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SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Technology Demonstration Summary

SITE Program Demonstration of a Trial Excavation at the McColl Superfund Site

Region IX of the U.S. Environmental Protection Agency (EPA), in cooperation with EPA's Air and Energy Engineering Research Laboratory (AEERL) and EPA's Superfund Innovative Technology Evaluation (SITE) Program, and with assistance from the California Department of Health Services (DHS), conducted a trial waste excavation project at the McColl Superfund site in Fullerton, CA.

In the early to mid-1940s, the McColl site was used for disposal of acidic refinery sludge, and in 1982, it was placed on the National Priorities List (NPL). The McColl waste is known to release volatile organic compounds (VOCs) and sulfur dioxide (SO_2) whenever disturbed. Since 1984, the entire site has been covered with soil in an attempt to minimize atmospheric emissions of VOCs and SO_2.

In February 1989, EPA and DHS issued a proposed plan for the McColl project selecting thermal destruction, either on or offsite, as the preferred remedy. An important component of this remedy is the excavation and waste-handling activities that must occur before thermal destruction. The overall goal of the trial excavation was to obtain information pertaining to these activities that would support the selection of thermal destruction as the preferred remedy and that would aid in the design of a thermal destruction remedy.

EPA determined that the trial excavation was necessary to ascertain if the McColl waste could be excavated with conventional equipment without releasing significant amounts of VOCs and SO_2 to the surrounding community. The trial excavation was also necessary to define the treatment needed, if any, to improve the handling characteristics of the waste as a precursor to thermal destruction. The trial excavation was a research project designed to gather information for use in the design of the final remediation for Superfund sites and specifically for the McColl Superfund site in Fullerton, CA.

This Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, and Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the SITE program demonstration that is fully documented in a separate volume of the same title (see ordering information at back).

Objectives

The trial excavation was conducted on a portion of the Los Coyotes sump L-4. The objectives of the trial excavation are presented below. Based on the goal and objectives of the project, EPA believes that the trial excavation was successful and that significant information useful in the design phase of the McColl remediation process was obtained.

Objective 1: To excavate approximately 100 yd^3 of waste to assess waste-handling characteristics and to determine if any treatment is required to improve handling characteristics as a precursor to thermal destruction.

More than 130 solid yd^3 of waste material (mud, tar, and char) was excavated under the enclosure using conventional excavation methods.

During the trial excavation, it was determined that the mud and char material did not need further treatment. For the mud, it was apparent that the waste could be easily sized to the nominal 2-in.-diameter thermal destruction requirement. For the char, it was determined that more than 50% of the excavated char was under 2 in. in diameter and that the remaining material could easily be sized using conventional methods [i.e., pug mill, shredder].

The tar material, however, required additional treatment to allow for future processing into a thermal destruction unit. Mixing the tar with cement or fly ash and water in a pug mill resulted in pellets that were less than 2 in. in diameter.

Objective 2: To determine the atmospheric emissions resulting from the excavation activities.

This objective was only partially achieved during the trial excavation. Data for SO_2 and total hydrocarbons (THC) are reported; however, no data for organic species or reduced sulfur species are reported.

High quality data were obtained for SO_2 and THC emissions exiting the enclosure exhaust treatment system. Five-minute averages for SO_2 emissions were maintained at less than 1 ppm throughout the project. The highest 5-min average for THC emissions was 98.1 ppm.

Although samples for organic and reduced sulfur compounds were collected from the stack and analyzed, an EPA audit deemed them invalid. Benzene (a known carcinogen), toluene, ethyl benzene, and xylenes are the major constituents of the THC concentrations reported, but no quantifiable concentrations for these compounds can be reported for the reason listed above.

Objective 3: To assess the degree of SO_2 and THC emission control achieved through the use of an enclosure and an enclosure exhaust treatment system.

The excavation area was enclosed, and ventilation air was exhausted through an enclosure exhaust treatment system consisting of a sodium-hydroxide wet scrubber and an activated carbon unit.

The daily average removal efficiency for SO_2 ranged from 71.8% to 99.9% with over 90% removal achieved on the majority of days.

The daily average removal efficiency for THC ranged from 15.8% to 90.7% with over 50% removal achieved on the majority of days.

Objective 4: To determine the emission levels for SO_2 and VOCs at the fence-line of the McColl site as an indicator of the effect on the local community.

This objective was partially achieved for the reasons outlined in Objective 2. Reliable data for SO_2 and THC emissions were collected at four perimeter monitoring stations; no levels were detected that would adversely affect the surrounding community.

An EPA audit determined that the samples for organic and reduced sulfur compounds collected at the fence-line and in the community and then analyzed were invalid. For this reason, no quantifiable concentrations of benzene (a known carcinogen), toluene, ethyl benzene, and xylenes, the major constituents of the THC concentrations reported, can be reported.

Objective 5: To assess the effectiveness of vapor-suppressing foam.

This objective was partially achieved. Reduction efficiency rates have been calculated for dynamic conditions, but the rates could not be calculated for static conditions because an EPA audit deemed the analytical data invalid.

In dynamic conditions, it has been estimated that the vapor-suppression foam can be up to 80% effective for SO_2 control and 60% effective for THC control.

Static flux chamber measurements were conducted on the mud, tar, and char within the enclosure. The gas streams from these tests were analyzed for organic compounds and reduced-sulfur compounds; an EPA audit, however, determined the data to be invalid.

Objective 6: To assess potential problems that might occur during excavation.

Assessments were made regarding problems that occurred because of higher-than-expected emissions of SO_2 and THC from the tar and char; high particulate diesel emissions; heat gain; work in Level B and Level A protective gear; excess water in a confined space; and seepage of tar material.

Excavation and Waste Processing

Overburden was removed and the underlying waste was excavated with a trackhoe equipped with an extended boom and a 1-yd^3 bucket. The waste, which was found to be fairly well segregated into layers, was placed in roll-off bins or piles for subsequent use. After routine removal of the overburden, a 3-ft-thick mud layer was excavated. A 4-ft-thick tar layer was excavated next. After the tar was removed, a trench shield was placed in the excavated area to reduce additional tar seeping into the opening. After the tar layer, a hard, coal-like, char layer was encountered. This material was broken up and excavated with the trackhoe.

During the tar excavation, SO_2 and THC levels within the enclosure increased dramatically and reached 5-min average values of 1000 and 492 ppm, respectively. The enclosure exhaust treatment system removed up to 99.9% of the SO_2 and 60% of the THC during this excavation period. The use of the enclosure and enclosure exhaust treatment system prevented any significant amounts of these pollutants from reaching the site perimeter, as evidenced by the low concentrations measured there. The higher-than-expected concentrations within the enclosure required personal protection equipment to be upgraded to Level A (completely encapsulated suit with supplied air).

During the char excavation, high concentrations of SO_2 and THC were also reached—5-min average values of 755 and 355 ppm, respectively. The enclosure exhaust treatment system operated efficiently during the entire study with up to 99% removal of the SO_2 and up to 90.7% removal of the THC.

The failure of vapor-suppressing foams to form an impermeable membrane over the exposed wastes caused higher-than-expected levels of SO_2 and THC within the enclosure. The foam's reaction with the extremely acidic waste severely affected the foam's ability to suppress emissions.

This ability was improved somewhat, however, when the concentration of foam reagents in water was increased. Though difficult to estimate, the overall reduction with foam was estimated at up to 80% for SO_2 and 60% of the THC; this is based on concentrations measured at the enclosure exhaust treatment system inlet during excavation activities with and without foam.

In all, 137 yd^3 of waste and 101 yd^3 of overburden were excavated. Maximum and

average trial excavation rates are summarized in Table 1.

Table 1. Maximum and Average Trial Excavation Rates (yd³/hr)

Component	Maximum	Average
Overburden	51	7.6
Mud	66	4.1
Tar	58	4.3
Char	9	2.6

The average excavation rates achieved during this trial excavation will be increased considerably during full-scale excavation as fewer observations and measurements will be needed. Anticipated average excavation rates that could be achieved during full-scale excavation are estimated at 49, 32, and 25 yd^3/hr for overburden and mud, tar, and char, respectively.

The tar waste was further processed to reduce its size and to form a solid and easier-to-handle pellet. Tar was mixed with cement, fly ash, and water in a pug mill, and 10 test runs were made within the enclosure at various ratios of tar, cement, fly ash, and water. A ratio of 1 part tar to between 2.3 and 7 parts cement and fly ash and from 0.26 to 1 part water formed a solid, easy-to-handle pellet. Approximately 3 tons of tar per hour was processed during the trial excavation, and it is estimated that this rate could be increased by up to a factor of 2 with a more continuous operation. Indications were evident that tar processing with alkaline materials such as cement and fly ash reduced the amount of SO_2 released by the tar. The mud and char waste fractions did not require further processing but could have been fed through the pug mill, if necessary.

Air Emission Controls

Because previous investigations at the McColl site indicated that the waste could emit significant amounts of VOCs, organic sulfur compounds, and SO_2 to the air, excavation could significantly affect workers and the community.

For the trial excavation, the effect on the community of this potential air emission was mitigated by erecting a temporary enclosure 60 ft wide, 160 ft long, and 26 ft high over the center of the excavation area. Before being released to the ambient air, air from the enclosure was vented through a sodium-hydroxide-based wet scrubber and an activated-carbon adsorber in series.

For the trial excavation, this potential air emission effect on workers was mitigated by having workers wear Level B or Level A protection at all times while inside the enclosure.

Concentrations of SO_2 and THC were continuously monitored before and after the enclosure exhaust treatment system. As part of a supplemental sampling and analytical effort, sampling for speciation of organic and reduced sulfur compounds occurred at the stack inlet and outlet, at the fence-line, and in the community. These data are not reported, however, because of invalidation by an EPA Audit.

Waste Characterization

Samples of excavated waste were analyzed to determine heat value and the concentrations of selected constituents (Table 2).

Toxicity characteristics of the raw tar and char were determined by the Toxicity Characteristics Leaching Procedure (TCLP) and California Wet Test. No metal constituents exceeded the regulatory limit in either case. Benzene in the tar and char waste exceeded the EPA TCLP limit of 500 µg/L by more than a factor of 2.

Community Impact

Perimeter air was continually monitored for SO_2 and THC during this study. Windspeed and direction were also continually recorded. This information was obtained to comply with the Community Contingency Plan, which mandates that all site work be stopped if SO_2 levels at the perimeter exceed 0.5 ppm for 5 min or if THC levels exceed 70 ppm for 30 sec. These levels were never reached during this study. The maximum 1-hr readings obtained at any perimeter station in June, which was the period of highest emissions from the waste, were 0.08 ppm for SO_2 and 21.9 ppm for THC.

Costs of Excavation and Tar Processing

The costs for the field aspects of this trial excavation work consisted of those involved with the enclosure and enclosure exhaust treatment system, actual excavation labor and equipment, foam application, tar processing, and air monitoring. Because much of the equipment for this project (e.g., enclosure framework, scrubber, and excavation machinery) was rented on a monthly basis, total costs were composed of the monthly machinery charges, labor, and fixed costs required to mobilize and demobilize. These costs are summarized (Table 3) for the 2-mo duration of the field work.

Table 3. Summary of Onsite Costs

Item	Total Cost
Enclosure	$70,976
Air exhaust control system	40,415
Foam vapor suppressants	89,591
Excavation*	82,512
Tar processing	17,367
Air monitoring	100,160
Total	$401,021

*Based on 18 days of excavation.

Conclusions

The overall goal of the trial excavation was to obtain information about excavation and waste-handling activities to support the selection of thermal destruction as the preferred remedy and to aid in the design of a thermal destruction remedy after one is selected in a Record of Decision (ROD). An important question to answer with information from the trial excavation is whether the McColl waste can be excavated with conventional equipment without significantly affecting the commu-

Table 2. Waste Characteristics, As-Received Basis

	Mud	Tar	Treated Tar	Char
Moisture, %	13.2	11.6	8.1	21.2
Sulfur, %	0.8	10.6	3.6	4.5
Fixed Carbon, %	0.2	26.9	2.0	4.0
Ash, %	82.9	1.6	75.9	54.7
Benzene, ppm	<0.7	240	NA*	97
Toluene, ppm	1.5	580	NA	150
Xylene, ppm	816	910	NA	220
Ethylbenzene, ppm	0.9	140	NA	35
Heat Value, Btu/lb	<500	9160	2200	5200

* NA = Not analyzed. Use of cement additive would reduce concentrations found in raw tar sample.

nity. Based on this goal, the following conclusions have been reached:

- Waste material was excavated with conventional excavation equipment without significant adverse effects on the community.
- Excavation under an enclosure is technically feasible and allowed for emissions generated during the excavation activities to be controlled with an enclosure air exhaust treatment system consisting of a sodium hydroxide wet scrubber and an activated carbon unit.
- Excavation and waste handling activities are not technically feasible without an enclosure and enclosure exhaust treatment system at this site.
- The waste material was successfully treated to improve its handling characteristic to allow easy processing in a thermal destruction unit, if desired.
- The vapor-suppressing foam did not perform as anticipated in controlling SO_2 and THC emission within the enclosure and cannot be exclusively relied on to control emissions during activity-related waste disturbances.

Observations

These observations of activities that occurred during the trial excavation are qualitative in nature, and no qualitative data exist to support them; however, they represent best engineering judgment in relation to activities related to the trial excavation. It is believed that:

- Community communication on this project was effective and a necessary part of the project. The community interaction was important to the success of the trial excavation and the success of the passive odor and health effects survey conducted by the California Department of Health Services.
- Excess water introduced into the enclosure through the foaming activities significantly affected operations within the enclosure. The excess water made the ground surface slippery for both workers and equipment.
- Visual observation and qualitative calculations determined that the trench shield was a very effective tool in minimizing the amount of tar material that could seep into the excavation area. It was also determined that the trench shield was not needed to shore up the soils or char material within the excavation area.
- Having workers in Level A protective gear adversely affected their productivity and communication but did not make excavation activities unfeasible.
- Lower airflow rates through the activated carbon unit increased the THC removal efficiencies. This supports the theory that residence time is a critical factor in the ability of activated carbon to remove organic compounds in an air stream.
- Contrary to original plans, EPA had to move major equipment into and out of the enclosure during operations. The community and workers were not adversely affected from opening the enclosure for short periods of time (under 1 hr) to allow for efficient equipment movement.
- The results of the tar processing indicate the pug mill could effectively process the char and mud fractions of the McColl waste for use in a thermal destruction remedy.
- Because tar seeped into the excavation area, approximately 100 yd^3 of material could not be replaced in the excavation pit at the completion of the project. This material was stockpiled onsite in the staging area under a plastic liner covered by topsoil.
- Under true field conditions (not research-restricted conditions), the excavation rating associated with the equipment could be achieved. The excavation rates achieved during the trial excavation were artificially constrained to allow for data collected and visual observations. The excavation rates were also constrained by unexpectedly high SO_2 and THC emissions rates.
- The observation camera was an invaluable tool in observing/recording activities that occurred within the enclosure. The camera also allowed all workers to be observed from a health and safety standpoint. Because of the camera, fewer employees were needed within the enclosure; this allowed for more efficient operations and reduced the risk of employee accidents.

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The complete report, entitled "SITE Program Demonstration of a Trial Excavation at the McColl Superfund Site," (Order No. PB92-226 448/AS; Cost: $35.00, subject to change) will be available only from:

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