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Pilot Scale Demonstration Project Application for the use of Bioremediated Petroleum Contaminated Soil as Daily Landfill Cover

Prepared for
The North Carolina Department of
Environment and Natural Resources
Division of Waste Management
Solid Waste Section

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1.0 INTRODUCTION

Marine Corps Base, Camp Lejeune, is a Marine Corps training installation located in Jacksonville, North Carolina. It spans approximately 150,000 acres, or 234 square miles, and supports more than 55,000 military personnel, civilian personnel, and dependents combined. The Marine Corps as a whole has established ambitious goals in all environmental areas, and it is Camp Lejeune's desire to contribute to the achievement of those goals. One method of contribution is the reuse of bioremediated petroleum contaminated soil as alternative daily landfill cover. It is the hope of the Installation that this innovative solid waste management method will further maximize the Installation's recycling and reuse efforts.

2.0 OBJECTIVE

The objective of the Camp Lejeune pilot scale demonstration project is to evaluate the effectiveness of using bioremediated soil from the Installation's permitted soil containment and treatment cell (biocell) as daily cover for the Camp Lejeune Solid Waste Landfill. The bioremediated soils will be treated to State targeted standards, which are outlined in Section 3.4.2 below, prior to use as daily cover.

The purpose of this application is to provide information to the State concerning the practices and procedures before, during, and after bioremediation, the operations and handling of soils, and details of biocell recordkeeping and reporting routines.

3.0 BIOREMEDIATION PROCESS

The Camp Lejeune pilot demonstration project will employ bioremediation to degrade petroleum hydrocarbon contaminants in soils. Bioremediation involves the spreading of soils in a lined treatment cell, followed by the controlled application of hydrocarbon-degrading microorganisms, nutrients, oxygen, and moisture to optimize the microbial growth rate and resultant degradation of the contaminants. As a result, contaminants degrade and transform into environmentally acceptable non-toxic constituents.

3.1 Biocell Construction

The biocell is an existing permitted[1] facility, which is located outside of the operating landfill. OHM Remediation Services Corporation (OHM) is under contract with the Department of the Navy to operate and manage the dedicated soil treatment facility. It was constructed during the spring of 1996 and has been in operation since July of 1996. Minimum design or performance requirements, which were key design parameters for the biocell, are itemized below.

- Site security to prevent unauthorized entry.
- 0,000 gallon leachate collection system to contain and prevent runoff.

[1] The application for the containment and treatment of soils containing petroleum fuel products was submitted to the Wilmington Regional Office of the North Carolina Department of Environment and Natural Resources in October 1995. The respective permit, Permit No. SR0800061, was granted November 1995.

- Provisions to dispose of leachate in an approved manner.
- Compliance with the buffer requirements of North Carolina Administrative Code 15A 2H .0219(j).
- State Groundwater Section (currently the UST Section) approved plans and specifications.
- Site maintenance including nutrient addition, oxygen enhancement, etc.
- Soil sampling and monitoring.
- Implementation of a 30 mil high density polyethylene geomembrane synthetic liner having a hydraulic conductivity $< 1x10^{-9}$ $^{cm}/_{sec}$.
- A graded treatment slope of 1% to divert leachate and storm water to the collection sump.
- A drainage layer above the synthetic liner of 24 inches of coarse, graded local sand.

The biocell's capacity is 1000 cubic yards with an internal cell area of 215 feet by 162 feet, including six feet wide earthen berms. Appendix A contains the Construction Plan and appropriate cross-sections for additional reference.

3.2 Soil Acceptance Standards and Initial Characterization

The subject facility was designed to manage only petroleum contaminated soil as defined in North Carolina General Statutes 143-215.1. Petroleum contaminated soils are categorized according to source and fall into one or more of the following classes:

Class I Products (Low boiling point fuels)	Motor gasoline, aviation gasoline, gasohol, military jet fuels i.e. JP-4, Jet A
Class II Products (High boiling point fuels)	All other jet fuels, i.e. JP-5, JP-8 and kerosene, diesel fuel, fuel oils, motor oils

Only Class I and II products are managed at the biocell. ***Excluded*** products which are toxic to bioremediation (not to be managed at the biocell) include chlorinated solvents, organic acids, tars, asphalts, petroleum refinery sludge, pesticides, and any other soil classified as a Resource Conservation Recovery Act hazardous waste. Any soils in question are evaluated on a case by case basis before being allowed on site.

In order to characterize a candidate soil, they are first screened to assure they have the proper statistical parameters suitable for bioremediation. The following criteria are used as a starting point in the evaluation of a candidate soil for bioremediation. Any soils having contaminants in excess

of 10,000 ppm TPH-GRO, 5,000 ppm TPH-DRO, and 3,000 ppm Oil and Grease[2] are diverted from biotreatment and disposed of appropriately. Initial characterization of incoming soils includes analysis for the following parameters.

Table I: Initial Characterization Sampling and Analysis

PARAMETER	EPA METHOD
Average total petroleum fuel hydrocarbon	5030/8015 and 3550/8015
Oil & Grease	9071
Total Organic Carbon	9060
Ammonium-Nitrogen	ASA/SSSA 33-3, 33-4
Phosphate-Phosphorous	ASA/SSSA 24-5.1, 24-5.3
pH	ASA/SSSA 12-2.6
Moisture Content	ASA/SSSA 21-22
Bacterial Population Density	SM EWW 9215B

The pH of the soils should be in the range of 6.0 and 8.0[3]; however, if it falls outside this range, adjustments may be made. These soils are reviewed on a case by case basis. Additionally, soils should be free of construction debris and other foreign material.

3.3 Soil Preparation

Once the soils have been determined to be acceptable candidates for biotreatment, they are placed directly into the biocell. Before treatment begins on a specific soil, however, it may require preparation to ensure efficient treatment. The following soil preparation techniques are employed.

- Removal of foreign debris, if necessary.
- Screen oversize debris down to 3/4" fraction if oversize material is greater than 20% in volume.
- Storage and disposal of debris[4].
- Addition of bulking agents[5] to the soil to increase porosity, if necessary.

Bulking agent addition may be performed after the soil has been placed in the biocell and is recommended when the soil is clayey in nature (i.e. cohesive when wet, rockhard when dry). After soil preparation, the biotreatment and performance monitoring phase begins.

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[2] Oil and Grease should be from a known source, such as heating oil, hydraulic fluid, or motor oil. In addition, only soils from MCB Camp Lejeune are accepted for bioremediation.

[3] Camp Lejeune soils have typical pH ranges of 5.0 - 6.5±1.0 pH as reported in the United States Department of Agriculture Soil Survey of Onslow County, North Carolina, July 1992.

[4] Any nonhazardous debris is containerized and stored on site until transportation and disposal can be arranged. Nonhazardous liquids are processed through the nearby groundwater treatment facility.

[5] Typical bulking agents include hay, rice hulls, or manure and are tilled into soils to improve aeration, defloculation, and moisture retention and serve as additional bacterial substrate. Since Camp Lejeune soils are inherently sandy in nature, no bulking addition has been required to date.

3.4 Bioremediation Implementation

3.4.1 Nutrient and Microorganism Addition

Once a specific soil has been prepared, the bioremediation process begins. The initial soil characterization sample[6] results provide the basis for determining types and quantities of initial nutrient and hydrocarbon-degrading microorganism addition. These results assist in the development of microorganisms, which most efficiently degrade the particular soil's contamination. They also aid in determining specifics as to nutrient application. Initial nutrient addition ratios are consistent with North Carolina regulations for dedicated facilities based on organic carbon : nitrogen : phosphorous ratios of $60:1:{}^{75}/_{1000}$.

Soil fertility is managed through conventional fertilization techniques, using relatively soluble commercial fertilizers. The biocell is designed to accommodate both dry granular or aqueous based fertilizer. Primary nutrients, including diammonium phosphate and ammonium sulfate, are stored on the concrete pad located within the bermed biocell prior to use. Operation personnel manually apply nutrients, usually in dry granular form, using a conventional spread caster.

Nutrient addition coupled with hydrocarbon degrading microorganism application ensures that hydrocarbon degraders are present and able to function at optimum contaminant reduction levels.

3.4.2 Maintenance and Performance Monitoring

Once specific soils have been augmented with microorganisms and supplemented with nutrients, intensive and regularly scheduled maintenance and performance monitoring is implemented. Maintenance and monitoring tasks are routinely performed not only to ensure that environmental conditions are optimized, but also to monitor the progression of bioremediation. The following table summarizes the maintenance and monitoring schedule.

Table II: Maintenance and Performance Monitoring Schedule

EVENT	SCHEDULE
Microorganism Addition	Initially
Nutrient addition	Initially, Monthly
Soil Tilling	Initially, three times per week thereafter, and immediately after nutrient, etc. addition.
Hydrocarbon Monitoring	Initially, Monthly
Nutrient Monitoring (including TOC, Ammonium-Nitrogen, Phosphate-Phosphorous, pH, Moisture content, and Bacterial population density)	Initially, Monthly

[6] These analyses were outlined in Table I Section 3.2.

Soil tilling allows for the mixing and pulverization of contamination hot spots, the reduction of soil particle size, and the introduction of oxygen to sustain maximum microbial activity. Tilling is performed three times per week and is done with a conventional rototiller or farm tractor with a plowing attachment.

Soil moisture is monitored monthly. Because microorganisms inhabit and are only active within thin films of water, the soil water content is maintained at optimal conditions for their growth[7]. Soil water moisture is monitored on-site with the Speedy Moisture Tester, 20 gram capacity. Target soil moisture content is approximately 60-80% of the field holding capacity, which corresponds to between 10 to 15 % moisture on a weight basis.

Any excess storm water or leachate, which is in the biocell sump, can be pumped into a holding pool adjacent to the facility (see Appendix A for approximate location). This water may then be applied manually for moisture control with a two inch submersible pump/flexible hose. Very little volume or concentrations of hydrocarbons migrate to the collection sump; therefore, it is a viable practice to recycle this liquid for moisture application.

Adjustment to soil pH may be made if extreme values are monitored. Applying lime (calcium carbonate) when the pH is low or elemental sulfur when the pH is high may do this. Maintaining pH between 6.0 and 8.0 is optimal for the microbial degradation of petroleum hydrocarbons in soil.

Hydrocarbon and nutrient monitoring is performed once per month to monitor progress toward soil treatment standards and to ensure maintenance of biological treatment efficiency.

Discrete samples are collected and composited for both performance and maintenance monitoring activities. In the design of a sampling program, best engineering judgment is used and, since the soils will be continuously homogenized through tilling, composite samples will be analyzed to characterize the presence of contaminants as best as possible without becoming cost prohibitive. The biocell (1000 yd^3) is divided into six equal quadrants for sampling and analysis. For interim sampling, representative samples are taken with a soil hand auger or similar sampling device from the middle of each of the six quadrants and composited into three samples for off site analysis[8]. For closure sampling, four to six confirmation samples per batch will be obtained using the same method as just described. Laboratory results from these confirmatory samples are then evaluated to determine whether or not the cleanup criteria have been met or to continue treatment.

Maintenance and monitoring is terminated once specific treatment soils have reached target TPH levels. Target TPH levels approved by the State of North Carolina Department of Environment and Natural Resources (NCDENR) are listed below.

- 105 ppm TPH – Low Boiling Point Hydrocarbons (gasoline, aviation fuel, gasohol, etc.) via EPA Method

[7] Statement taken from OHM Biocell Work Plan and Permit Application submittal dated June 1995.
[8] Grab samples are collected from approximately six inches below the surface in the middle of each quadrant. These grab samples are then composited to yield three samples for analysis.

- 500 ppm TPH – High Boiling Point Hydrocarbons (kerosene, diesel, mineral spirits, etc.) via EPA Method 3550

- 500 ppm TPH – Heavy Fuels, Oils and Grease (Fuel Oil #4,#5,#6, motor oil, etc.) via EPA Method 9071

- Total BTEX 10 ppm – BTEX indicator via EPA Method 8020

4.0 TRACKING, RECORDKEEPING, AND REPORTING

Each soil batch that is placed in the cell for biotreatment is tracked and monitored to assess the effectiveness of treatment in removing hydrocarbons to below cleanup criteria. The objective of the tracking program is to ensure treatment of individual waste soils is organized, efficient, and cost-effective. Tracking measures taken during treatment periods include:

- Documentation of incoming soils.

- Assignment of incoming soils to specific quadrants[9] in the biocell.

- Scheduling of soil microbial inoculation.

- Scheduling initial and periodic nutrient applications.

- Scheduling analytical monitoring dates.

- Confirming that all operation and monitoring tasks are being performed.

OHM as well as Camp Lejeune's Environmental Management Department/Installation Restoration Division (EMD/IRD) track the soils as they proceed from acceptance and treatment to monitoring and final disposition. Individual records are generated for each batch, and all interim analyses are maintained on file. A database serves as a reference for documentation of daily activities, nutrient additions, TPH assessments, and confirmation sampling. The tracking program maintains additional information on the following topics.

- Soils scheduled to arrive.

- Soils undergoing treatment.

- Soils in final treatment stage.

- Soils scheduled for confirmation sampling.

- Soils to be removed from cell for disposal[10].

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[9] There are a total of six quadrants in the 1000 yd^3 capacity biocell. The cell is broken into six equal quadrants for ease of sampling and monitoring.

These records are kept in a central location for ease of access to the history of each treatment job.

Treatment Facility activities are regulated through monthly written reports from OHM to EMD/IRD. Additional OHM and EMD/IRD record keeping includes filing copies of the following documents for each soil batch: initial waste characterization data, any soil shipping documents, bioremediation feasibility data, performance monitoring data, confirmation sampling data, and all supporting materials. All files are available for regulator review.

5.0 FINAL CONFIRMATION SAMPLING

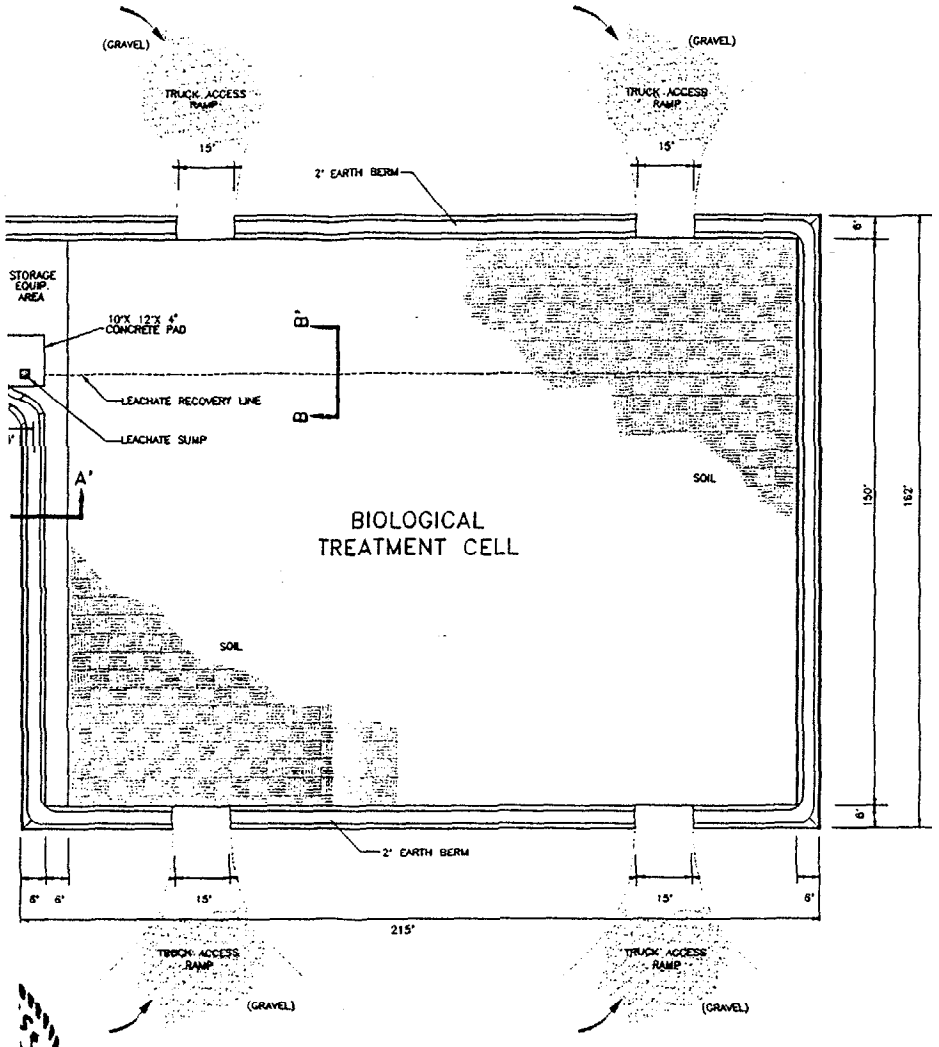
Following confirmation testing and completion of treatment to the specified standards, the soil is stockpiled with a light bulldozer and loaded onto the transport vehicle for transport to the landfill for use as daily cover. The soil is tarped and covered to ensure containment within the transport vehicle.

Finally, all records are updated to reflect the BIOREMEDIATION COMPLETE classification and maintained for future reference.

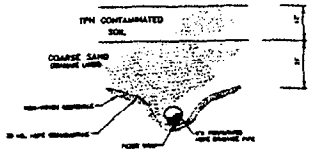
[10] Each remediated soil batch will be used directly as daily landfill cover. The location will be noted in tracking files for future reference.

Appendix A

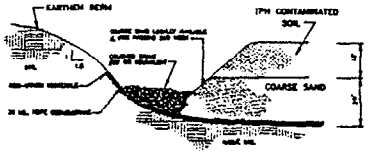
Biocell Construction Plan



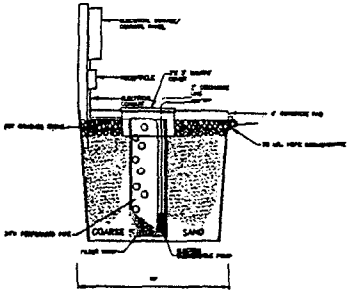
FACILITY LAYOUT DETAIL
PLAN VIEW
SCALE: 1" = 20'



SECTION B-B'
N.T.S.



SECTION A-A'
N.T.S.



SUMP DETAIL
N.T.S.

20 0 10 20
1 INCH = 20 FEET

BY	DATE	APP.
-	-	

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION NORFOLK, VIRGINIA

NEESA CONTRACT N47408-92-D-3042 DELIVERY ORDER NO. 0032

OPERABLE UNIT NO. 2 MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 4

CONSTRUCTION PLAN AND CROSS-SECTIONS

DRAWING NUMBER: G-1

SHEET NUMBER: _ of _

DATE: 7/19/95