However, the depths of the curtain wall panels were designed to be at least 2 feet below the historical seasonal low water table elevation. The seals will be hydrated to some extent by capillary action. In addition, the wet weather season for the site traditionally occurs from October through February, which will raise the groundwater levels and provide additional hydration. The as-built survey for the curtain wall alignment was based on locating every fourth panel joint (which are 4 feet apart). Based on current monitoring data, it appears that the wall is functioning as designed and that methane is not passing through the wall. Monitoring data are available in weekly reports on the Navy website (http://www.efdsw.navfac.navy.mil/06/HPS_E/Landfill_Gas/index.htm.)

2. **Comment:** **The work plan does not mention the need for long-term operations and maintenance. After the concentrations of landfill gas are reduced on the University of California, San Francisco (UCSF) property, the barrier wall and passive venting system must be maintained so the landfill gas will not reach the UCSF property in the future. This is particularly important in light of the potential for earthquakes, which could damage the barrier wall and passive vent system. Please indicate whether a long-term operations and maintenance plan will be developed.**

Response: The intent is to leave the barrier wall in place and maintain it, if required, to prevent future migration from the landfill site. Regarding earthquakes, the geotechnical data collected in Spring 2002 and evaluated for liquefaction indicate that the soil column above the bedrock will attenuate any vibrations that are caused by seismic activity at the site. The potential for liquefaction in this area is further detailed in the landfill liquefaction report to be submitted under separate cover. In addition, the geomembrane liner will remain flexible and will elongate up to 700 percent before breaking. Consequently, earthquakes are not expected to have a significant effect on the liner system.

A long-term operation and maintenance (O&M) and monitoring plan will be developed as part of the final remedy for the site. The Navy is presently monitoring the passive vents on the landfill side of the wall and the gas monitoring probes (GMP) on the University of California, San Francisco (UCSF) side of the wall. Monitoring will continue on a quarterly basis, after the removal action is completed, using the protocols established in the "Draft Final Sampling Plan [FSP]/Quality Assurance Project Plan [QAPP] for Parcel E Nonstandard Data Gaps Investigation (Industrial Landfill and Wetlands Delineation)" (Tetra Tech EM Inc. [Tetra Tech] 2002a), as long as no problems are detected. Quarterly monitoring also will continue until the final monitoring plan is developed and implemented. The Navy will monitor and inspect the system after an earthquake event (7.0 magnitude or higher centered within 40 miles of the site, 6.0 magnitude or higher within 10 miles, or 4.0 magnitude or higher within 1 mile) within 24 hours of the event.

Specific Comments on the WP

1. **Comment:** **Section 5.0, Extraction Well Installation and GMP Removal/ Monitoring Well Abandonment, Page 7: The scope of work in Section 2.1 indicates that one existing groundwater monitoring well was to be abandoned, and it appears that the procedures for this abandonment should have been discussed in Section 5.0, but there is no text in this section that discusses monitoring well abandonment. Please specify which monitoring well was to be abandoned and discuss well abandonment procedures.**

   Response: Monitoring well IR01MW07A was abandoned on August 12, 2002, because the landfill gas barrier wall intersected its location. The well was abandoned in accordance with California Well Standards, as described in California Department of Water Resources Bulletin Nos. 74-81 and 74-90. The well was overdrilled using hollow-stem auger drilling methods, and all well materials were removed from each boring. The borehole was then backfilled with bentonite grout.

2. **Comment:** **Appendix C, Extraction, Monitoring and Maintenance Plan: The Extraction, Monitoring and Maintenance Plan (EMMP) should have procedures for handling wastes generated during the removal action (e.g. spent carbon and liquids from the water knock-out pots). Please revise the EMMP to address the handling of wastes generated during the effort.**

   Response: All liquid from the water knockout pots will be containerized in Department of Transportation-approved 55-gallon drums (supplied by the O&M contractor) and will be transported to a central investigation-derived waste storage location within HPS. In the first 2 months of operation, less than 30 gallons of liquid was collected in the knockout pots. All waste generated will be profiled for acceptance by an approved disposal facility. The carbon and Hydrosil filters are expected to last for the life of the project.

3. **Comment:** **Appendix C, Extraction, Monitoring and Maintenance Plan, Table 4: The first decision rule in the table indicates that, "if the concentration of NMOCs (Non-Methane Organic Compounds) after the Hydrosil vessel of a treatment unit exceeds 5 ppmv, then the gas extraction system is to be shut down and the Hydrosil filter replaced before the system is restarted." However, the text in Section 4.1.1, Gas**

Extraction System Samples, indicates that, "Breakthrough of a carbon vessel or the Hydrosil is assumed if (1) there is a steady observed increase in vapor concentrations over 1 week or (2) there is a sudden increase in NMOC concentrations." Please revise the table to match the text. In addition, if one of the purposes of the Hydrosil filter is to control odors (e.g., hydrogen sulfide) please provide criteria for replacing the Hydrosil filter based on noxious odors.

Response: Please see revised Table 4 included in this RTC as Attachment A. The design purpose for inclusion of the hydrosil filter in the treatment train was to remove lighter-end volatile organic compounds. Results of the soil gas survey did not indicate significant amounts of hydrogen sulfide gases. No other noxious odors were expected, nor have they been detected during operation of the system.

RESPONSES TO COMMENTS FROM DTSC

General Comment

1. **Comment:** **The AM and WP were received and this review has been conducted <u>after</u> the implementation (on August 22, 2002) of the RA described in the AM and WP. RA construction was completed by October 1, 2002.**

Response: The Navy has provided monthly updates to the Base Realignment and Closure Cleanup Team (BCT) members on the findings of the soil gas investigation and subsequent planning, design, and implementation of the TCRA since discovery in Spring 2002.

General Comments on the WP

1. **Comment:** **The Navy is required per Title 27 to prevent any landfill gas (LFG) migration to any adjacent property. However, the scope of this RA is limited to the University of California at San Francisco (UCSF) compound.**

Response: During the nonstandard data gaps investigation, the Navy found that fill materials were present on the UCSF compound and that landfill gas had migrated beyond the extent of the fill material. The scope of the removal action is to remove methane from the UCSF compound and install a gas barrier to prevent future migration of gas from the landfill. The location of the barrier wall was based on information obtained during the soil gas survey conducted in Spring 2002. The survey concluded that methane had migrated only in the northern portion of the landfill and that both ends of the wall extend past the areas where methane was detected.

Soil gas extraction wells were designed and located within the UCSF compound (EX1 through EX9) and the railroad museum property (EX10) based on an assumed radius of influence (ROI) of 60 feet. Current monitoring data have shown that the ROI for each extraction well is greater than 60 feet in all wells and up to 120 feet on the western portion of the UCSF compound. The location of EX-1 allows methane to be extracted from up to 100 feet within the Lowpensky property. Data collected to date indicate that the system is successfully removing methane from beneath the UCSF compound.

2. **Comment:** **Page 13, Section 11.0: Environmental Protection Plan. The text in the second paragraph mentions environmental protection requirements for soil and water. Air should be included.**

Response: Section 4.0, Barrier Wall Installation, of the WP addresses emissions to the atmosphere during construction. Rusmar® foam was applied to the excavated and backfilled sections of the trench at the completion of each day. In addition, all soil stockpiles were covered daily with long-term Rusmar® foam and maintained throughout the project duration. Water trucks managed dust control by keeping road surfaces damp during all excavation activities.

3. **Comment:** **Page 14, Section 11.6.2 and Page 02506-3, Section 3.03: Installation, Paragraph B: Glues and Solvents. For piping and fixtures, threaded joints with gaskets are recommended over glued (solvent fused) joints to the maximum extent possible. Over time, with varying environmental conditions (hot/cold, wet/dry), degradation of glued joints is more likely to occur.**

Response: The recommendation is noted. Solvent-welded polyvinyl chloride (PVC) joints were used only for the shallow trench vent and risers and are sufficient for this purpose. The depth and backfill material used around the pipe is expected to remain stable and will provide protection for the pipe and joints. The passive risers are presently attached to the fence between the UCSF compound and the landfill. More permanent risers may be installed in the future; however, solvent-welded PVC was used, rather than a more permanent solution, until the final remedy is selected, because the final configuration of that area is not yet known. This issue will be considered during the selection of the final remedy.

4. **Comment:** **Page 15, Section 11.9: Fire. Hazards include combustible gases, especially methane. The text refers to combustible liquids but not to combustible gases. ESU recommends that consideration be given to prevent fires from all possible sources including gases, vapors, and liquids.**

Response: As stated in Appendix A, Health and Safety Plan, of the project WP, a site health and safety officer was assigned to monitor for combustible gases during all work activities (Innovative Technical Solutions Incorporated [ITSI] 2002).

5. **Comment:** **Page 17, Section 11.12.5.2: Controlling the Source. With respect to spill control, the last sentence is unclear. On the one hand, ITSI is tasked to meet the environmental protection requirements as stated in the introduction (Section 11.1, page 13). On the other hand, ITSI will not engage to contain or control any spill of unknown chemicals. Please clarify the role of ITSI. Please identify who will manage spill control.**

Page 20, Section 13.1: Introduction. Previously, the removal action (RA) was designated as an emergency removal action. And in this section, the preparation of a "Draft Emergency Landfill Gas Removal Action" is mentioned. However, in the title of the WP, the RA is called a time-critical removal action. Clarify whether this RA is an emergency RA or a time-critical RA.

Response: ITSI is responsible for managing any spills resulting directly from their work activities, such as glues/solvents, equipment, and so forth. Because the scope of the project involved excavating into a landfill with unknown elements, the Navy Project Engineer, Steve Tyahla (Resident Officer in Charge of Construction office), would have been notified to manage any unknown containers that were discovered. Excavation has been completed, and no containers or other unknown elements were discovered.

The title of the document is correct; this is a TCRA. The Navy understands that some confusion has arisen on this issue and will henceforth refer to this action as a TCRA in subsequent formal documents.

6. **Comment:** **Figure G-2 and C102: Lockable Valves. To minimize vandalism and operator error, <u>lockable valves</u> are strongly recommended to prevent the unintentional release of landfill gas from the vent well directly into the atmosphere before treatment. (The figure depicts a non-locking flow control valve, which is depicted as normally closed.) Existing valves should be replaced.**

Figures and the text should clearly indicate that methane gas will not be treated by either granulated activated carbon (GAC) or Hydrosil (permanganate zeolite). That is, methane will be vented to the atmosphere by both the active and the passive systems. The treatment system (GAC and Hydrosil) is designed to capture volatile organic compounds (VOCs) in LFG.

Response: The valves are on a portion of the vent system contained within the landfill area and are monitored on a regular basis. This area is fenced and locked on a continuous daily basis. To date, vandalism has not been a problem; however, should problems occur in the future, it may be necessary to reevaluate the valves. Monitoring results are reported on a weekly basis and made available on the Navy website: http://www.efdsw.navfac.navy.mil/06/indexHP.htm.

A flare system would have destroyed both methane and nonmethane organic compounds. However, the Navy and the BCT chose this system instead of a flare system because of the concern about the possibility for dioxins to be generated.

7. **Comment:** **It appears that Gundwalls are used primarily for hydraulic control (not gas control) as indicated by example applications shown on the manufacturers' website at http://www.gseworld.com/global/unitedstates/products/GundWall/Index.htm.**

Discuss the appropriateness of the Gundwall for landfill gas control. Please provide information on gas permeability and chemical compatibility of Gundwall materials. Show that the wall materials and design are effective for controlling other gases in addition to methane, in particular volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH). Provide examples where Gundwalls have been used for LFG control elsewhere.

With respect to gas permeability, the sealant material (HyperTite, a hydrophilic gasket) between panels is critical. The sealant material has to be wet in order to expand to fill the space between panels. When installed below the water table for hydraulic control, the sealant is wetted during installation or soon after as water attempts to migrate through the space between panels. Please explain how the sealant is wetted in this application which is above the water table. How does the sealant maintain its wetness?

Similarly, the bentonite seal in the trench must be wet to maintain its effectiveness. Please explain how the bentonite will remain wet through long arid summers.

Response: Title 27 of the *California Code of Regulations* (CCR) requires that geomembrane liners be included in gas barrier walls. The Gundwall used the landfill is made from an 80-mil high-density polyethylene (HDPE) geomembrane. The primary difference between Gundwall and other HDPE geomembranes is the installation method and jointing method. Gundwall was initially designed as a hydraulic barrier for liquids. However, they have been used successfully as both hydraulic and gas barriers at landfills, chemical plants, refineries, and other industrial facilities (Attachment B). The analytes discovered in the landfill gas do not adversely affect HDPE. The very low permeability of the HDPE (1×10^{-13} centimeters per second) makes the material an effective barrier for water, vapor, and gas (methane) phases. Also, the 4-foot width of the panels allows for fewer joints than other direct installation methods, such as metal or plastic sheet pile. Gundwall can be installed in a very limited space without opening a wide installation trench. Gundwall was selected for this application because of the limited space available between the edge of waste and the adjacent UCSF compound.

The barrier wall is only one part of the barrier/vent system. The second part of the system includes a highly permeable, granular collection trench with riser pipes. This passive vent system, on the landfill side of the barrier, provides a preferential pathway for gas to escape. Gas at the barrier will move toward areas of lower pressure (that is, the path of least resistance). Landfill gas that migrates to the north and reaches the HDPE barrier will move into the collection trench, pass through the piping, and discharge from the vent system through the carbon and Hydrosil filters. The base of the HDPE barrier is installed below the historical low groundwater elevation, thereby preventing gas migration under the base of the barrier. While the goal is to provide a positive barrier, this design does not require the barrier wall to be impermeable. It must only be substantially less permeable than the preferential pathway provided by the collection trench.

The HDPE panels were installed with an interlocking joint that includes a hydrophilic eslastomer cord, which is capable of swelling to three times its volume in water within 72 hours. The seal was attached to the bottom of the female interlock and fed into the opening from the bottom. The seal was monitored during installation to ensure that its rate of insertion was the same as the curtain wall panel. The elastomer cord makes contact with both sides of the joint and provides a seal, even in its unhydrated state. It will, of course, provide a better seal if hydrated; however, the pressure expected from the generated methane is only a fraction of that expected because of hydrostatic pressure in liquid containment applications. The eslastomer cord will be hydrated to some extent by groundwater, but even in a completely dry state it should sufficiently restrict the flow of gas through the granular collection system.

The as-built survey for the curtain wall alignment was based on locating every fourth panel joint (which are 4 feet apart). Based on current monitoring data, it appears that the wall is functioning as designed and that methane is not passing through the wall, as indicated by the low levels of methane in the GMPs and the higher levels immediately on the other side of the barrier wall (in the passive vents). Monitoring data are available in weekly reports on the Navy's website: http://www.efdsw.navfac.navy.mil/06/indexHP.htm.

8. **Comment:** **Page 2, Attachment C, Extraction, Monitoring, and Maintenance Plan, Section 2.1: Gas Extraction System. Provide methane production rates for each well location.**

Response: It is not clear if this comment refers to methane production at each well or the amount of methane extracted from each well. In the first case, the premise of the TCRA was that methane was produced from within the landfill material and not at the wells. No waste was encountered during installation of the extraction wells. In the latter case, extraction rates measure removal of existing methane from past production, but do not measure the production of methane within waste. During active extraction, extraction rates were maintained between 20 and 70 cubic feet per minute and methane levels were monitored on a daily basis at a discrete point in time. However, methane levels dropped rapidly so production rates could not be measured. Additional information is provided on the Navy's website to allow interested parties to estimate the quantity of methane extracted from each well (http://www.efdsw.navfac.navy.mil/06/ indexHP.htm).

9. **Comment:** **Page 2, Attachment C, Extraction, Monitoring, and Maintenance Plan, Section 2.1: Gas Extraction System. Vapor pressure measurements in gas monitoring probes (GMPs) and in surrounding wells are proposed. Vapor pressures at operating extraction well(s) should also be measured.**

Response: The extraction units are equipped with vapor pressure gauges and recorded as part of the extraction maintenance and monitoring plan.

10. **Comment:** **Page 3, Attachment C, Extraction, Monitoring, and Maintenance Plan, Section 2.1: Gas Extraction System. Provide calculations for the predicted carbon vessel life. Include all assumptions made with regard to the composition and concentration of vapor, moisture content, anticipated flow rate, estimated retention time, etc.**

Response: Attachment B to this RTC contains a table that lists the influent compounds, which was provided to the vendor. This table was based on laboratory analytical data from the soil gas investigation. Attachment A to this RTC provides vendor calculations on the estimated life of the carbon.

11. **Comment:** **Page 4, Attachment C Extraction, Monitoring, and Maintenance Plan, Section 3.1: Initial Setup and Startup, Item 8. Error. The text says if no vacuum pressure is obtained at approximately 100 feet from the well/point then the flowrate will be increased in increments of 10 cfm to a maximum pressure of 50 cfm. However, 50 cfm is a flowrate--not a measure of pressure or vacuum. Please correct.**

Response: This comment is correct. The landfill gas removal action closeout report will reflect this fact.

12. **Comment:** **Page 10, Attachment C Extraction, Monitoring, and Maintenance Plan, Section 4.3. Analyses should be performed by a laboratory, which is California-certified to perform the analyses.**

Response: All samples are sent to Atmospheric Analysis & Consulting, Inc., which is a California-certified laboratory.

General Comments on the AM

1. **Comment:** **The purpose of the AM should be: 1) remove methane gas from the subsurface of the UCSF compound and other adjoining properties; 2) prevent future migration of methane; and 3) eliminate the potential for fire from methane.**

Response: The purpose of the AM is to document the Navy's decision to undergo a TCRA to remove methane gas from the subsurface near the Parcel E Industrial Landfill. The purpose of the TCRA is to (1) remove methane gas from the subsurface of the UCSF compound, which is the only off-site area where it has been discovered, and (2) prevent future migration of methane from the landfill. The TCRA will eliminate the potential for fire or explosion from the presence of methane in the subsurface at the UCSF compound and adjoining properties at concentrations greater than the lower explosive limit (LEL). The installation of the gas control system will prevent future migration of methane gas from the landfill.

2. **Comment:** **The potential for migration of LFG into buildings should be discussed for each building on adjacent property and for each building on Navy property adjacent to or overlying methane concentrations in excess of 5%. For example, discuss the heating, ventilation and air**

conditioning (HVAC) systems—especially, please note whether positive or negative air pressures exist interior to each building. Some buildings may need to be pressurized to prevent vapor intrusion. The adequacy of seals for penetrations through building pads and the parking lot should be discussed. The present use of each building should be described. Compliance with Title 27 requirements for buildings on adjacent properties should be explicitly discussed.

Response: The Navy investigated the potential for methane gas to migrate from the landfill into buildings during the Parcel E nonstandard data gaps investigation in accordance with the approved FSP/QAPP (Tetra Tech 2002a). Results of the investigation indicated that a significant level of methane was not present in any of the buildings surveyed. Results of this investigation, including the buildings and structures surveyed, are documented in the landfill gas technical memorandum (Tetra Tech 2002b). The Navy conducted additional monitoring that found no significant levels of methane present in any of the buildings surveyed. Title 27 of the CCR requires that a gas control system be installed to prevent levels of methane at or above the LEL at the landfill boundary. A control system that effectively prevents off-site gas migration will eliminate the need for additional engineering controls in buildings on adjacent property.

Specific Comments on the AM

1. **Comment:** **Page 2, Section II: Site Conditions and Background, Subsection A. Site Description, Subpart 1. Removal Site Evaluation. The document should summarize the following:**

   a) Cause(s) of methane migration,

   b) Depth of fill of the landfill,

   c) Concentrations and locations of the methane gas measurements (in ambient air, GMPs, etc.),

   d) Analyses performed on samples,

   e) Description of the of the landfill cap,

   f) Extent of the landfill cap vis a vis extent of the waste.

   Response: Section II of the AM provides a concise description of site conditions and background information pertinent to this TCRA. Section II.A.4, Page 3, discusses cause of methane migration; Section II.A.2, Page 2, discusses depth of fill; the landfill gas TM documents concentrations and locations of methane gas measurements (Tetra Tech 2002b), as referenced in the AM, Page 5; the landfill gas WP and TM provide information on sample analyses (ITSI 2002; Tetra Tech 2002b); the landfill gas WP describes the landfill cap (ITSI 2002); and Figures 1 through 4 of the AM show the extent of the landfill cap and waste.

2. **Comment:** **Page 3, Section 4: Release. The text says that the paving on the UCSF compound is a confining layer through which gases cannot easily dissipate. Please provide support for this statement. Paving is not always a sufficient confining layer for gas migration. Breaks or penetrations in paving may allow for air to be pulled into the subsurface resulting in dilution of chemical concentrations in soil gas, and potentially short-circuiting the extraction system (by creating a preferential pathway for air to enter). Has the paving been inspected for breaks and penetrations?**

Response: The Navy does not understand what the reviewer means by "sufficient" layer. The Navy inspected the pavement during the soil gas survey for penetration and cracks and concluded that the pavement at this site is in good shape and does provide a confining layer over the granular soils beneath the pavement. The Navy believes that the pavement, along with the shallow bedrock to the north, has prevented methane that was generated in the landfill from dissipating to some extent. Methane has not extended very far past the edge of waste on other areas of the landfill. While this is only a theory, it is relevant to the TCRA because it explains why methane may have traveled this far from the edge of waste and is not expected to be generated within the UCSF compound. If correct, operation of the extraction system and subsequent monitoring will verify this theory.

The extraction system exists in areas that are both paved and unpaved, and the existence of pavement was considered to assist, but was not relied on, in the system design. The entire system was designed using a 60-foot ROI, which was considered to be conservative based on soil data collected during the soil gas survey. Subsequent data from the system operation (EX-1) indicate an ROI in unpaved areas larger than 100 feet in diameter. This ROI is expected to be greater in paved areas, but is not necessary for successful operation of the system. Rapid depletion of methane in the GMPs located within the UCSF compound indicates that the system operated as expected during the first round of extraction.

3. **Comment:** **Page 3, Section 4: Release. The text says that "trace organics gases" detected in the landfill gas will be addressed in the future in the revised Parcel E RI. It is not appropriate to relegate some compounds to a future action. All compounds detected should be identified and the RA should be designed to address/treat all compounds at this time.**

Response: The Navy disagrees with this comment. The purpose of the TCRA is to eliminate an immediate hazard, as required by Title 27 of the CCR, by reducing the potential for fire or explosion resulting from elevated methane concentrations detected in the subsurface at off-site locations. Trace organics were identified during the landfill gas investigation; however, this investigation was not designed to evaluate the extent or source of these organics because groundwater samples were not collected. Table 2 of the AM provides the concentrations of trace organics detected in the soil vapor. These organics do not pose an immediate threat, and the Navy does not believe that is it prudent to design a system to address the organics until they have been better characterized and the level of risk to human health and the environment can be determined.

The landfill gas control system was designed to remove these organics from the extracted air stream to eliminate any potential exposure from air emissions. The system may remove some or all of the organics in the soil vapor, but it was not specifically designed for that purpose. Operational monitoring may provide additional insight into the quantity and location of sources (if any) located on the UCSF compound.

4. **Comment:** **Page 4, Section 2: Current Actions. How will occupants of Building 830 (or other buildings) be alerted if detection at or above 25% of the LEL for methane is measured?**

Response: The Navy is in direct contact with UCSF facility manager, Bob Cotter. Mr. Cotter is continually kept up to date with site activities and would be immediately alerted.

5. **Comment:** **Page 5, Section IV: Endangerment Determination. Ambient air, soil gas, monitoring well, and GMP measurements indicate that an immediate threat to public health, welfare or the environment exists. However, all relevant data has not been included in this AM. For example, ambient air data has not been included. Please summarize all data collected. Include map(s) with sampling locations and concentrations. With respect to all site data, average values are not sufficient to demonstrate the actual threat: please include point measurements.**

Response: The purpose of the AM is to document for the Administrative Record the Navy's decision to undergo a TCRA. Although the AM summarizes the landfill gas investigation, it is not intended to restate all of the data collected. As referenced in the AM, Page 5, the landfill gas TM presents all of the data collected during the landfill gas investigation (Tetra Tech 2002b). Data collected after the TM was completed will be presented in the revised remedial investigation report for Parcel E.

6. **Comment:** **Page 6, Section V: Proposed Actions and Estimated Costs (Subsection A), Proposed Action (Subsection 1), Proposed Action Description. When Title 27 requirements are met (less than 5 percent methane) on the UCSF compound, the Navy intends to terminate the RA. What contingencies are planned if this goal is not achieved?**

Response: As shown on Figure 3, Closure Criteria Flowchart, in Attachment C, Extraction, Monitoring, and Maintenance Plan, to the project WP (ITSI 2002), if the goal is not met, the system design will be reevaluated to determine a remedy that may include modifications in the extraction process, well spacings, or well locations.

7. **Comment:** **What criteria were used to determine the number and locations of gas extraction wells and monitoring wells? Please provide supporting documentation to demonstrate that the number and the locations are appropriate with respect to site stratigraphy (e.g. location and extent of permeable zones) and the site conceptual model (e.g., air permeability, radius of influence, etc.).**

Response: Soil under the UCSF compound is primarily fill and is heterogeneous across the site, so a normal stratigraphy is not applicable. However, most of the UCSF compound is covered by concrete, which makes a very effective surface seal and prevents infiltration of air into the soil. Under such conditions, a vacuum induced at a wellhead can spread over 200 feet through moderately permeable soil, such as exists at the site. The UCSF compound is about 775 feet in length, which would require a minimum of two to four gas extraction wells, depending on the amount of overlap allowed for each well's radius of influence. At active landfills, gas extraction wells are typically spaced 250 to 300 feet apart, once a low-permeability cover is placed at the surface. However, because of the heterogeneity at the site and to ensure rapid removal of all methane gas, the Navy designed the extraction system with a much tighter well spacing, using 10 wells that have significant overlap of extraction zones of influence. The design of this system was planned to remove most methane gas with two passes of the vacuum/treatment system and ensure that the methane concentration would be below 5 percent (by volume) LEL within four passes of the vacuum/treatment system. Operational monitoring has verified these assumptions made during design of the system.

8. **Comment:** **Provide further details regarding the integrity of the Gundwall sealant. How will the wall be tested to confirm that there are no breaches, especially at panel joints?**

Response: Attachment A, Drawings and Specifications References, to the project WP includes the technical specifications for the HDPE liner (Technical Specification Section 02800) (ITSI 2002). The Navy is monitoring the passive vents on the landfill side of the barrier and the GMPs immediately on the other side of the wall. Methane levels ranging from 10 to 40 percent have been recorded in the passive vents, while very low levels have been recorded in the GMPs. So far, the levels have not rebounded within the GMPs, which indicates that the wall is operating as expected.

Recommendations

1. Comment: **Sampling in addition to that shown on Figure 3 of the WP may be requested by DTSC. Long term monitoring will be required until the final remedy for the landfill is implemented. Analyses should include the following.**

   a) **Method TO 14A for volatile organic compounds (VOCs),**

   b) **Method TO-3 for methane,**

   c) **California Air Resources Board (CARB) Method 14/15 for total non-methane**

   d) **organic compounds (NMOCs), fixed and biogenic gases data obtained using**

   e) **a Thermal-Conductivity Detector,**

   f) **USEPA Method 23 or CARB Method 428 for Dioxin/Furan sample with analysis by high resolution GC/MS (USEPA Method 8290).**

   Response: EPA Methods TO-14A and TM-3 are already included in the sampling. A long-term O&M and monitoring plan will be developed as part of the final remedy for the site. The Navy is presently monitoring the passive vents on the landfill and UCSF sides of the wall. Monitoring will continue on a quarterly basis, after the TCRA is completed, using the protocols established in the FSP/QAPP (Tetra Tech 2002a), as long as no problems are detected. Quarterly monitoring will continue until the final monitoring plan is developed and implemented.

2. Comment: **Grading and Drainage. Grading will be extensive during the RA, with several consequences, as noted below.**

   a) **Shallow and surficial contaminants have been redistributed. So data gaps now exist with regard to the extent of shallow contamination. Spider maps should be updated with new data and revised to distinguish areas affected by grading. That is, results for soils moved or removed should be distinguished from those still in place.**

b) Over a portion of the graded area, BART soil has been used as surface cover. Please provide results of chemical analyses for BART soil. The extent and depths of BART surface cover should be indicated on figures.

c) Please provide any engineering soils data for the BART cover soil, particularly hydraulic and air permeability. Titles 22 and 27 require cover materials over waste must have hydraulic permeability of at least 1 x 10^{-8} cm/sec.

d) In other areas, BART soil has not been used as a surface cover, bare soil is exposed, and the nature and extent of surface contamination is now unknown. Moreover, surface soil may contain significant contamination, based on data from the remedial investigation (RI).

e) The Gundwall has been installed in a topographic low. Drainage from the landfill may collect in the area of the Gundwall. How will surface ponding etc. effect the operation of the Gundwall? Drainage volumes should be provided, including volumes for a 100-year storm. Is the drainage system sufficient for the 100-year storm?

f) Surface runoff will be drained partly to a storm water system and partly to an unlined drainage ditch on the western property boundary. Estimate volumes expected for each diversion of the drainage. Runoff patterns should be shown on a figure. Runoff may carry contaminants from uncovered areas into the drainage ditch and subsequently to the wetlands areas southwest of IR01/21 (the major landfill area).

g) Waste characterization results for soils disposed should be provided.

Response: The following responses address recommendation 2 in respective order of the lettered items:

a.) Soil samples were collected from excavated soil during the pretrenching activity for off-site disposal. The landfill gas removal action closeout report will provide the analytical results for these samples. In addition, soil samples were collected during the nonstandard data gaps investigation of lateral extent activity. These data will be incorporated into the remedial investigation for the landfill and assessed as part of the feasibility study for Installation Restoration Site 01/21.

b.) Design drawings C-1 through C-3 in Attachment A of the project WP indicate areas where fill material by Bay Area Rapid Transit (BART) soil is required (ITSI 2002). The forthcoming landfill gas removal action closeout report will provide construction details, including as-built survey data with final topography, to confirm fill areas.

c.) The areas covered with BART soil were filled as part of the grading plan to allow storm water runoff, prevent storm water ponding, and allow access for monitoring and maintenance. The placed soil was not intended as part of a Title 27 landfill cover, so the permeability requirement is not relevant.

d.) Except for surface debris removal consisting of concrete and wood, the TCRA did not alter surface ground cover except where fill material was specified for grading purposes. "Exposed" surface soil that was not covered as part of the grading activities has been assessed under the standard gaps investigation (Tetra Tech 2002c).

e.) Water will not collect on any area of the Gundwall. The area was graded to provide drainage for a 100-year, 24-hour storm and to prevent standing water. Water contacting the Gundwall, from storm water or elsewhere, will have the effect of further hydrating the elastomeric seal. Drainage patterns have not been significantly altered, but drainage has been enhanced on the western side to prevent ponding. The existing ditch on the western side of the site that accepts drainage has not been altered and is more than sufficient for a 100-year storm. In addition, the Navy installed a pipe to allow drainage from the UCSF compound. Complete drainage calculations will be performed when the Navy proposes the final site remedy.

f.) The storm water discharge management plan addresses potential issues and provides a management plan, which includes new drainage resulting from this TCRA (Tetra Tech 2003).

g.) Waste characterization data will be provided in the forthcoming landfill gas removal action closeout report.

3. **Comment:** **All documents should comply with the Business and Professions Code Section 6735. The code states that all engineering documents (which would include both the AM and the WP) must be signed by a California Registered Professional Engineer. The registered professional, by signing and providing his or her registration number, takes responsibility for the engineering design contents of the report or design document. Professional engineering work involving the exercise of discretion and independent professional judgment is required to be conducted under the responsible charge of a professional engineer registered in the appropriate branch of engineering. Final design drawings and plans require a signature and seal or stamp, date of signing and sealing or stamping, and the expiration date of the certificate or authority by a California Registered Professional Engineer.**

Response: The comment is noted.

RESPONSES TO COMMENTS FROM CIWMB

Comments on the AM

1. **Comment:** **Page 1: It is stated that one of the purposes of installing the landfill gas control system is to "prevent future migration of methane gas onto the USCF compound".**

   We recommend that the primary purpose of this system should be to control offsite migration of landfill gas from the Navy's landfill to all adjacent properties, not just the UCSF property. (As previously stated in our May 7, 2002 letter to DTSC - 2nd paragraph)

   Response: During the nonstandard data gaps investigation conducted at Parcel E in Spring 2002 (Tetra Tech 2002a), the Navy conducted a soil gas survey to characterize and delineate the extent of landfill gas in the vicinity of the Parcel E landfill. The investigation was conducted on all adjacent off-site properties except for the property adjacent to the north-northwest boundary of Parcel E (Lowpensky Property). Access to the Lowpensky Property was denied by the property owner. The results of the soil gas survey indicated that methane was present in the subsurface at the UCSF compound at potentially hazardous levels. As a result, the TCRA was specifically targeted to reduce the potential threat of fire or explosion, which may be caused by high methane concentrations detected at the UCSF compound. However, because the HDPE liner (barrier wall) and passive gas vent were installed along the northern edge of landfill in all areas that gas was detected, future migration from the landfill is not expected. The soil gas extraction wells were designed and located within the UCSF compound (EX1 through EX9) and the railroad museum property (EX10) based on an assumed ROI of 60 feet. Current monitoring data have shown that the ROI for each extraction well is greater than 60 feet in all wells and up to 120 feet on the western portion of the UCSF compound. The location of EX-1 allows methane to be extracted from up to 100 feet within the Lowpensky property. Data collected to date indicate that the system is successfully reducing methane concentrations beneath the UCSF compound. In addition, future data collected from existing GMPs located near each end of the barrier should provide early detection if the present gas flow patterns change.

2. **Comment:** **Page 1: It is also stated that the proposed removal action will eliminate the potential for fire from methane gas at the UCSF compound.**

We suggest once again, that the Navy should be concerned with the potential for subsurface landfill fire on their own parcel. The chance of a subsurface fire at the USCF compound is very low due to either the lack of waste or the inert waste deposited there.

Response: The purpose of the TCRA is to eliminate concentrations of gas above the LEL in off-site areas where it is discovered. The Navy agrees that the potential for off-site fire caused by methane is very low, particularly in the subsurface. However, methane was detected over 100 percent of the LEL at one location within the UCSF compound, in ambient air near the base of a light pole. The Navy felt that this detection provided sufficient reason to warrant the TCRA to eliminate any potential for off-site migration. This response action will not introduce air into the landfill waste and will not increase the risk of fire within the landfill. A greater threat to health and safety would exist if methane were to remain in place, increasing the possibility that it would accumulate in a structure with the potential to explode or cause asphyxiation.

3. **Comment:** **<u>Page 6:</u> Last paragraph from "Proposed Action Description" from page 5 – the report states that "...extraction system will operate until methane levels within the UCSF compound can be maintained below 5%...........".**

Please note that our standards contained in Title 27 CCR is 5% methane by volume at the property boundary and 1.25% methane by volume in on site structures. Cessation of the system should only occur if there is no longer a threat from the landfill gas.

Response: The comment is noted. The landfill gas extraction system will operate until methane levels are below 5 percent at the UCSF compound, as monitored at the perimeter by GMPs. At that time, a threat of fire or explosion from subsurface landfill gas at the UCSF compound or at the landfill boundary will no longer exist. As stated in the response to CIWMB comment 1 on the AM, a barrier wall and passive vent system have been installed along the northern edge of landfill waste to prevent future migration of gas from the landfill. After the TCRA is completed, the Navy will continue monitoring to ensure that rebound of methane within the area and at the perimeter GMPs and in on-site structures does not occur.

4. **Comment:** **<u>Page 6:</u> "No-Action Alternative" – the report states that "..................potential hazard was deemed unacceptable by state authorities as expressed in a letter from CIWMB on May 7, 2002......".**

To clarify, what that letter stated was the fact that the Navy should keep their landfill gas from migrating offsite. In fact the letter states

that "....it appears that a landfill gas control system is necessary to address the migration of landfill gas *from the Parcel "E" Landfill.*

Response: The comment is noted.

Comments on the Project WP

1. **Comment:** **<u>Page 7:</u> "Gas Monitoring Probes" – When will these probes be installed?**

   Response: GMP01A through GMP08A were installed on September 12, 2002, and GMP11A, GMP05B, and GMP06B were installed on November 25, 2002.

General Comments

1. **Comment:** **The work that is done at the site to remedy the gas issues should be in compliance with appropriate sections of Title 27 CCR.**

   Response: The gas control system complies with the substantive requirements of Title 27 of the CCR.

2. **Comment:** **The installation of the impermeable layer should have considered historical low ground water.**

   Response: The design of the barrier wall considered historical low groundwater levels. The HDPE barrier was installed a minimum of 2 feet below the historical low groundwater levels.

3. **Comment:** **Gas monitoring probes should be installed at appropriate locations and at appropriate depth to determine the functional adequacy of the landfill gas system.**

   Response: GMPs were installed in appropriate locations to evaluate the functionality of the gas barrier and gas extraction systems. Additional GMPs were installed along Crisp Avenue to ensure that gas has not migrated that far. No methane has been detected in GMPs along Crisp Avenue.

4. **Comment:** **Our concern, as expressed previously, is for the opportunity of a subsurface fire to occur *at the landfill.* We are concerned that the operation of the landfill gas extraction system can result in air entering the landfill. Overdrawing extraction wells especially those installed near the perimeter and in areas with no waste could create a situation where air can be drawn into the refuse mass. Furthermore,**

excessive gas extraction caused by an improperly operated or balanced gas extraction system can also cause air intrusion.

Response: The Navy believes that this concern is unwarranted. The HPDE barrier, which was installed between the extraction wells and the waste, will effectively prevent air from being drawn into the landfill mass. The extraction well ROI does not extend past either end of the wall, and groundwater will prevent air from moving under the wall. To date, results of operational monitoring have verified this assumption.

5. **Comment:** **Furthermore, please note that installation of either an active or a passive system or a combination thereof at the site to remedy the gas problems will not be a guarantee that landfill gas will stop migrating offsite. It may take from a few months to a few years for systems to function adequately in bringing the gas concentration within the regulatory threshold by preventing gas from migrating offsite.**

Response: Ongoing monitoring shows that the extraction system has already removed methane levels to below regulatory thresholds in all areas of the site. Weekly monitoring reports are available on the Navy's website (http://www.efdsw.navfac.navy.mil/06/ indexHP.htm). Results of the TCRA will be further detailed in the forthcoming landfill gas removal action closeout report.

RESPONSES TO COMMENTS FROM RWQCB

General Comments

1. **Comment:** **Review of the subject documents indicates that the specific requirements for landfill gas monitoring of structures and the area within 1000 feet of the landfill perimeter boundary found in California Code of Regulations (CCR) Title 27 were not considered for this removal action. Although RWQCB staff understand that this work was of an emergency nature, we recommend that the post-closure maintenance and monitoring requirements specified in Title 27 should be incorporated into future monitoring activities as these requirements are considered a standard practice of care for the protection of the health and safety of inhabitants of parcels on and adjacent to closed landfills. RWQCB staff expects in the future to see CCR Title 27 used as an ARAR, as we believe that this regulation is relevant and appropriate.**

Response: Buildings and other structures containing subsurface voids surrounding the landfill were monitored during the initial soil gas survey, including basements, sewers, and vaults. Methane was not detected in any significant quantities at these locations. A long-term monitoring plan will be developed as a part of the remedy. Recommendations for that monitoring plan are noted, and it is the Navy's intent to comply with the relevant portions of Title 27 of the CCR.

2. **Comment:** **Review of the subject documents and observations made during site visits conducted by Board staff on October 21 and October 31, 2002 indicates that newly graded areas including drainage ditches and sloped areas were comprised of loose fresh soils that would likely not be retained on-site during a severe rainfall event. Board staff learned that a Construction Stormwater Pollution Prevention Plan (CSWPPP) was not obtained nor were "best mangement practices" for erosion control implemented during the removal action. Appropriate erosion control measures should be implemented in this area prior to the winter rains. All future activities at the HPSY, including "time-critical removal actions" shall include a CSWPPP that incorporates best management practices" for erosion control. In addition, long-term monitoring of stormwater on the landfill area shall be included either in a facility-wide or landfill-specific SWPPP. Please provide Board staff with written documentation that appropriate erosion control measures have been taken on the landfill, including the area of the subject removal action. In addition, please provide a copy of any current SWPPP or any other document that incorporates stormwater protection measures that may be in place for any portion of the facility (all Parcels). Board staff asked for this information after the October 21, 2002 site visit and has still not received it.**

Response: At the time of the TCRA, a construction permit was required for construction areas that were 5 acres or larger. This construction project encompassed less than 5 acres, so the construction permit was not required; however, best management practices (BMP) have been established at the site and were in place before initial winter rains. The BMPs presently employed include seeding and vegetation of the disturbed areas to prevent erosion and silt fences and hay bales to prevent sediment transport from the area.

The Navy has prepared and submitted an SWDMP for the entire landfill to the RWQCB (Tetra Tech 2003). This plan is in compliance with the overall base SWDMP.

REFERENCES

Innovative Technical Solutions, Inc. (ITSI). 2002. "Time-Critical Landfill Gas Removal Action Project Work Plan, Hunters Point Naval Shipyard, Parcel E, San Francisco, California." October.

Tetra Tech EM Inc. (Tetra Tech). 2002a. "Field Sampling Plan/Quality Assurance Project Plan for Parcel E Nonstandard Data Gaps Investigation (Industrial Landfill and Wetlands Delineation), Hunters Point Shipyard, San Francisco, California." January 8.

Tetra Tech. 2002b. "Landfill Gas Technical Memorandum, Parcel E Industrial Landfill, Hunters Point Shipyard, San Francisco, California." July 2.

Tetra Tech. 2002c. "Draft Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Parcel E Standard Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California." August 22.

Tetra Tech. 2003. "Final Storm Water Discharge Management Plan, IR-01/21, Industrial Landfill, Parcel E, Hunters Point Shipyard, San Francisco, California." June 12.

ATTACHMENT A
ATTACHMENTS FOR RESPONSES TO COMMENTS FROM U.S. ENVIRONMENTAL PROTECTION AGENCY

Table 4 Revised Sampling Quality Criteria

Calculations and Gas Phase Carbon Adsorbers

TABLE 4: REVISED SAMPLING QUALITY CRITERIA

Extraction, Monitoring, and Maintenance Plan, Landfill Gas Removal Action
Parcel E Industrial Landfill, Hunters Point Shipyard, San Francisco, California

Statement of Problem

The concentrations of methane and volatile organic compounds (VOC) in landfill gas at the site are needed to (1) monitor potential risks to human health near gas vents and release areas (open monitoring vents and fugitive emissions), (2) evaluate the effectiveness of the gas collection system to mitigate off-site migration of landfill gas, and (3) monitor the service life of the treatment system filters.

Required Decisions

- Does the methane concentration create a potential explosion hazard?
- Are VOCs (nonmethane organic compounds [NMOC]) being released to the work area at concentrations that create a potential risk to site workers?
- Is the gas collection system reducing the volume of off-site landfill gas?
- Are the treatment system filters still functioning and removing VOCs and NMOCs at design specifications, or do the filters need to be recharged or replaced?

Inputs to Decision Resolution

- Analytical results from gas monitoring probes (GMP) for methane concentrations and screening results for general NMOCs.
- Laboratory analytical results for VOCs when screening concentrations for general NMOC are equal to or above 5 parts per million by volume (ppmv) for organic vapors.

Study Boundary

- The immediate areas around the gas extraction and gas treatment systems and related connections to the gas extraction wells and passive gas vents.
- The immediate areas around the wellheads of the GMPs on the University of California, San Francisco (UCSF) compound. The GMPs should be sealed shut except during monitoring activities.

Decision Rules

- If concentrations of NMOCs after the Hydrosil vessel of a treatment unit exceed 5 ppmv, then the gas extraction system will be shut down and the Hydrosil filter will be replaced before the system is restarted.
- Breakthrough of a carbon vessel or the Hydrosil is assumed if (1) a steady observed increase is observed in vapor concentrations over 1 week or (2) concentrations of NMOCs increase suddenly. When breakthrough occurs in a carbon or Hydrosil vessel, the filter will be replaced.
- If concentrations of NMOCs after a carbon vessel (but before the next vessel in sequence) exceed 5 ppmv, then the treatment unit will be shut down and the carbon filter will be replaced before the system is restarted.
- If fugitive emissions about the extraction units, treatment units, or wellhead connections equal or exceed 5 ppmv, the leak is to be located, the system shut down, and repairs made before the system is restarted.
- If the methane concentration in fugitive emissions is within the explosive range, then immediate measures will be taken to mitigate risks, followed by steps to repair the system to prevent emissions.
- If landfill gas in an operating extraction well meets the completion criterion for an individual extraction event, then operators will move the extraction and treatment unit to the next extraction well.

TABLE 4: REVISED SAMPLING QUALITY CRITERIA (Continued)

Extraction, Monitoring, and Maintenance Plan, Landfill Gas Removal Action
Parcel E Industrial Landfill, Hunters Point Shipyard, San Francisco, California

Decision Rules (Continued)

- If landfill gas concentrations in all off-site GMPs and all extraction wells or all passive vents meet project completion criteria for the active portion of the project, then the operators will switch to the monitoring phase to ensure that the wells or vents do not experience a rebound of landfill gas. If a rebound occurs, the operators will return to the active extraction phase.
- If all gas and vapor concentrations meet project completion criteria in all GMPs in the UCSF compound and all extraction wells for both the 4-week and 4-month postoperation monitoring period, then the gas extraction wells can be plugged and abandoned and the UCSF GMPs will be incorporated into the regular gas monitoring program.
- If all gas and vapor concentrations meet project completion criteria in all GMPs on the landfill perimeter outside of the barrier wall and in all passive vents for both the 4-week and 4-month postoperation monitoring period, then the passive vents can be sealed shut or abandoned and regular gas monitoring will continue for the perimeter GMPs to the end of the postclosure care period.

Tolerable Limits on Decision Errors

- Site-specific sampling objectives and media being monitored negate the use of statistical methods because unit operations and potential exposure points define the specific sampling locations. Tolerable limits on decision errors cannot be precisely defined, because the project criteria precisely define action concentrations.

Optimization of Sampling Design

- Extraction systems will be monitored between the carbon vessels, between the carbon and Hydrosil vessels, after the Hydrosil vessel at the system effluent, and at hose connections to the wellhead and the extraction and treatment units.
- Influent gas concentrations will be monitored at the wellhead of the extraction wells and passive vents.
- Gas concentrations at GMPs will be monitored at the wellhead.

Carbonair Environmental Systems

2731 Nevada Ave N, New Hope, MN 55427 Phone: 800-526-4999 Fax: 763-544-2151

Customer:	Tetra Tech EM Inc.		
Site:	Hunters Point Shipyard		
Date:	7/18/02		
Design Basis:	Flow rate:	20	cfm
	Air temperature:	90	°F (after a heater)
	Relative humidity:	50	% (after a heater)
	Design compound:	Trans-1,2-DCE	
	Max influent conc.:	0.1	ug/l (20 ppbv)
	Average influent conc.:	0.01	ug/l (2 ppbv)

Recommendations: Two GPC3's in series, each with 200 lbs of carbon
(Both vessels are predicted to last 176 and 487 days at the maximum and average concentrations, respectively.)

Note: The following compounds will not be effectively removed by carbon adsorption: trichlorotrifluoroethane, dichlorotetrafluoroethane, 1,3-butadiene, acetone, bromomethane, carbon dioxide, carbon disulfide, chloroethane, chloromethane, dichlorodifluoromethane, ethanol, isopropyl alcohol, methane, methylene chloride, nitrogen, oxygen, propylene, THF, trichlorofluoromethane, and vinyl chloride.

Hydrosil HS-600 can be used to remove vinyl chloride, 1,3-butadiene and propylene. One GPC3 with 400 lbs of HS-600 is predicted to last 800 and 3,333 days at the maximum and average concentrations, respectively.

Carbonair Environmental Systems

2731 Nevada Ave N, New Hope, MN 55427 Phone: 800-526-4999 Fax: 763-544-2151

VAPOR-PHASE CARBON MODEL CALCULATIONS

Customer:	Tetra Tech EM Inc.		
Site:	Hunters Point Shipyard		
Date:	7/18/02		
Design Basis:	Flow rate:	20	cfm
	Air temperature:	90	°F
	Relative humidity:	50	%
	Design compound:	Trans-1,2-DCE	
	Expected conc.:	0.100	µg/L
	Model conc.:	4.300	µg/L
	Operating Press	760.000	mm mercury
	Vapor Press	438.150	mm mercury
	K value (µMOLE/GM)(L/µMOLE)**1/N		329.128
	1/N Value (Dimensionless)	0.725	
	Carbon Capacity	0.340	%
	Carbon Usage	2.268	lbs/day

Note: The model concentration results from the impact of the other background compounds, which is determined by using a competitive adsorption model.

µG = microgram
µMOLE = micromole

Disclaimer: Actual results may vary significantly from the model. The model is based on the assumptions that the flow rate and influent concentration are constant, and only the contaminants provided to Carbonair are present in the air. Varying operating conditions can have adverse effects on carbon adsorptive capacity. The predicted carbon usage rate is not guaranteed.

Carbonair Environmental Systems

2731 Nevada Ave N, New Hope, MN 55427 Phone: 800-526-4999 Fax: 763-544-2151

VAPOR-PHASE CARBON MODEL CALCULATIONS

Customer:	Tetra Tech EM Inc.		
Site:	Hunters Point Shipyard		
Date:	7/18/02		
Design Basis:	Flow rate:	20	cfm
	Air temperature:	90	°F
	Relative humidity:	50	%
	Design compound:	Trans-1,2-DCE	
	Expected conc.:	0.010	µg/L
	Model conc.:	0.050	µg/L
	Operating Press	760.000	mm mercury
	Vapor Press	438.150	mm mercury
	K value (µMOLE/GM)(L/µMOLE)**1/N		447.823
	1/N Value (Dimensionless)	0.790	
	Carbon Capacity	0.011	%
	Carbon Usage	0.821	lbs/day

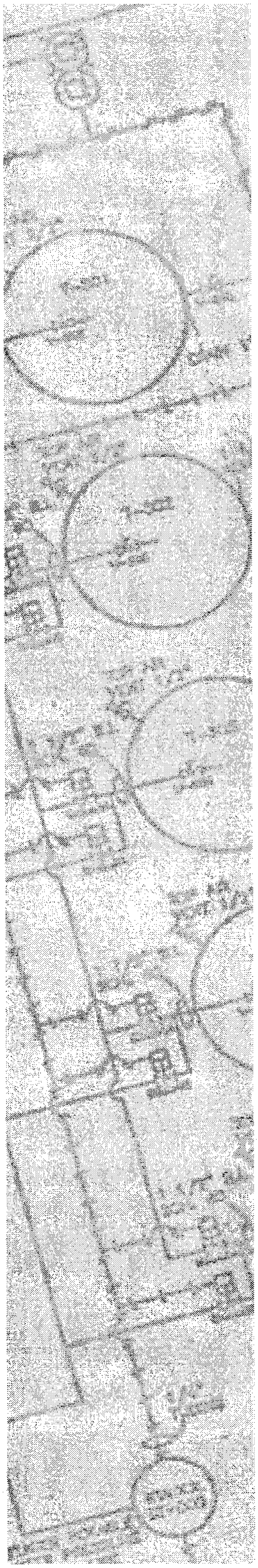
Note:

The model concentration results from the impact of the other background compounds, which is determined by using a competitive adsorption model.

µG = microgram
µMOLE = micromole

Disclaimer:

Actual results may vary significantly from the model. The model is based on the assumptions that the flow rate and influent concentration are constant, and only the contaminants provided to Carbonair are present in the air. Varying operating conditions can have adverse effects on carbon adsorptive capacity. The predicted carbon usage rate is not guaranteed.



Gas Phase Carbon Adsorbers

Carbonair's gas phase carbon adsorbers are designed to provide an efficient and economical means to control odor, toxic vapors and corrosive gases. Several types of activated carbons are available for a variety of applications.

Design

GPC 3 & 3H

- UN Standard 55-gallon steel drum
- Two 2" PVC connections (GPC 3)
- Two 4" PVC connections (GPC 3H)
- Baked enamel exterior
- Epoxy-phenolic interior lining
- Quick installation

Carbon Capacities: GPC 3 - 200 pounds
GPC 3H - 200 pounds

GPC 3.85

- UN Standard 85-gallon steel drum
- Two 4" PVC connections
- Baked enamel exterior
- Epoxy-phenolic interior lining
- PVC internals

Carbon Capacity: GPC 3.85 - 250 pounds

GPC 5R

- Welded steel round construction
- Two 4" NPT connections
- One ½" drain
- Fork tubes for easy lifting
- Bolt down lugs
- Polyamide epoxy/urethane interior & exterior finish
- Steel grate with stainless steel screen

Carbon Capacity: GPC 5R - 500 pounds

GPC 7R

- Welded steel roundconstruction
- Two 6⅝" nozzle connections
- Steel grate with stainless steel screen.
- Bolt down lugs
- Polyamide epoxy/urethane interior & exterior finish
- Fork tubes for easy lifting

Carbon Capacity: GPC 7R - 1000 pounds

GPC 13R, 20R & 28R

- Welded steel round construction
- Fork tubes for easy lifting
- One condensation drain
- Steel grate with stainless steel screen
- Polyamide epoxy/urethane interior & exterior finish
- Two 8⅝" nozzle connections

Carbon Capacities: GPC 13R - 1,500 pounds
GPC 20R - 2,000 pounds
GPC 28R - 3,000 pounds

GPC 50R

- Welded steel round construction
- Fork tubes for easy lifting
- Steel grate with stainless steel screen
- Two 12¾" nozzle connections
- Bolt down lugs
- Polyamide epoxy/urethane interior & exterior finish
- Two ½" drain/sample couplings

Carbon Capacity: GPC 50R - 5,000 pounds

GPC 70 & 120

- Welded steel rectangular construction
- Skid mounted with lifting lugs
- Polyamide epoxy/urethane interior & exterior finish
- Steel grate with stainless steel screen
- Four 12¾" inlet ports
- Two quick-disconnect off-gas ports
- Two sample ports
- One condensation drain

Carbon Capacities: GPC 70 - 10,000 pounds
GPC 120 - 13,600 pounds

Options

Sampling couplings and valves
Influent/effluent ducting
Humidity control
Discharge stack
Blowers
Controls

2731 Nevada Avenue North
New Hope, MN 55427
800-526-4999 *Toll-free*
763-544-2154 *Voice*
763-544-2151 *Fax*
www.carbonair.com

Specifications

Model	GPC 3	GPC 3H	GPC 3.85	GPC 5R	GPC 7R
Dimensions	24 1/2" OD x 36 1/2" H	24 1/2" OD x 36 1/2" H	28 1/2" OD x 38 1/2" H	30" OD x 5'8" H	3' OD x 7'2" H
Bed area	2.7 ft²	2.7 ft²	3.68 ft²	4.91 ft²	7.07 ft²
Flow range	20 - 100 cfm	20 - 270 cfm	36 - 360 cfm	40 - 380 cfm	76 - 500 cfm
Carbon capacity	200 pounds	200 pounds	250 pounds	500 pounds	1,000 pounds
Fittings	1 1/2" NPT PVC inlet and outlet ports	4" NPT PVC inlet and outlet ports	4" NPT PVC inlet and outlet ports	4 1/2" nozzle, (2) 1/2" half couplings, 30" access port	6 5/8" nozzle, (2) 1/2" half couplings, 24" access port
Empty weight	65 pounds	65 pounds	100 pounds	375 pounds	700 pounds
Operating weight	275 pounds	275 pounds	350 pounds	900 pounds	1,800 pounds
Inlet/Outlet nozzles	1 1/2"	4"	4"	4 1/2"	6 5/8"

Model	GPC 13R	GPC 20R	GPC 28R	GPC 50R	GPC 70	GPC 120
Dimensions	4' OD x 7'2" H	5' OD x 7'2" H	6' OD x 7'2" H	8' OD x 7'2" H	16'8 1/2" L x 5' W x 7'6" H	16'6" L x 8' W x 7' H
Bed area	12.57 ft²	19.63 ft²	28.27 ft²	50.27 ft²	69.80 ft²	120 ft²
Flow range	120 - 800 cfm	200 - 1800 cfm	240 - 2,200 cfm	480 - 4,000 cfm	700 - 7,000 cfm	200 - 12,000 cfm
Carbon capacity	1,500 pounds	2,000 pounds	3,000 pounds	5,000 pounds	10,000 pounds	13,600 pounds
Fittings	8 5/8" nozzle, (2) 1/2" half couplings, 24" access port	8 5/8" nozzle, (2) 1/2" half couplings, 24" access port	8 5/8" nozzle, (2) 1/2" half couplings, 24" access port	12 3/4" nozzle, (2) 1/2" half couplings, 24" access port	(4) 12 3/4" inlet nozzle, (2) 12 3/4" outlet nozzle, 1" condensate drain, (2) 3/4" half coupling, (2) 20" access ports	(4) 12 3/4" inlet nozzle, (2) 12 3/4" outlet nozzle, 1" condensate drain, (2) 3/4" half coupling, (2) 20" access ports
Empty weight	950 pounds	1,200 pounds	1,600 pounds	2,900 pounds	5,500 pounds	7,500 pounds
Operating weight	2,450 pounds	3,200 pounds	4,600 pounds	8,000 pounds	16,000 pounds	22,220 pounds
Inlet/Outlet nozzles	8 5/8"	8 5/8"	8 5/8"	12 3/4"	12 3/4"	12 3/4"

All specifications subject to change without notice.

ATTACHMENT B
ATTACHMENTS FOR RESPONSES TO COMMENTS FROM DEPARTMENT OF TOXIC SUBSTANCES CONTROL

Table B-1 Influent Compounds at IR-01/21 Industrial Landfill, Parcel E

Vertical Barrier Personal References

TABLE B-1: INFLUENT COMPOUNDS AT IR-01/21 INDUSTRIAL LANDFILL, PARCEL E
Hunters Point Shipyard, San Francisco, California

Compound	High Concentration	Average Concentration	Units	Carbon Effective (Yes/No)	Hydrosil Effective	California Air PRG*	Units	Average Concentration Exceeds PRG Without Treatment (Yes/No)	Average Concentration Exceeds PRG With Treatment (Yes/No)	NIOSH *10-Hour REL (ppb)	Comments
1,1,1-Trichloroethane	7	1	ppbv	Yes		180.21	ppbv	No	No		
1,1,2-Trichloro-1,2,2-trifluoro	1		ppbv	No		397.67	ppbv	No	No		
1,1,2-Trichloroethane	1		ppbv	Yes		0.02	ppbv	No	No		
1,1-Dichloroethane	35		ppbv	Yes		0.29	ppbv	No	No		
1,2,4-Trichlorobenzene	325	5	ppbv	Yes		27.83	ppbv	No	No		
1,2,4-Trimethylbenzene	5,500	200	ppbv	Yes		1.24	ppbv	Yes	No	25,000	NIOSH
1,2-Dibromomethane	2		ppbv	Yes		NA	ppbv	No	No		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	150	75	ppbv	No		NA	ppbv	No	No		
1,2-Dichlorobenzene	85	2	ppbv	Yes		34.34	ppbv	No	No		
1,2-Dichloroethane	6		ppbv	Yes		0.02	ppbv	No	No		
1,2-Dichloropropane	1.2		ppbv	Yes		0.02	ppbv	No	No		
1,3,5-Trimethylbenzene	3,600	100	ppbv	Yes		1.24	ppbv	Yes	No	25,000	NIOSH
1,3-Butadiene	8	2	ppbv	No	Yes	0.0016	ppbv	Yes	No	1,000,000	OSHA
1,2-Dichlorobenzene	35	5	ppbv	Yes		0.54	ppbv	Yes	No	50,000	CEILING
1,4-Dichlorobenzene	120	10	ppbv	Yes		0.05	ppbv	Yes	No	75,000	OSHA
2-Butanone	60	5	ppbv	Yes		333.43	ppbv	No	No		
2-Hexanone	10	1	ppbv	Yes		NA	ppbv	No	No		
4-Ethyltoluene	2,100	25	ppbv	Yes		NA	ppbv	No	No		
4-Methyl-2-pentanone	180	1	ppbv	Yes		19.91	ppbv	No	No		
Acetone	1,800	150	ppbv	No		153.09	ppbv	No	No		
Acrylonitrile**	NA	NA	ppbv			2.10	μ/m^3			1,000	
Benzene	235	50	ppbv	Yes		0.08	ppbv	Yes	No	100	NIOSH
Bromomethane	5		ppbv	No		0.16	ppbv	No	No		
Carbon dioxide	30	15	%	No		NA	%	No	No		
Carbon disulfide	150	5	ppbv	No		230.61	ppbv	No	No		
Carbon tetrachloride	100		ppbv	Yes		0.02	ppbv	No	No		
Chlorobenzene	385	75	ppbv	Yes		13.24	ppbv	Yes	No	2,000	(15-Minute Exposure, 10,000 OSHA)
Chlorodane**	NA	NA	ppbv			0.73	μ/m^3			500	μ/m^3 NIOSH
Chloroethane	425	75	ppbv	No		0.86	ppbv	Yes	Yes	1,000,000	(OSHA)
Chloroform	7	1	ppbv	Yes		0.02	ppbv	Yes	No	2,000	15-Minute Exposure, OSHA Ceiling equals 15,000
Chloromethane	120	10	ppbv	No		0.52	ppbv	Yes	Yes	100,000	OSHA
cis-1,2-Dichloroethene	20	1	ppbv	Yes		9.18	ppbv	No	No		
Cyclohexane	600	100	ppbv	Yes		5995.72	ppbv	No	No		
Dichlorodifluoromethane	250	50	ppbv	No		41.76	ppbv	Yes	Yes	1,000,000	NIOSH
Ethanol	260	25	ppbv	No		NA	ppbv	No	No		
Ethylbenzene	6,400	100	ppbv	Yes		249.00	ppbv	No	No		
Heptane	550	100	ppbv	Yes		NA	ppbv	No	No		
Hexachlorobutadiene	45	1	ppbv	Yes		0.008	ppbv	Yes	No	20	NIOSH
Hexane	1,000	200	ppbv	Yes		58.57	ppbv	No	No		
Isopropyl Alcohol	230	5	ppbv	No		NA	ppbv	No	No		
M,P-Xylenes	13,000	200	ppbv	Yes		165.25	ppbv	Yes	No	100,000	NIOSH

TABLE B-1: INFLUENT COMPOUNDS AT IR-01/21 INDUSTRIAL LANDFILL, PARCEL E (Continued)

Hunters Point Shipyard, San Francisco, California

Compound	High Concentration	Average Concentration	Units	Carbon Effective (Yes/No)	Hydrosil Effective	California Air PRG*	Units	Average Concentration Exceeds PRG Without Treatment (Yes/No)	Average Concentration Exceeds PRG With Treatment (Yes/No)	NIOSH *10-Hour REL (ppb)	Comments
Methane	720,000	400,000	ppmv	No		NA	ppmv	No	No		
Methane	75	40	%	No		NA	%	No	No		
Methylene chloride	120	10	ppbv	No		1.16	ppbv	Yes	Yes	25,000	OSHA
Nitrogen	90	78	%	No		NA	%	No	No		
NMOC	220 (SG05B)	80	ppmv			NA	ppmv	No	No		
Oxygen	20	19	%	No		NA	%	No	No		
O-Xylene	8,400	200	ppbv	Yes		165.25	ppbv	Yes	No	100,000	NIOSH
PCBs**	NA	NA	ppbv	Yes		0.0034	μ/m^3	No			The carbon will filter the solids
Polypropylene**	NA	NA	ppbv			NA	ppbv				No PRG or REL
Propylene	2,100	500	ppbv	No	Yes	NA	ppbv	No	No		
Radon**	NA	NA	ppbv			NA	ppbv				
Styrene	6	1	ppbv	Yes		253.78	ppbv	No	No		
t-1,2-Dichloroethylene	20	2	ppbv	Yes		18.09	ppbv	No	No		
t-1,3-Dichloropropene	20		ppbv	Yes		0.10	ppbv	No	No		
Tetrachloroethylene	30	5	ppbv	Yes		0.05	ppbv	Yes	No	100,000	OSHA
Tetrahydrofuran	5	1	ppbv	No		0.33	ppbv	Yes	Yes	200,000	NIOSH
Toluene	3,300	25	ppbv	Yes		104.41	ppbv	No	No		
Trichloroethene	10	2	ppbv	Yes		0.20	ppbv	Yes	No	100,000	OSHA
Trichlorofluoromethane	3		ppbv	No		127.72	ppbv	No	No		
Vinyl chloride	110	15	ppbv	No	Yes	0.08	ppbv	Yes	No	1,000	OSHA

Notes

*	NA is listed for compounds with no PRG
**	No analysis for this compound was performed during initial TO-14 testing
CA	California
NIOSH	National Institute for Occupational Safety and Health
NMOC	Nonmethane organic compound
OSHA	Occupational Safety and Health Administration
PCB	Polychloriated biphenyl
ppb	Parts per billion
ppbv	Parts per billion volume
ppmv	Parts per million volume
PRG	Preliminary remediation goal
REL	NIOSH-recommended exposure limit based on 10-hour/day during a 40-hour work week. (Source: *NIOSH Pocket Guide to Hazardous Chemicals*)

VERTICAL BARRIER PERSONAL REFERENCES

Project	Square Footage	Contact
Reach 11 Dike Modification Phoenix, AZ CurtainWall®	3,000,000	Gary Wilson Barnard Construction Bozeman, MT (406) 586-1995
Shell Bulk Storage Terminal East Chicago, IN GundWall®	3,983	Tim Franceschini Shell Oil Company Houston, TX (713) 241-6037
Greenfield Landfill Massachusetts GundWall®	39,039	Fritz Achhorner Slurry Walls, Inc. Irving, TX (214) 717-6505
Rhom Tech Massachusetts GundWall®	4,000	Glen Gordon Metcalf & Eddy Wakefield, MA (617) 246-5200
ITT Rayonier Pulp & Paper Mill Florida GundWall®	25,000	Roberta Caviness ITT Rayonier Fernandina Beach, FL (904)261-3611
AT & SF Railways Iowa GundWall®	3,900	Jeff Brown Radian Corp. Milwaukee, (414) 643-2695
Sun Oil Pennsylvania CurtainWall®	19,000	Peter Nicholson GEO-CON Monroeville, PA (412) 856-7700
Unocal Lease California GundWall®	21,648	Brad Williams Granite Construction Watsonville, CA (408) 763-6130
Contaminated Site Missouri GundWall®	2,800	Ken Wilson K. R. Wilson Company Sullivan, MO (573) 468-5161
Storage Terminal California Gund Wall®	4,730	George Drew Soils Engineering Cnstr. Redwood City, CA (415) 367-9595

GSE Vertical Barrier Installation List

Year	Product	Project	Location	Contractor	Area (sf)	Depth (ft)
1980	CW	Arab Potash Co. Soil Stabilization	Jordan	Winpey Geotech	1,398,800	23
1985	CW	Leachate Barrier	Sprendingen FRG	Zueblin, AG	53,792	56
1985	GL	Zwaanhals	Rotterdam NL	Cofra	646	7
1985	GL	Total Station	Rotterdam NL	Cofra	4,521	10
1985	GL	Vogermeerpolder	Amsterdam NL	Cofra	753	49
1985	GL	Contaminated Site	Bork NL	Stade	10,011	10
1985	GL	Bell Foundry	Heiligerlee B	Cofra	5,920	13
1985	GL	Test Project	Wesel D	Wayss & Fretag	4,413	98
1985	GL	Vierhavenstraat	Rotterdam NL	Cofra	2,691	13
1985	GL	Melanchtonweg	Rotterdam NL	Cofra	2,045	13
1985	GL	Chemical Plant	Marschacht NL	Stade	7,965	13
1988	CW	Deutsche Bundesbahn Leachate Barrier	Bruchsaal FRG	Zueblin, AG	118,342	66
1988	CW	Arlington Development Gas Barrier	Portsmouth UK	Sir Robert McAlpine	17,213	16
1988	CW	Senesi Landfill Gas Barrier	Senesi I	Rodio Spa	3,228	33
1988	GL	Castle Peak	Hong Kong	Bachy	43,056	13
1988	GL	Kralingen	Rotterdam NL	Cofra	753	7
1988	GL	Landfill de Heining	Amsterdam NL	Cofra	2,691	16
1988	GL	Landfill	Belfast IR	GSE / UK/Cofra	72,119	26
1988	GL	Gas Plant	Dordrecht NL	Cofra	16,899	30
1988	GL	Contaminated Site	Randers DK	Per Aarsleff	8,934	20
1988	CW	Mobay Chemical Plant	Texas	Force Corp	2,100	15
1988	CW	Charles River Pollution Control Trench	Massachussets	U.S. Navy	10,000	10
1989	CW	Cavenham Forest Products Site	Alabama	GIT/Merit	68,000	66
1989	CW	Gulf Coast Refinery Hydrocarbon Recovery	Texas	GEO-CON	18,000	15
1989	CW	Mobay Chemical Plant	Texas	Force Corp	3,600	20
1989	CW	Ministry of Defense Gas Barrier	Nottingham UK	GKN - Keller	6,983	16
1989	CW	Rochdale MBC Landfill Gas Barrier	Rochdale UK	Breinreith Devl. Ltd.	2,152	16
1989	CW	Stratford District Council	Stratford-on-Avon UK	GKN - Colcrete	6,455	13
1989	CW	Streetley Brick & Tile	Wellington UK	Breinreith Devl. Ltd.	2,152	7
1989	GL	Chemical Factory	Savona I	Acna	109,900	39
1989	GL	Contaminated Site	Saijo City JPN	Taiyo	68,890	39
1989	GL	Contaminated Site	Oleggio I	Carpi	12,917	39
1989	GL	Contaminated Site	Hokkaido JPN	Taiyo	2,583	16
1989	GL	Contaminated Site	Hiroshima JPN	Taiyo	52,744	46
1990	CW	Walsall MBC Landfill Gas Barrier	Walsall UK	Kinmanin Constr.	7,531	16
1990	CW	Burningham Landfill Gas Barrier	Birmingham UK	Fairclough	32,275	33
1990	CW	Wrekin Council Lanfill Gas Barrier	Telford UK	Wrekin DC	15,062	13
1990	GL	Contaminated Site	Rotterdam NL	Mourik	4,198	66
1990	GL	Contaminate Site	Amsterdam NL	Cofra	7,427	10
1990	GL	Landfill	Kazo City JPN	Taiyo	5,382	13
1990	GL	Aquaduct	Grouw NL	Bachy	84,820	112
1990	GL	Permanent Dewatering for Highway	Best NL	NGT	215,280	89
1990	GL	Contaminated Site	Amsterdam NL	Cofra	2,799	26
1990	GL	Contaminated Site	Rotterdam NL	Cofra	4,682	13
1990	GL	Contaminated Site	Sydney, Australia	Klika	7,965	13
1990	GL	Contaminated Site	JPN	Taiyo	53,820	39
1990	GL	Contaminated Site	Pori SF	Kaitos	72,119	23
1990	GL	Dam	Trento I	Italdreni	11,087	33
1990	GL	Gas Plant	Genova I	Italdreni	13,240	13
1990	GL	DSM "Katberging"	Geleen NL	NGT	96,966	82
1990	GL	Contaminated Site	Uusikaupunki SF	Kaitos	43,056	46
1990	GL	Test Project	Gent B	Herbosch Kiere	25,834	72
1990	GL	Contaminated Site	Rotterdam NL	Visser & Smit	6,674	16
1991	GW	Demonstration Project	Wilmington, DE	GSE	720	18
1991	GW	Bulk Storage Terminal	East Chicago, IN	GSE	3,983	10
1991	GW	Carlstadt Superfund Site	Carlstadt, NJ	GSE	32,292	20
1991	GL	Landfill Gas Barrier	Irlam UK	GSE UK	14,531	23
1991	GL	Reconstruction RW775	Nederweert NL	Cofra	141,008	8
1991	GL	Chemical Factory	Savona I	Acna	53,820	43
1991	CW	Bermingham Landfill Gas Barrier	Bermingham UK	Keller Colcrete	32,275	26
1991	CW	Somerset CC Landfill Gas Barrier	Wellinton UK	Wimpey Geotech	43,034	43
1991	CW	Morovalle Council Leachate Barrier	Morovalle I	Rodio Spa, Milano	32,275	49
1992	GW	Wal-Mart Palestine	Palestine, TX	GSE / Arkansas Const	2,300	10
1992	GW	BFI Keller Canyon Project	Pittsburg, CA	GSE	2,565	27
1992	GW	Montana Post & Pole	Butte, MT	GSE	10,800	12
1992	GW	Contaminated Site	St. Louis, MO	GSE / IT Corp	2,800	4
1992	GW	Levee Repair	Sacramento, CA	GSE	2,500	25
1992	GW	Mottolo Superfund Site	Raymond, NH	GSE / Metcalf & Eddy	4,370	10
1992	GW	Naval Base Closure	Suffolk, VA	GSE	4,788	19
1992	GL	Subterrain Highway	Ljungskile SWD	Cofra	66,737	20
1992	CW	Rochdale MBC Landfill Gas Barrier	Manchester UK	Keller Colcrete	2,690	10
1992	CW	Berminham Landfill Gas Barrier	Berminham UK	Keller Colcrete	15,062	26
1992	CW	Costain Containment Site	Bracknell UK	Keller Colcrete	40,183	16
1992	CW	ESSCO Leachate Control	Bowling UK	Deller Colcrete	5,917	16

1992	CW	City of Florence Leachate Control	San Domino I	Rodio Spa	98,997	98
1993	GW	Contaminated Site	Jefferson, OH	GSE	9,240	21
1993	GW	ITT Rayonier Pulp & Paper	Fernandina Bch, FL	GSE	25,000	25
1993	GW	Port of Los Angeles Storage Terminal	Los Angeles, CA	GSE / Soils Engrg Cons	4,730	10
1993	GL	Landfill	Dordrecht NL	NGT	103,334	87
1993	GL	Landfill	Coventry UK	Cementation	12,056	17
1993	GL	Landfill	Hereford UK	Cementation	107,640	36
1993	GL		Tubize, BE	Icos	283,000	
1993	CW	La Porte Demonstration Site	La Porte, TX	EnviroWall	400	10
1993	CW	Texaco Chemical Contaminated Site	Guelph, CAN	Slurry Systems	25,000	35
1993	CW	Mechema Contaminated Site	Port Talbot UK	Keller Colcrete	26,896	23
1993	CW	Morrison Super Mkts Landfill Gas Barrier	Coventry UK	Keller Colcrete	13,986	20
1993	CW	Leisester Lanfill Gas Barrier	Leiester UK	Cementaion	32,275	23
1993	CW	Landfill Gas Barrier	Thames UK	Keller Colcrete	16,138	26
1993	CW	Sufolk CC Leachate Barrier	Acton UK	Keller Colcrete	9,683	30
1993	CW	Reconstruction	Maassluis NE	Cofra BV	75,060	33
1994	GW	Deep Foundation Cutoff Wall	Kaohsiung, Taiw ROC	GSE / Sweet Join	91,900	110
1994	GW	Water Treatment Plant	Decatur, IL	GSE / Fisher Stone	10,585	10
1994	GW	Contaminated Site	Glenrock, WY	GSE / Reidel	8,400	14
1994	GW	Rollins Leasing	Smyrna, GA	GSE / US Contracting	900	6
1994	GW	Fly Ash Disposal Area	LaPlata, MD	GSE / Hayward Baker	34,300	45
1994	GW	Dayton Prison Foundation Liner	Dayton, TX	GSE / Zeti-Neb	68,464	8
1994	GW	Rohm Tech	Malden, MA	GSE / Allied Pile	4,000	10
1994	GW	AT & SF Railways	Fort Madison, IA	GSE / Iowa Bridge	3,900	10
1994	CW	Leeds Contaminated Site	Leeds UK	Keller Colcrete	5,648	18
1994	CW	Ards BC Leachate Barrier	Ballygowan IRL	TAL	16,138	10
1994	CW	Beazer Homes Landfill Gas Barrier	Nottingham UK	Cementation	6,778	26
1994	CW	British Gas Contaminant Site	Sydenham UK	AMEC	86,067	49
1994	CW	Barnsley MBC Landfill Gas Barrier	Barnsley UK	Cementation	18,289	16
1994	CW	G. Manchester CC Leachate Barrier	Irlam UK	Keller Colcrete	24,744	26
1994	CW	Wilmott Dixon Landfill Gas Barrier	Cambridge UK	Keller Colcrete	24,206	26
1994	CW	Lumsden & Carrol Contaminate Site	Newcastle UK	Keller Colcrete	19,365	33
1994	CW	Costain Contaminated Site	Eastbourne UK	Keller Colcrete	16,827	16
1994	CW	Wilmott Dixon Landfill Gas Barrier	Cambridge UK	Keller Colcrete	24,206	
1994	GW	Unocal	Guadalupe Bch, CA	GSE / Foundation Pile	21,648	22
1994	CW	3e Merwedehaven	Dordrecht NE	CDD	103,680	89
1994	CW		Meldegem BE	Herbosch Kiere	478,019	29
1994	CW		Maldegem BE	Herbosch Kiere	6,869	20
1995	GW	Citgo Linden Terminal Facility	Linden, NJ	GSE	15,300	17
1995	GW	Tesoro Tank Storage Facility	Port Hueneme, CA	GSE / Foundation Pile	6,415	14
1995	GW	Port of Oakland Containment Wall	Oakland, CA	GSE / Soils Engrg Cons	30,217	37
1995	GW	Greenfield Landfill Methane Barrier	Greenfield MA	Slurry Walls, Inc.	40,040	39
1995	GW	Columbia Manufactured Gas Plant	York, PA	GSE	14,544	25
1995	GW	Clinton County Landfill	Schuyler Falls, NY	GSE / Luck Bros	9,158	26
1995	GW	Amoco Storage Terminal	Carteret, NJ	GSE	4,653	12
1995	GW	Mt Pleasant - Former Roosevelt Refinery	Mt Pleasant, MI	OEC	6,750	15
1995	CW	Liverpool Pumpfields	Liverpool UK	Keller Colcrete	6,240	16
1995	CW	Costain Landfill	Eastbourne UK	Keller Colcrete	20,171	16
1995	CW	City of Bermingham Landfill	Kitts Green UK	Cementation	29,821	46
1995	CW	Lidl Leachate Control	Hinckley UK	Keller Colcrete	23,130	26
1995	CW	Burslem BC Landfill	Burslem UK	Keller Colcrete	20,817	20
1995	CW	Alcon Leachate Control	Ashington UK	ELS / Balfour Beatty	7,531	20
1995	CW	Harbor Lining	Lubeck, GMNY	Dyniv	200,000	40
1995	CW		Rotterdam, NE	Cofra BV	500	48
1995	CW	Roadway	Rotterdam, NE	H. de Man	650	11
1995	CW	Landfill Schoteroog	Haarlem, NE	Cofra BV	450	48
1995	CW	Ray Mines - Lower Sludge Pond	Hayden, AZ	GSE / GEO-CON	66,680	50
1995	CW	Roadway	Rotterdam, NE	H. de Man	1,850	10
1995	CW		Italy	Italdreni	13,000	33
1995	CW	Harbour Lining	Rotterdam, NE	Cofra BV	630	10
1996	GW	Hunter Ridge Subdivision - Demo Site	Jacksonville, FL	GroundWater Control	540	15
1996	GW	Shell Oil	Montreal, CAN	PKM	8,500	13
1996	GW	PPG Stabilization Measure	Lake Charles, LA	GSE	5,904	8
1996	GW	CP Rail	Chapleau, CAN	PKM	11,000	13
1996	CW	Des Plaines River Levee Repair	Des Plaines, IL	The Concrete Doctor	2,800	8
1996	CW	Landfill Schoteroog	Haarlem, NE	Cofra BV	309,500	
1996	GW	Superfund Landfill Leachate Barrier	Michigan City, IN	Groundwater Control	25,000	23
1996	GW	Shell Oil	Montreal, CAN	PKM	8,500	13
1996	GW	CP Rail	Chapleau, CAN	PKM	11,000	13
1996	GW		Dallas, TX	Groundwater Control	2,400	24
1997	GW	Clinton County Landfill	Morrisonville, NY	Groundwater Control	29,435	15
1997	GW	Bay City Marine Site	San Diego, CA	Groundwater Control	4,371	16