PERFORMANCE EVALUATION OF A NEW LOW-COST FIELD TEST KIT FOR ANALYSIS OF HYDROCARBON-CONTAMINATED SOIL AT A DIESEL FUEL RELEASE SITE

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ABSTRACT

Dexsil Corporation's new low cost PetroFLAG™ field test kit was used in conjunction with a mobile laboratory to field test soil contaminated by diesel fuel. This innovative new technology uses no CFCs and is completely field portable. Initially the PetroFLAG field test results were compared directly to sample splits analyzed by an on-site mobile laboratory using EPA method 8015 for diesel. The field generated PetroFLAG results proved to be very accurate when compared to the mobile laboratory results. The first time PetroFLAG users required only 5 minutes of training to become proficient enough at using the test kit to achieve this high degree of correlation. Due to the excellent correlation between PetroFLAG results and the mobile laboratory results, the PetroFLAG test kit was used exclusively in the field to find the zero line of contamination in the soil. When the PetroFLAG test indicated that no hydrocarbons were present in the soil, the sample was given to the mobile laboratory for confirmation analysis. By using the PetroFLAG test, site work including lateral and vertical definition of the contaminated area and excavation and removal of the contaminated soil could proceed without delays caused by lack of test data. The mobile laboratory was spared the inconvenience of "hot" samples that might otherwise overload the laboratory equipment necessitating a time consuming recalibration, thus saving time and expense. Overall, the use of the PetroFLAG test kit allowed more samples to be tested at a low cost, freed up the mobile laboratory to perform confirmation analysis only, provided an accurate method for locating the zero line of contamination so that additional volumes of uncontaminated soil were not excavated, accelerated the project, and helped to keep the project, equipment and manpower working without delays.

INTRODUCTION

Releases of petroleum hydrocarbons to surface and subsurface environments are an unfortunate reality in todays world. These releases can result in significant degradation of the quality of our soil and water resources and may result in substantial health risks to people, plants, and animals in the vicinity of the release. Environmental professionals are typically called upon when a release of petroleum hydrocarbons is reported to assess the nature and extent of the release and to formulate a remedial action plan to address the

problem. The characterization work is frequently conducted on an emergency response basis, requiring rapid turn around of data to support remedial decisions in the field.

A common problem with characterizing the nature and extent of petroleum hydrocarbons in soil at a release site has been the lack of a quick, easy to use and accurate method of measuring the concentration of petroleum hydrocarbons in soil at the site. Typically, soil vapors are measured using a field photoionization detector (PID) or other similar device to test for the presence of gasoline in soil, while observations of staining and odors are used to check for the presence of "heavier", less volatile petroleum hydrocarbons (i.e., diesel, motor oil, kerosene, jet fuel, crude oil). These semi-quantitative field data are often used to direct soil excavation activities and to determine where confirmation samples are to be collected and sent to a state-certified laboratory for analysis.

Use of these semi-quantitative field methods typically results in the following problems: false positives (field methods indicate the presence of petroleum hydrocarbons where they are not present) resulting in unnecessary excavation, excessive confirmation sampling and lost time and money; false negatives (field indicators do not indicate the presence of petroleum hydrocarbons where they are present above the target concentration) resulting in re-excavation of areas presumed to be "clean" and lost time and money; uncertainty in the data, resulting in excessive confirmation sampling and down time.

Dexsil Corporation, recognizing the need for a fast, low cost, quantitative field test for determining the concentration of a full range of hydrocarbon contaminants in soil, recently developed the PetroFLAG field test kit. The PetroFLAG test is inexpensive, fast, easy to learn and yields quantitative results for a full range of hydrocarbons in soil. The PetroFLAG analyzer displays sample results directly in parts per million (ppm). The test kit can be used to analyze one sample, or multiple samples at a time.

Correlation between PetroFLAG test results and standard EPA Laboratory methods 8015 and 418.1 is excellent. The PetroFLAG test kit provides environmental professionals with a new tool to perform quantitative on-site sample analysis quickly and inexpensively. PetroFLAG test results can be used to determine when and where to collect soil samples for (more expensive) laboratory confirmation analysis, thus eliminating subjective observations such as soil color and soil odor for the process.

This paper presents a case study involving the use of the PetroFLAG test kit at a diesel fuel release site where excavation was the selected remedial measure.

BACKGROUND

Several thousand gallons of diesel fuel were released from an underground pipeline beneath the roadway in a residential neighborhood in California. The diesel fuel was released under pressure from the top of the pipeline at approximately 3 feet below ground surface, resulting in the upward migration and lateral spread of the diesel beneath the asphalt road. Some of the diesel emerged from the seams between the asphalt road and the concrete sidewalk and subsequently flowed above ground into an adjacent storm drain.

Levine•Fricke, Inc. was called in to assess the nature and extent of the release and to formulate a remedial action plan for the site. Levine•Fricke is a nation-wide full-service environmental consulting firm and is recognized as an industry leader in the characterizing and remediation of petroleum-affected sites.

Due to the residential setting of the site and the specific concerns of the local residents, the responsible party agreed to excavate the diesel-affected soil beneath the road to a concentration below laboratory detection limits (i.e., less than 1 ppm for total petroleum hydrocarbons as diesel [TPH/d]). The excavated diesel-affected soil is to be treated using bioremediation at an off-site location. A mobile laboratory was dispatched to the site to provide real-time on-site data to help direct the excavation. In addition, Levine•Fricke arranged for an on-site demonstration of the PetroFLAG test kit by a representative of Dexsil Corporation to help assess whether PetroFLAG would be appropriate for use at the Site. The following sections discuss how the PetroFLAG test kit was used on the project.

FIELD PROCEDURES

Training and Confirmation Sampling

A representative of Dexsil Corporation provided Levine•Fricke personnel with a demonstration on the morning of the second day of the excavation activities. The demonstration consisted of calibrating the PetroFLAG analyzer using two prepackaged calibration standards. The calibration standards consist of a blank and a 1000 ppm spike, and are provided with every ten pack of soil test reagents used in the PetroFLAG test kit. The on-site calibration took approximately 10 minutes to perform.

A ten gram sample of the soil from the site was weighed directly into the extraction container and a premeasured ampulized extraction solvent mixture was added to the soil sample. A timer was set, and the soil and extraction solvent were then shaken vigorously several times during the first four minutes of the five minute extraction period. The mixture was allowed to settle during the final minute. The solvent/soil mixture was then decanted into a filter syringe and the sample extract was filtered directly into a cuvette containing the pre-measured color development solution. The digital timer was then set for ten minutes (the color development quantification period). The cuvetted contents were then mixed thoroughly during this period. At the end of the ten minute quantification period, the cuvette was placed into the calibrated PetroFLAG Analyzer and analyzed for diesel. The

total demonstration including analyzer calibration took approximately 25 minutes.

Upon completion of the demonstration, Levine•Fricke personnel collected a soil sample near the excavation and split the sample into two sub-samples. One sample split was analyzed by the on-site mobile laboratory for TPH/d using EPA method 8015; the other split sample was analyzed for TPH/d using the methods described above. The short demonstration period was sufficient for Levine•Fricke personnel to conduct the analysis using the PetroFLAG kit. Results from both analyses were below detection limits (e.g. less than 1 ppm) for the mobile laboratory. The PetroFLAG result was zero. Based partially on these results, and the quick and easy nature of the PetroFLAG analysis method, PetroFLAG was selected for use at the site.

Excavation and Sampling Procedures

The objective of the remedial action plan was to excavate petroleum-affected soil with a concentration of TPH/d greater than the laboratory detection limit (1 ppm) from the site. To meet this objective, soil samples were collected from the bottom and sidewalls of the excavation using a slide-hammer sampler fitted with clean brass liners. Subsamples were collected from the brass liners and analyzed for TPH/d using the PetroFLAG test kit.

Results of the PetroFLAG analyses were used to assess whether additional excavation would be required in the area sampled and to assess where confirmation samples were to be collected. If the results from the PetroFLAG analysis indicated the presence of petroleum hydrocarbons above 1 ppm, additional excavation was conducted in that area. When the results of the PetroFLAG analysis indicated that petroleum hydrocarbons were not present, the subject sample was sent to a state-certified laboratory for confirmatory analysis and excavation in that portion of the site was stopped. After results were received from the state-certified laboratory confirming the PetroFLAG results, the area was backfilled with clean fill, compacted and paved. This procedure was followed until the entire portion of the road was remediated.

Approximately 210 samples were analyzed on-site using the PetroFLAG test kit during the excavation work (approximately 8 weeks). Of the 156 samples that were sent to the state-certified laboratory for confirmation, only 3 samples had results greater than the detection limit (at 1, 3 and 4 ppm, respectively). Based on the excellent agreement between results from PetroFLAG analysis and analysis results from the state-certified laboratory, the mobile laboratory was sent off of the Site after two weeks and confirmatory samples were sent to a (less expensive) stationary laboratory.

RESULTS AND DISCUSSION

Training

The on-site training session for Levine•Fricke personnel took approximately 25 minutes to complete, 10 minutes of that time consisted of calibrating the PetroFLAG analyzer. From this short training session, Levine•Fricke personnel were able to use the PetroFLAG test kit with confidence on the same day, immediately after the training session. Levine•Fricke personnel operated the PetroFLAG test kit several times a day during the excavation project with virtually no problems or delays.

Results of Confirmation Analysis

Of the 156 samples analyzed using PetroFLAG and sent to the state-certified laboratory for confirmation, only 3 had results greater than the detection limit (at 3, 4, and 1 ppm, respectively). It is possible that the disagreement in the results associated with these samples may have been the result of soil heterogeneity's within the collected soil sample volume. In any case, the data collected during this study indicate an excellent agreement between PetroFLAG results and results from a stationary, state-certified laboratory using EPA method 8015.

Use of the PetroFLAG Test Kit at the Excavation

The PetroFLAG test kit was used exclusively at the site to assess when the lateral and vertical extent of the diesel-affected soil had been reached. Based on the excellent agreement between the PetroFLAG results and the results from the mobile laboratory, the mobile laboratory was sent off of the Site after two weeks and confirmatory samples were sent to a (less expensive) stationary laboratory. The confidence in the PetroFLAG data was sufficiently high to allow for use of the PetroFLAG data only to direct the excavation.

Use of the PetroFLAG test kit in this manner resulted in substantial savings of both time and money. The quick turn-around time for PetroFLAG results (approximately 10 minutes) made it possible to make decisions regarding where to excavate and where to halt excavation and collect confirmatory samples rapidly, resulting in efficient use of manpower and excavation equipment. This resulted in an accelerated progress of the excavation project and completion of the excavation ahead of schedule. Also, use of the PetroFLAG test kit to screen samples for confirmatory analysis prevented "hot" samples from being submitted to the mobile laboratory that might overload the mobile laboratory equipment, resulting in costly downtime.

Use of the PetroFLAG test kit at the Site also resulted in substantial savings of money. Perhaps the most significant cost savings was realized in the overall savings of time described above. Other more direct cost savings realized through the use of PetroFLAG included reduced volume of excavated soil and reduced total laboratory costs. The quick (approximately 10 minutes) and inexpensive (approximately $15.00/sample) nature of the

PetroFLAG analysis process allowed for frequent collection and analysis of samples to assess the limits of the excavation. This increased sampling density and frequency resulted in better definition of the excavation boundary at any given place and time, thus minimizing excavation of clean soil.

The overall cost of the PetroFLAG test is $15.00 per test. As discussed above, use of the PetroFLAG test kit resulted in less samples being submitted to a state-certified laboratory (cost of $100 to $200/sample for 24-hr. turnaround) and allowed Levine•Fricke to discontinue use of the mobile laboratory (approximate cost of $1500.00 per day).

SUMMARY AND CONCLUSIONS

The PetroFLAG test kit was used at a diesel fuel release site to provide rapid, inexpensive and accurate data regarding the nature and extent of the diesel fuel in soil. Agreement between PetroFLAG results and results from a stationary, state-certified laboratory using EPA Method 8015 was excellent. Because of the excellent agreement between these methods, the PetroFLAG test kit was used exclusively at the Site to direct the excavation and to determine where confirmatory samples were to be collected for submittal to a state-certified laboratory for analysis.

Use of the PetroFLAG test kit at the subject site resulted in substantial savings of both time and money. The quick turn-around time for PetroFLAG results (approximately 10 minutes) made it possible to make decisions regarding where to excavate and where to halt excavation and collect confirmatory samples rapidly, resulting in efficient use of manpower and excavation equipment. Also, use of the PetroFLAG test kit replaced the need for an on-site mobile laboratory and reduced the total number of samples sent to a state-certified laboratory for confirmation analysis.

Based on the performance of the PetroFLAG test kit during the excavation phase of this project, Levine•Fricke is using the PetroFLAG test kit in the bioremediation treatment phase of the project. A soil biotreatment cell has been constructed to treat the diesel-affected soil excavated from the release area. When results from the PetroFLAG tests indicate that the concentration of diesel in soil in the biotreatment cell is below the target remediation level, confirmation samples will be collected and sent to a state-certified laboratory for analysis. Additionally, the low cost associated with the PetroFLAG test kit will allow for increased sampling of diesel concentrations in soil in the biotreatment cell while the bioremediation is in progress. These on-going monitoring data will be used to track the rate and distribution of bioremediation within the biotreatment cell and to evaluate what adjustments to the biotreatment cell (e. g., increased air flow, addition of nutrients) may be warranted.