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LETTER REPORT WORK PLAN FOR CHEMICAL INJECTION USING DIRECT PUSH TECHNOLOGY AT BP WELL SITES NAS CECIL FIELD FL

6/14/2011

TETRA TECH

TETRA TECH

PITT-06-11-033

June 14, 2011

Project Number 112G02267

Mr. David Grabka
Remedial Project Manager
Technical Review/Federal Facilities.
Florida Department of Environmental Protection
2600 Blairstone Road
Tallahassee, Florida 32399-2400

Reference: CLEAN IV Contract Number N62470-08-D-1001
Contract Task Order JM09

Subject: Work Plan for Chemical Injection Using Direct Push Technology
BP Wells Site
Naval Air Station Cecil Field
Jacksonville, Florida

Dear Mr. Grabka:

On behalf of the Navy, Tetra Tech, Inc. (Tetra Tech) is pleased to submit this Work Plan to evaluate the effectiveness of chemical injection using direct push technology (DPT) to remediate petroleum related contaminants at the BP Wells Site. This Work Plan was prepared for Naval Facilities Engineering Command Southeast (NAVFAC SE) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001.

The primary objective of this Work Plan is to implement a direct-injection slurry application of Oxygen Release Compound (ORC^{TM}) Advanced, prepared by Regenesis, at twenty-four injection points to treat a volatile organic compound (VOC) plume which lies within the vicinity of wells CEF-BP-1S and CEF-BP-6S, which have not shown any significant reductions in contamination levels since July 2008.

BACKGROUND

The BP Wells Site is located on the north-south flightline, southeast of Building 880. During assessment activities in 1999 and 2000, five shallow wells (CEF-BP-1S through CEF-BP-4S and CEF-BP-6S) and one intermediate well (CEF-BP-5I) were installed at the site and subsequently sampled. The groundwater was determined to be contaminated with petroleum-related hydrocarbons. After this initial assessment, Tetra Tech conducted a Site Assessment to identify the extent of groundwater contamination and the groundwater flow direction (Tetra Tech, 2000).

Based on the results of the Site Assessment, a Natural Attenuation Monitoring Plan (NAMP) was prepared and submitted in 2000 to the Florida Department of Environmental Protection (FDEP), which issued a NAMP Approval Order (NAMPAO) on August 31, 2000 (FDEP, 2000). In accordance with this NAMPAO, Tetra Tech performed the first two semi-annual monitoring events in April and October 2001. Hydrocarbon concentrations [1,2,4-trimethylbenzene (TMB), 1,3,5-TMB, ethylbenzene, toluene, and total xylenes] in groundwater exceeded FDEP Natural Attenuation Default Concentrations (NADCs) during both sampling events (Tetra Tech 2001a). The second monitoring report recommended that a Remedial

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Action Plan (RAP) be prepared for this site because contaminant concentrations at the source well (CEF-BP-1S) were greater than NADCs and there was a significant increase in contaminant concentrations from April 2001 to October 2001 (Tetra Tech, 2001b). On February 20, 2002, FDEP concurred that a RAP was warranted. A treatability study was recommended and approved to evaluate the effectiveness of in-situ enhanced bioremediation as a possible remedy to be included in the RAP, and a work plan was prepared and approved. The treatability study was conducted between October 2002 and November 2003. Injection wells CEF-BP-7S through CEF-BP-9S were installed during the treatability study. Three in-situ oxygen curtain (iSOC) diffusers were installed in wells CEF-BP-7S through CEF-BP-9S, which were located about 10 to 15 feet from CEF-BP-5I, CEF-BP-1S, and CEF-BP-6S, respectively. The results of these oxygen injections were evaluated by Tetra Tech in the April 2004 Enhanced Natural Attenuation Treatability Study Evaluation Report for the BP Wells Site, and it was determined that remediation efforts were not completely successful (Tetra Tech, 2004). Further groundwater monitoring at the BP Wells Site was not completed until the November 2006 event conducted in conjunction with the adjacent Tank G82 Site groundwater sampling. Groundwater analytical results confirmed that natural attenuation was occurring at the BP Wells Site and that concentrations of contaminants of concern (COCs) were decreasing over time (CH2MHill, 2007).

In May 2008, CH2MHill Constructors, Inc. (CH2MHill) submitted an updated NAMP for Building 82 (Tank G82) and BP Wells that recommended long-term semi-annual groundwater sampling for the following COCs based on the results of the November 2006 groundwater sampling event (CH2MHill, 2008).

- Benzene, toluene, ethylbenzene, and xylenes (BTEX) and naphthalene via United States Environmental Protection Agency (U.S. EPA) Method 8260B.
- Polycyclic Aromatic Hydrocarbons (PAHs) including 1-methylnaphthalene and 2-methylnaphthalene via U.S. EPA Method 8270 Selected Ion Monitoring (SIM).
- Total recoverable petroleum hydrocarbons (TRPH) via the Florida Petroleum-Range Organics (FL-PRO) Method.
- Natural attenuation parameters including dissolve methane (Method RSK 175), nitrate/nitrite and sulfate (U.S. EPA Method 300.0).

Semi-annual sampling in accordance with the updated NAMP began in July 2008. FDEP Groundwater Cleanup Target Levels (GCTLs) for ethylbenzene, total xylenes, naphthalene, 1,2,4-TMB, 1,3,5-TMB, and isopropylbenzene were exceeded in the source well (CEF-BP-1S) during the July 2008 sampling event. The July 2008 concentration of isopropylbenzene in downgradient well CEF-BP-6S also slightly exceeded its GCTL (Tetra Tech, 2008).

During the January 2009 sampling event, GCTLs and NADCs for ethylbenzene, xylenes, isopropylbenzene, 1,2,4-TMB, and 1,3,5-TMB were exceeded at CEF-BP-1S. GCTLs for naphthalene, 2-methylnaphthalene, and benzene were also exceeded at CEF-BP-1S, but these concentrations were less than NADCs. The January 2009 concentrations of isopropylbenzene and 1,2,4-TMB also exceeded GCTLs in downgradient well CEF-BP-6S (Tetra Tech, 2009).

During the July 2009 sampling event, GCTLs and NADCs for 1,2,4-TMB, 1,3,5-TMB, isopropylbenzene, and xylenes were exceeded at CEF-BP-1S. The GCTLs for ethylbenzene and benzene were also exceeded at the source well (CEF-BP-1S). Concentrations of 1,2,4-TMB, isopropylbenzene, and xylenes exceeded GCTLs at CEF-BP-6S; concentrations of benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded GCTLs at upgradient well CEF-BP-7S; and concentrations of benzo(a)anthracene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded GCTLs at downgradient well CEF-BP-9S.

During the January 2010 sampling event, GCTLs and NADCs for total xylenes, 1,2,4-TMB, 1,3,5-TMB, and isopropylbenzene were exceeded in source well CEF-BP-1S, and concentrations of naphthalene and ethylbenzene exceeded GCTLs only. GCTLs for 1,2,4-TMB, isopropylbenzene, 1,3,5-TMB, ethylbenzene, total xylenes, and naphthalene were exceeded in CEF-BP-6S, and concentrations of 1,2,4-TMB, total xylenes, and isopropylbenzene also exceeded NADCs (Tetra Tech, 2010a).

In April 2010, Tetra Tech submitted a Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP), approved by FDEP in May 2010, which recommended long-term semi-annual monitoring of the following COCs based on discussions at the August 2009 Data Quality Objective (DQO) Meeting (Tetra Tech 2010b):

- VOCs – ethylbenzene, isopropylbenzene, 1,2,4-TMB, 1,3,5-TMB, and total xylenes via U.S. EPA Method 8260B.
- PAHs – 2-methylnaphthalene and naphthalene via U.S. EPA Method 8270 SIM.
- TRPH via the FL-PRO Method.

Based on discussions at the February 2010 Base Realignment and Closure (BRAC) Cleanup Team (BCT) meeting (Decision No. 777, Minute 2603) regarding exceedances at downgradient well CEF-BP-6S, additional wells were proposed (BCT, 2010a). The UFP-SAP was not yet submitted as final, but had already been approved by the Navy Chemist; therefore, a Field Task Modification Report (FTMR) was prepared. FTMR No. 01 submitted by Tetra Tech in May 2010 recommended the installation of two shallow groundwater monitoring wells downgradient of CEF-BP-6S and the collection of four soil samples in the vicinity of CEF-BP-1S (with analysis for the same COCs listed in the UFP-SAP, with the addition of 1-methylnaphthalene) to establish a new downgradient groundwater monitoring point for the shallow zone of the surficial aquifer and to ensure that a continuing source in the soil was not contributing to groundwater contamination (Tetra Tech, 2010c). The groundwater monitoring well and soil sample locations were confirmed at the May 2010 BCT meeting (BCT, 2010b).

On July 19, 2010, in accordance with FTMR No. 01, four soil samples were collected from four borings: CEF-BP-SS01 (located adjacent to CEF-BP-1S), CEF-BP-SS02, CEF-BP-SS03, and CEF-BP-SS04 (located approximately 10 feet west, northwest, and north, respectively, from CEF-BP-1S). No borings were installed south or east of CEF-BP-1S because of Building 838 and the flightline. Soil samples were collected at 1-foot intervals until the water table was encountered [approximately 4.5 feet below ground surface (bgs)] and tested with an organic vapor analyzer-flame ionization detector (OVA-FID).

Concentrations reported by the laboratory for soil samples collected during this sampling event were compared to FDEP Soil Cleanup Targer Levels (SCTLs). Concentrations of benzo(a)pyrene equivalents (BaPEqs) exceeded the residential SCTL of 0.1 mg/kg in soil samples CEF-BP-SS01. TRPH concentrations exceeded residential and leachability SCTLs in CEF-BP-SS01 and CEF-BP-SS04. No other analytes were detected in excess of SCTLs in any of the other soil samples, as reported in the Groundwater Monitoring and Supplemental Soil Sampling Report, 1st Semi-Annual, 3rd Year – July 2010 report (Tetra Tech 2010d).

During the November 2010 BCT meeting it was decided that wells CEF-BP-7S and CEF-BP-8S no longer required monitoring, but water levels would continue to be collected from these wells and also that no further action with regards to soils was required at this time (BCT, 2010c). An FTMR was prepared to reflect this change to the monitoring program.

During the January 2011 sampling event, GCTLs for total xylenes, 1,2,4-TMB, 1,3,5-TMB, isopropylbenzene, naphthalene, and ethylbenzene were exceeded in groundwater from source well CEF-BP-1S. GCTLs for 1,2,4-TMB, isopropylbenzene, 1,3,5-TMB, ethylbenzene, total xylenes, and naphthalene were exceeded in CEF-BP-6S. Concentrations of 1,2,4-TMB, isopropylbenzene, and total xylenes in groundwater from CEF-BP-6S also exceeded NADCs (Tetra Tech, 2011).

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It was agreed upon during the May 2011 BCT meeting that ORC™ Advanced would be appropriate for use at the BP Wells Site. It was decided that an ORC™ Advanced injection Work Plan would be prepared by Tetra Tech to identify necessary actions to take place during the injection event (BCT, 2011).

FIELD GUIDANCE

The following section and attachments provide information regarding the injection of ORC™ Advanced using DPT. This procedure is being implemented at the BP Wells Site to address ethylbenzene, total xylenes, 1,2,4-TMB, 1,3,5-TMB, isopropylbenzene, and naphthalene contamination in groundwater at levels exceeding FDEP NADCs and/or FDEP GCTLs.

Twenty-four injection points have been identified as shown on Figure 1. Tetra Tech will procure and oversee the services of a qualified drilling subcontractor to perform the injection. The layout is designed to treat a 1,200 square-foot area encompassing wells CEF-BP-1S and CEF-BP-6S at a depth of 5- to 20-feet bgs, resulting in a total volume of 18,000 cubic-feet as identified in the Proposal for Remediation Using ORC Advanced at BP Wells Site provided as Attachment 1. The injection points are effectively spaced at 7-foot intervals (1 point every 50 square-feet) and can be adjusted in the field to accommodate site features, for example underground utilities, as needed.

Utility clearance will be conducted and verified via hand auger to a depth of 5-feet. The injection points are located in both paved and unpaved areas. A 3-inch to 4-inch core will be required for the points located on the concrete airplane apron. The estimated thickness of the concrete is 18-inches.

A total of 1,800 pounds of ORC™ Advanced, delivered as a fine powder, will be mixed with a total of 504 gallons of water to create a slurry product. The instructions for creating the slurry are provided in Attachment 2. The slurry mix will be evenly distributed among each of the twenty-four injection points (75 lbs of product combined with 21 gallons of water) as identified in the Proposal in Attachment 1. Slurry will be prepared in batches with the volume based on the amount which can be injected within 30 minutes. Recommended instructions for the direct injection of the slurry as provided by Regenesis are provided as Attachment 3. The Material Safety Data Sheet (MSDS) for ORC™ Advanced is provided as Attachment 4. Soil boring advancement will be conducted at all twenty-four locations to a depth of 20-feet bgs and the slurry will be injected in equal amounts from 20 feet bgs to the top of the water table which is assumed to be 5 feet bgs. Upon completion of the chemical injection, the probe holes will be finished at surface with native soil in the unpaved areas and with a high strength concrete mixture for the concrete pavement areas.

Information regarding the use of ORC™ Advanced on petroleum projects in Florida is provided in Attachment 5.

Tetra Tech will continue to monitor the groundwater at this site in accordance with the UFP-SAP. Prior to the injection of the ORC™ Advanced a baseline evaluation of the standard water quality parameters (pH, DO, ORP, and specific conductance) and fixed base analysis of chemical oxygen demand (COD), biological oxygen demand (BOD), total and dissolved iron, and methane will be collected. These parameters will be collected during the next two regularly scheduled semi-annual groundwater sampling events after the injection has been completed. The chemical injection is tentatively scheduled to be conducted after Building 838, septic tank, and oil/water separator are removed and before the construction of the new hangar begins. This timeframe is currently anticipated to occur during summer 2011. Any monitoring wells that are included in the groundwater monitoring program and are damaged or abandoned during the construction activities will be replaced by the construction contractor.

If you have any questions regarding this submittal, please feel free to contact me at (412) 921-8163 or via e-mail at Robert.Simcik@tetratech.com.

TETRA TECH

Sincerely,

Robert F. Simcik, P.E.
Task Order Manager

RFS/clm

Attachments (5)

c: A. Sanford, BRAC PMO SE (electronic copy)
M. Davidson, BRAC PMO SE (electronic copy)
S. Martin, NAVFAC Atlantic (electronic copy)
D. Vaughn-Wright, U.S. EPA (electronic copy)
M. Halil, CH2M Hill (electronic copy)
S. Currie, Tetra Tech CTO JM09 project file (1 copy, unbound)
J. Trepanowski, Tetra Tech
M. Jonnet, Tetra Tech (electronic copy)
M. Boerio, Tetra Tech (electronic copy)
J. Johnson, Tetra Tech (1 copy for Information Repository)

CERTIFICATION

The information contained herein is based on the investigation data and information obtained from previously submitted reports. If conditions are determined to exist that differ from those described, the undersigned engineer should be notified to evaluate the effects of any additional information on the information described in this report. This Work Plan for Chemical Injection Using Direct Push Technology was submitted for the EP Wells Site at Former Naval Air Station Cecil Field, Jacksonville, Florida, and should not be construed to apply to any other site.

STATE OF FLORIDA
No. 00061263
PROFESSIONAL ENGINEER

Robert F. Simcik, P.E.
P.E. License Number 61263

REFERENCES

BCT (Base Realignment and Closure Cleanup Team), 2010a. Minutes of Meeting. Minutes Reference No. 2603, Decision No. 777, February 2.

BCT, 2010b. Minutes of Meeting. Minutes Reference No. 2621, May 5.

BCT, 2010c. Minutes of Meeting. Minutes Reference No. 2651, Decision Nos. 794 and 795, November 3.

BCT, 20111. Minutes of Meeting. Minutes Reference No. 2682, Decision No. 813, May 11.

CH2MHill (CH2MHill Constructors, Inc), 2007. Evaluation of Groundwater Analytical Results, BP Wells Site and Building 82 (Tank G82), Naval Air Station Cecil Field, Jacksonville, Florida. April.

CH2MHill, 2008. Natural Attenuation Monitoring Work Plan, BP Wells Site and Building 82 (Tank G82), Naval Air Station Cecil Field, Jacksonville, Florida. May.

FDEP (Florida Department of Environmental Protection), 2000. Natural Attenuation Monitoring Plan Approval Order for BP Wells Area, Naval Air Station Cecil Field, Jacksonville, Florida, August.

Tetra Tech (Tetra Tech NUS, Inc), 2000. Site Assesssment Report – BP Wells and North-South Apron Plume, Naval Air Station Cecil Field, Jacksonville, Florida, July.

Tetra Tech, 2001a. Groundwater Monitoring Report, 1st Semi-Annual, 1st Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. September.

Tetra Tech, 2001b. Groundwater Monitoring Report, 2nd Semi-Annual, 1st Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. January.

Tetra Tech, 2004. Enhanced Natural Attenuation Treatability Study Evaluation Report, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. April.

Tetra Tech, 2008. Groundwater Monitoring Report, 1st Semi-Annual, 1st Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. November.

Tetra Tech, 2009. Groundwater Monitoring Report, 2nd Semi-Annual, 1st Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. July.

Tetra Tech, 2010a. Groundwater Monitoring Report, 2nd Semi-Annual, 2nd Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. May.

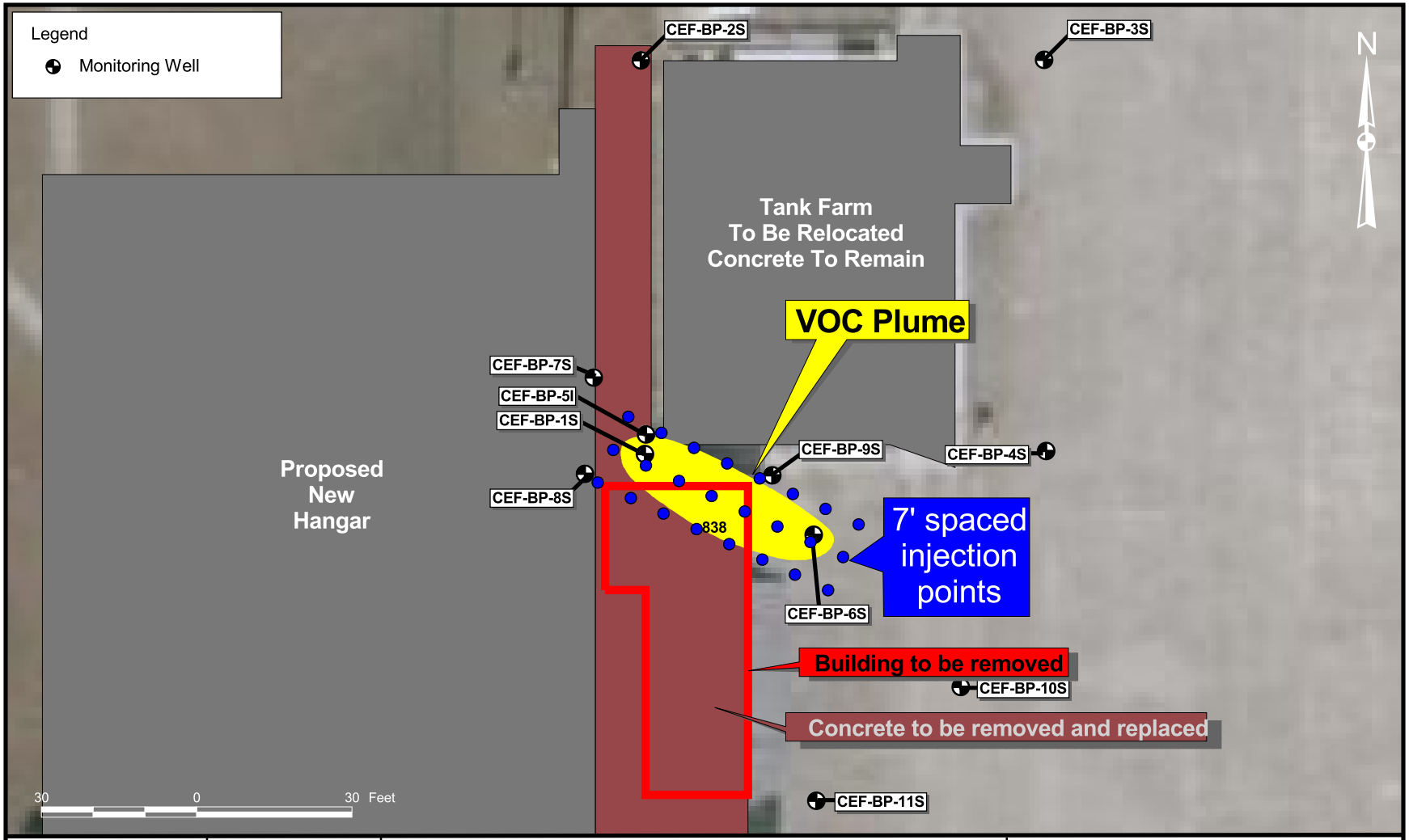
Tetra Tech, 2010b. Final Sampling and Analysis Plan, Petroleum Sites: North-South Apron, Building 82 (Tank G82), BP Wells, 815 Wash Rack, Naval Air Station Cecil Field, Jacksonville, Florida. May.

Tetra Tech, 2010c. Field Task Modification Request Form, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. May.

Tetra Tech, 2010d. Groundwater Monitoring and Supplemental Soil Sampling Report, 1st Semi-Annual, 3rd Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. December.

Tetra Tech, 2011. Groundwater Monitoring Report, 2nd Semi-Annual, 3rd Year, BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. March.

FIGURE



DATE		DRAWN BY	CONTRACT NUMBER
MJJ	09Apr10		2267
CHECKED BY	DATE	APPROVED BY	DATE
COST/SCHEDULE-AREA		APPROVED BY	DATE
SCALE		DRAWING NO.	REV
AS NOTED		FIGURE 1	0

NAVFAC

GROUNDWATER INJECTION LOCATIONS
CHEMICAL INJECTION WORK PLAN
BP WELLS SITE
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

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Attachment 1

Proposal for Remediation Using ORC Advanced at BP Wells Site
Located at Naval Air Station Cecil Field, Jacksonville, Florida
(Regenesis Proposal No. bmont39602-revA)

REGENESIS

April 26, 2011

Robert Simcik, P.E.
Tetra Tech Civil Engineering Group
661 Anderson Drive, Foster Plaza #7
Pittsburg, PA 15220

RE: Proposal for Remediation using ORC Advanced at BP Wells Site Located at Naval Air Station Cecil Field, Jacksonville, Florida
Regenesis Proposal No. bmont39602-revA

Dear Robert:

Thank you for the opportunity to technically evaluate this project. Below we have provided information related to the design and application of ORC Advanced® to treat dissolved-phase residual petroleum hydrocarbons within the defined target treatment area at the above-referenced site.

The following attachments contain information pertinent for our proposed remedial design:

1. Site Map Depicting the Proposed Treatment Area.

2. ORC Advanced Design Summary Calculations.

Product Description

ORC Advanced contains ~17% active oxygen and will provide a controlled release of molecular oxygen for up to 12 months upon hydration. Further details of ORC Advanced can be found at the following website link: ORC Advanced.

Product Quantities and Cost*

ORC Advanced

Quantity – 1,800 lbs

ORC Advanced Product Cost - $15,750

*The above cost does not include freight or applicable taxes. Please contact Regenesis customer service at 949-366-8000 for a shipping quote.

Proposed Application Design

Our proposed treatment plan includes 1 application of ORC Advanced to provide an oxygen source for aerobic biodegradation of hydrocarbon mass in the area encompassing monitoring wells CEF-BP-1s and CEF-BP-6s. ORC Advanced will sustain aerobic levels and enhance aerobic biodegradation for up to 12

months. The attached site map graphically depicts the proposed design. The attached ORC Advanced Design Summary Output Page specifies input parameters used to determine product quantity estimates and design assumptions.

Please note that this design accounts for treatment of an approximate 1,200 square ft area as denoted on the attached site plan. We have designed for approximate 7 ft effective spacing between injection points (24 points total or 1 point every 50 square ft). Points can be placed in the field to accommodate site features. Regenesis can further assist with injection point spacing as this project moves forward.

Application Guidance

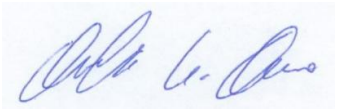
We propose the use of direct push technology injection techniques to apply ORC Advanced. Guidance for the mixing and application of ORC Advanced can be found at the following website link: ORC Advanced.

Groundwater Monitoring

We recommend collecting the following groundwater parameters prior to and during quarterly performance monitoring following completion of the injection activities: chemicals of concern, pH, dissolved oxygen, oxidation-reduction potential, specific conductance, chemical oxygen demand, biological oxygen demand, total and dissolved iron, and methane.

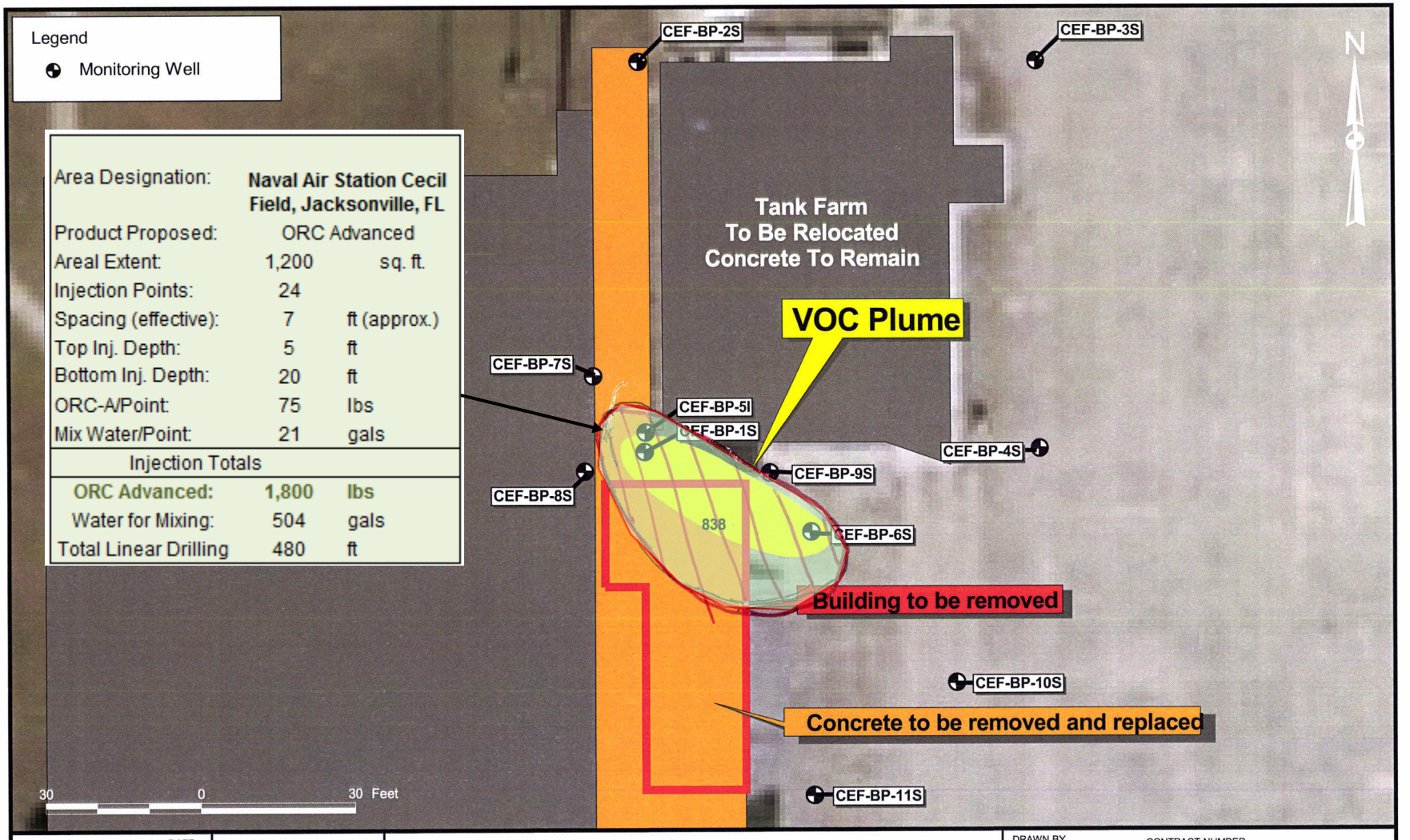
Regenesis appreciates the opportunity to present you with this proposal. If you need any additional information please feel free to contact Barry Poling at 812-923-7999 or me at 614-447-0492.

REGENESIS



Douglas A. Davis
Technical Services Manager – Central Region

attachments



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MONITORING WELL LOCATION MAP
2nd SEMI-ANNUAL, YEAR 3 EVENT - JANUARY 2011
GROUNDWATER MONITORING REPORT
BP WELLS SITE
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

NAVFAC

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ORC Advanced Design Summary Output Page - Grid Application

Regenesis Technical Support: USA (949) 366-8000

www.regenesis.com

Regensis Proposal:	**bmont39602**
Date:	4/26/2011
Site Name:	BP Wells Site
Treatment Area Location:	Naval Air Station Cecil Field, Jacksonville, FL
Consultant (Contact):	Tetra Tech

ORC Advanced Grid-Based Design Specifications
BP Wells Site
Naval Air Station Cecil Field, Jacksonville, FL

Design Specification Summary		**Units**
Treatment Area Location	Naval Air Station Cecil Field, Jacksonville, FL	
Treatment Areal Extent	1,200	ft^2
Vertical Treatment Thickness	15	ft
Top Treatment Interval	5	ft
Bottom Treatment Interval	20	ft
Treatment Volume	18,000	ft^3
Method of Application (Direct Push/Inj. Wells)	Direct Push	---
Soil Type (sand, silt, gravel, clay, etc.)	sand	---
Porosity	0.33	cm^3/cm^3
Effective Porosity	0.25	cm^3/cm^3
Hydraulic Conductivity	25	ft/day
Hydraulic Gradient	0.005	ft/ft
Seepage Velocity	182.5	ft/yr
Application Design		**Units**
Number of Injection Points	24	---
Injection Point Spacing (within rows)	7	ft on center
Injection Point Spacing (between rows)	8	ft on center
Application Rate	5	lb/ft
Total ORC Advanced Requirement	**1,800**	**lbs**
Field Mixing/Injection Ratios		**Units**
ORC Advanced Slurry %	30%	%
ORC Advanced per Point	75	lbs
Mixing Water per Point	21	gallons
Total Water to be Injected	504	gallons
Volume ORC-A Slurry (ORC-A + water) to be injected per point (can vary +/-20%)*	23	gallons
Total Linear Footage to be Drilled	480	ft

*Water can be increased up to a 20% solution (up to 30 gallons per point) to make ORC-A slurry volume that is easily injectable across desired injection lifts.

ORC Advanced Grid-Based Design Assumptions

BP Wells Site

Naval Air Station Cecil Field, Jacksonville, FL

Dissolved Phase Contaminants	Concentration	Units
Benzene	0.00	mg/L
Toluene	0.0	mg/L
Ethylbenzene	0.2	mg/L
Xylenes	0.3	mg/L
MTBE	0.0	mg/L
cis-1,2-DCE	0.0	mg/L
Vinyl Chloride	0.0	mg/L
1,2,4-trimethylbenzene	0.20	mg/L
1,3,5-trimethylbenzene	0.0	mg/L
Reduced metals: Fe+2 and Mn+2	10.0	mg/L
TPH	0.0	mg/L
Chemical Oxygen Demand (COD)	0.0	mg/L
Dissolved Phase Contaminant Mass	***3.95***	***lbs***
Sorbed Phase Contaminants	**Concentration**	**Units**
Benzene	0.0	mg/kg
Toluene	0.0	mg/kg
Ethylbenzene	0.1	mg/kg
Xylenes	0.2	mg/kg
MTBE	0.0	mg/kg
cis-1,2-DCE	0.0	mg/kg
Vinyl Chloride	0.0	mg/kg
1,2,4-trimethylbenzene	0.3	mg/kg
Napthalene	0.1	mg/kg
Sorbed Phase Contaminant Mass	***1.5***	***lbs***

Additional Assumptions/Qualifications

1) Data Used for Modeling - Groundwater monitoring data provided by client dated January 2011 for monitoring well CEF-BP-6s.

Attachment 2

Regenesis ORC™ Installation Instructions
(Slurry Mixing)

REGENESIS

Oxygen Release Compound (ORC®) Installation Instructions

(Slurry Mixing)

1. OPEN 5 GALLON BUCKET, AND REMOVE PRE-MEASURED BAG OF ORC.
2. MEASURE AND POUR WATER INTO THE 5-GALLON BUCKET ACCORDING TO THE FOLLOWING DESIRED CONSISTENCY:

65% Solids Slurry	Mix .63 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 1.26 gallons of water.
		Mix 30 pounds of ORC with 1.89 gallons of water.
60% Solids Slurry	Mix .79 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 1.58 gallons of water.
		Mix 30 pounds of ORC with 2.37 gallons of water.
50% Solids Slurry	Mix 1.19 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 2.38 gallons of water.
		Mix 30 pounds of ORC with 3.57 gallons of water.
25% Solids Slurry	Mix 3.57 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 10 pounds of ORC with 3.57gallons of water.

3. ADD THE APPROPRIATE ORC QUANTITY TO THE WATER. Check weight of each bucket (see label). The 5 gallon shipping bucket weighs 2 pounds. An additional 4 pounds of ORC would require one additional quart of water, at the 65% solids level.
4. USE AN APPROPRIATE MIXING DEVICE TO THOROUGHLY MIX ORC AND WATER. A hand held drill with a “jiffy mixer” or a stucco mixer on it may be used in conjunction with a small paddle to scrape the bottom and sides of the container. Standard environmental slurry mixers may also be used, following the equipment instructions for operation. For small quantities a usable slurry can be mixed by hand, if care is taken to blend all lumps into the mixture thoroughly.

CAUTION: ORC MAY SETTLE OUT OF SLURRY IF LEFT STANDING. ALSO, ORC EVENTUALLY HARDENS INTO A CEMENT-LIKE COMPOUND, AND CANNOT BE RE-MIXED AFTER THAT HAS HAPPENED. THEREFORE:

Mix immediately before using. Do not let stand more than 30 minutes, and re-mix immediately before use, to be sure the mixture has not settled out. If a mechanical slurry mixer attached to a pump is being used, the material may be cycled back through the mixer to maintain slurry suspension and consistency.

5. CHECK SLURRY CONSISTENCY FOR POURABILITY. ADD WATER IF NECESSARY (IN 1 CUP INCREMENTS) TO ACHIEVE THE CORRECT CONSISTENCY.

For direct assistance or answers to any questions you may have regarding these instructions, contact Regenesis Technical Services at 949-366-8000.

Attachment 3

Regenesis ORC™ Installation Instructions
(Direct-Injection Slurry Application)

REGENESIS

Oxygen Release Compound (ORC®) Installation Instructions

(Direct-Injection Slurry Application)

SAFETY:

Pure ORC is shipped to you as a fine powder rated at -325 mesh (passes through a 44 micron screen). It is considered to be a mild oxidizer and as such should be handled with care while in the field. Field personnel should take precautions while applying the pure ORC. Typically, the operator should work upwind of the product as well as use appropriate safety equipment. These would include eye and respiratory protection, and gloves as deemed appropriate by exposure duration and field conditions.

Personnel operating the field equipment utilized during the installation process should have appropriate training, supervision and experience.

GENERAL GUIDELINES:

ORC may be installed in the contaminated saturated zone in the ground utilizing hand augered holes, Geoprobe® type hydraulic punch equipment, or hollow stem augers. This set of instructions is specific for Geoprobe equipment. Alternate instructions may be obtained from the Regenesis Technical Support Department.

For optimum results the ORC slurry installation should span the entire vertical contaminated saturated thickness, including the capillary fringe and “smear zone”.

Two general installation approaches are available. The first is to backfill only the probe hole with slurry. This is a simple approach, in that it is easy, straightforward, and the location of the ORC slurry is precisely known after installation. However, this method requires significantly more probe holes than the alternative, and may take more time for the completion of the remediation process. A separate set of instructions for this method utilizing Geoprobe equipment is available from Regenesis.

The second method is to inject the slurry through the probe holes into the contaminated saturated zone. This method requires fewer probe holes, is less disruptive to the site, and aids the spread of oxygen by spreading the ORC source material. However, it may be difficult to know the exact, final disposition of the ORC installed with this method. This is the method described in these instructions.

Note: It is important that the installation method and specific ORC slurry point location be established prior to field installation. It is also important that the ORC slurry volume and solids content for each drive point be predetermined. The Regenesis Technical Service Department is available to discuss these issues, and Helpful Hints at the end of these instructions offers relevant information. Regenesis also has available Technical Bulletins covering source treatments with ORC.

SPECIFIC INSTALLATION PROCEDURES

1. Identify the location of all underground structures, including utilities, tanks, distribution piping, sewers, drains, and landscape irrigation systems.
2. Identify surface and aerial impediments.
3. Adjust planned installation locations for all impediments and obstacles.
4. Pre-mark the installation grid point locations, noting any that have special depth requirements.
5. Set up the Geoprobe unit over each specific point, following manufacturer recommended procedures. Care should be taken to assure approximate vertical probe holes.
6. Penetrate surface pavement, if necessary, following standard Geoprobe procedures.
7. Drive the 1 1/2" (one-and-one-half inch) pre-probe (part #AT-148B) with the expendable tip (part #AT142B) to the desired maximum depth. Standard 1" (one inch) drive rods (part AT104B) should be used, after the pre-probe. (Hint: Pre-counted drive rods should be positioned prior to the installation driving procedure to assure the desired depth is reached.)
8. Disconnect the drive rods from the expendable tip, following standard Geoprobe procedures.
9. Mix the appropriate quantity of ORC slurry for the current drive point. (See separate "Directions for ORC® Slurry Mixing" and Helpful Hints). **Note: Do not mix more slurry than will be used within a 30 minute period.**
10. Set up and operate an appropriate slurry pump according to manufacturer's directions. Based on our experience, a Geoprobe model GS-1000 pump is recommended. Connect the pump to the probe grout pull cap (GS-1054) via a 1 inch diameter delivery hose. The hose is then attached to the 1" drive rod with its quick connector fitting. Upon confirmation of all connections add the ORC slurry to the pump hopper/tank.
11. Withdraw the pre-probe and drive stem 4' (four feet). (Also note Helpful Hints - Operations at end of instructions.)
12. Optional pretreatment step. (See Helpful Hints - Operations at end of instructions). Pump one to two gallons of tap water into the aquifer to enhance dispersion pathways from the probe hole.
13. Pump the predetermined quantity of ORC slurry for the depth interval being injected. Observe pump pressure levels for indications of slurry dispersion or refusal into the aquifer. (Increasing pressure indicates reduced acceptance of material by the aquifer).
14. Remove one 4' section of the 1" drive rod. The drive rod will contain slurry. This slurry should be returned to the ORC bucket for reuse.
15. Repeat steps 11, 13, and 14 until treatment of the entire affected thickness has been achieved. It is generally recommended that the procedure extend to the top of the capillary fringe/smear zone.
16. Install an appropriate seal, such as bentonite, above the ORC slurry through the entire vadose zone. This helps assure that the slurry stays in place and prevents contaminant migration from the surface. Depending on soil conditions and local regulations, a bentonite seal can be pumped through the slurry pump or added via chips or pellets after probe removal.
17. Remove and decontaminate the drive rods and pre-probe.

18. Finish the probe hole at surface as appropriate (concrete or asphalt cap, if necessary).
19. Move to the next probe point, repeating steps 5 through 18.

HELPFUL HINTS:

A. Physical characteristics

A1. Slurry

The ORC slurry is made using the dry ORC powder (rated at -325 mesh). It makes a smooth slurry, with a consistency that depends on the amount of water used.

A thick, but pumpable, slurry that approaches a paste can be made by using 65-67% solids. This material would normally be used for back-filling a bore or probe hole. It is especially useful where maximum density is desired such as where ground water is present in the hole or there are heaving sands.

Thinner slurries can be made by using more water. Typical solids for the thinner slurries content will range from 35% to 62%. Such slurries are useful for injecting through a probe or bore hole into the saturated aquifer.

As a rule, it is best to mix the first batch of slurry at the maximum solids content one would expect to use. It can then be thinned by adding additional water in small increments. By monitoring this process, the appropriate quantities of water for subsequent batches can be determined.

The slurry should be mixed at about the time it is expected to be used. It is best to not hold it for more than 30 minutes. Thinner slurries, especially, can experience a separation upon standing. All ORC slurries have a tendency to form cements when left standing. If a slurry begins to thicken too much, it should be mixed again and additional water added if necessary.

Care should be taken with slurry that may be left standing in a grout pump or hose. Problems can generally be avoided by periodically re-circulating the slurry through the pump and hose back into the pump's mixing or holding tank.

A2. Equipment

Most geotechnical grout pumping equipment has a holding tank with a capacity sufficient for injection.

When applying measured volumes of ORC slurry to probe holes, it is sometimes useful to know the volumes and content of the delivery system lines. The following information may be useful in this regard.

Geoprobe pump: At the end of a pump stroke virtually no deliverable slurry remains in the pump.

5/8" O.D. connecting hose (10 feet long):	0.2 gallons (26 fluid ounces).
Four foot (4') length of 1" drive rod:	.04 gallons (5 fluid ounces).
Three foot (3') length of 1 1/2" pre-probe:	.03 gallons (4 fluid ounces).

Cleaning and maintenance:

Pumping equipment and drive rods can be lightly cleaned by circulating clear water through them. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier's standard procedures and local regulatory requirements.

B. Operating characteristics

B1. Operations - General

Judgment will be needed in the field when injecting ORC slurries. In general, it is relatively easy to inject ORC slurries into sandy soils, and this can usually be accomplished at very moderate pressures. Silts and clays require more pressure, and may accept less slurry.

Careful observation of pressure during slurry pumping is the best indication of the effectiveness of the slurry injection. To test the soil's ability to accept the slurry and to "precondition" the injection point for the slurry, it is sometimes useful to inject a small volume of plain water prior to the slurry. Normally, one-half (0.5) gallons to two (2) gallons would be appropriate.

During injection, increasing pressure and decreasing flow rate are signs of refusal by the soil matrix to accept the slurry. The site geologist should determine whether to increase pressure, and possibly fracture ("frac") the soil matrix to achieve ORC slurry installation in a tight site that has refused the slurry at lower pressures.

B2. Fill Volumes

Probe hole back-filling

Probe hole capacities:

Per 10' (Ten Foot) Length			
Theoretical		**Operating Volume**	
(Gallons/Fluid Ounces/Cubic Inches)		**(Gallons/Fluid Ounces)**	
Sand, Silts & Clay		**Sand**	**Silts & Clay**
1" Diameter	.41 gal/52 fl. oz./94.2 cu. in.	.61 gal/78 fl. oz.	.51 gal/65 fl. oz.
1 1/2" Diameter	.92 gal/117 fl. oz./212.0 cu. in.	1.38 gal/176 fl. oz.	1.15 gal/146 fl. oz.
2" Diameter	1.63 gal/209 fl. oz./376.8 cu. in.	2.44 gal/313 fl. oz.	2.04 gal/261 fl. oz.
2 1/4" Diameter	2.06 gal/264 fl. oz./476.9 cu. in	3.09 gal/396 fl. oz.	2.57 gal/330 fl. oz.

Note that the operating volumes include a 50% excess above the theoretical volume in sands and 25% in clays and silts. This is important to successful treatment. The additional material allows for a small degree of infiltration of the slurry into the surrounding soil and fractures, as well as hole diameter variability. It is important to assure that the entire contaminated saturated zone is treated (including the capillary fringe), since this is often the area of highest pollution concentration. Failure to treat this area due to improper installation can undermine an otherwise successful remediation effort.

For direct assistance or answers to any questions you may have regarding these instructions, contact Regenesis Technical Services at 949-366-8000.

REGENESIS, 2002
www.regenesis.com

Attachment 4

Material Safety Data Sheet (MSDS)
Oxygen Release compound – Advanced (ORC *Advanced*)

Oxygen Release Compound (ORC®)
MATERIAL SAFETY DATA SHEET (MSDS)

Last Revised: **September 14, 2009**

Section 1 - Material Identification

Supplier:

1011 Calle Sombra
San Clemente, CA 92673
Phone: **949.366.8000**
Fax: **949.366.8090**
E-mail: **info@regenesis.com**

Chemical Description:	**A mixture of Magnesium Peroxide (MgO_2), Magnesium Oxide (MgO), and Magnesium Hydroxide [$Mg(OH)_2$]**
Chemical Family:	**Inorganic Chemical**
Trade Name:	**Oxygen Release Compound (ORC®)**
Product Use:	**Used to remediate contaminated soil and groundwater (environmental applications)**

Section 2 – Chemical Identification

CAS#	Chemical
14452-57-4	**Magnesium Peroxide (MgO_2)**
1309-48-4	**Magnesium Oxide (MgO)**
1309-42-8	**Magnesium Hydroxide [$Mg(OH)_2$]**
7758-11-4	**Dipotassium Phosphate (HK_2O_4P)**
7778-77-0	**Monopotassium Phosphate (H_2KO_4P)**
Assay:	**25-35% Magnesium Peroxide (MgO_2)**

Section 3 - Physical Data	
Melting Point:	**Not Determined (ND)**
Boiling Point:	**ND**
Flash Point:	**Not Applicable (NA)**
Self-Ignition Temperature:	**NA**
Thermal Decomposition:	**Spontaneous Combustion possible at ≈ 150°C**
Density:	**0.6 – 0.8 g/cc**
Solubility:	**Reacts with Water**
pH:	**Approximately 10 in saturated solution**
Appearance:	**White Powder**
Odor:	**None**
Vapor Pressure:	**None**
Hazardous Decomposition Products:	**Not Known**
Hazardous Reactions:	**Hazardous Polymerization will not occur**
Further Information:	**Non-combustible, but will support combustion**

Section 4 – Reactivity Data	
Stability:	**Product is stable unless heated above 150 °C. Magnesium Peroxide reacts with water to slowly release oxygen. Reaction by product is Magnesium Hydroxide**
Conditions to Avoid:	**Heat above 150 °C. Open Flames.**
Incompatibility:	**Strong Acids. Strong Chemical Agents.**
Hazardous Polymerization:	**None known.**

Section 5 - Regulations	
Permissible Exposure Limits in Air	**Not Established. Should be treated as a nuisance dust.**

Section 6 – Protective Measures, Storage and Handling	
Technical Protective Measures	
Storage:	**Keep in tightly closed container. Keep away from combustible material.**
Handling:	**Use only in well ventilated areas.**
Personal Protective Equipment (PPE)	
Respiratory Protection:	**Recommended (HEPA Filters)**
Hand Protection:	**Wear suitable gloves.**
Eye Protection:	**Use chemical safety goggles.**
Other:	**NA**
Industrial Hygiene:	**Avoid contact with skin and eyes**
Protection Against Fire & Explosion:	**NA**
Disposal:	**Dispose via sanitary landfill per state/local authority**
Further Information:	**Not flammable, but may intensify a fire**
After Spillage/Leakage/Gas Leakage:	**Collect in suitable containers. Wash remainder with copious quantities of water.**
Extinguishing Media:	**NA**
Suitable:	**Carbon Dioxide, dry chemicals, foam**
Further Information:	**Self contained breathing apparatus or approved gas mask should be worn due to small particle size. Use extinguishing media appropriate for surrounding fire.**
First Aid:	**After contact with skin, wash immediately with plenty of water and soap. In case of contact with eyes, rinse immediately with plenty of water and seek medical attention.**

Section 7 – Information on Toxicology

Toxicity Data:	**Not Available**

Section 8 – Information on Ecology

Water Pollution Hazard Raging (WGK):	**0**

Section 9 – Further Information

After the reaction of magnesium peroxide with water to form oxygen, the resulting material, magnesium hydroxide, is mildly basic. The amounts of magnesium oxide (magnesia) and magnesium hydroxide in the initial product have an effect similar to lime, but with lower alkalinity.

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available.

Attachment 5

FDEP approval correspondence
ORC Advanced Oxygen Release Compound
(February 4, 2005)

Department of
Environmental Protection

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Jeb Bush
Governor

Colleen M. Castille
Secretary

February 4, 2005

Mr. Peter Kalleres
Regenesis
1707 Forest Avenue
Neptune Beach, Florida 32266

Re: **ORC *Advanced* ™ Oxygen Release Compound**

Dear Mr. Kalleres:

The Bureau of Petroleum Storage Systems hereby accepts ORC *Advanced* Oxygen Release Compound as a stimulant for in situ bioremediation of petroleum and other suitable contaminants in groundwater and soil. As Regenesis has indicated, ORC *Advanced* contains calcium oxyhydroxide, and is formulated in such a way that it slowly releases its full 17 percent (by weight) oxygen when wetted, for the purpose of accelerating the growth of microorganisms that biodegrade contaminants. The chemical composition of ORC *Advanced* is shown in enclosure 1.

This acceptance applies only to the jurisdiction of this Bureau, which is the cleanup of petroleum pursuant to Chapter 62-770, Florida Administrative Code (F.A.C.). Other bureaus within the Florida Department of Environmental Protection, or other state agencies and local governments may choose to recognize this acceptance if their needs and requirements are similar, but this Bureau is not responsible for applications beyond its jurisdiction.

For vadose remediation, if the underlying groundwater will not be affected by leaching of this product, there are no special concerns beyond those that would normally need to be addressed in preparing a Remedial Action Plan and conducting a cleanup in accordance with the petroleum cleanup requirements of Chapter 62-770, F.A.C. But for in situ groundwater remediation, via direct injection of ORC *Advanced* into an aquifer, there are underground injection control (UIC) regulations that must be observed. Since in situ aquifer remediation is likely to be the most common application of this product, the bulk of the regulatory requirements discussed herein will be directed to that topic.

The bureau recognizes ORC *Advanced* as a viable product for the bioremediation of petroleum contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a Remedial Action Plan is approved by the Department; and (c) applicable and appropriate underground injection control regulations are observed when the product is used for injection-type in situ aquifer remediation. For ORC *Advanced*, the major environmental and regulatory considerations are set forth in enclosure 2.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it

does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health and safety. Vendors must then market the products and processes on their own merits regarding performance, cost and safety against competing alternatives in the marketplace. In no way, however, shall this regulatory letter of acceptance be construed as certification of product performance. Additionally, the Department emphasizes a distinction between regulatory "acceptance" and approval. Products and processes are accepted; they are not approved.

Those who prepare Remedial Action Plans may include a copy of this letter in the appendix of plans they submit, and call attention to it in the text of their document. In this way, technical reviewers throughout the state will be informed that you have contacted the Department of Environmental Protection to inquire about ORC *Advanced*'s environmental acceptability. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 3.

Even though it may be convenient to have an acceptance letter for inclusion in the appendix of a plan, as suggested above, the Bureau would like to emphasize that it is not a requirement for a particular remediation product or process have an official acceptance letter in order to be proposed in a site-specific Remedial Action Plan. The plan, however, must contain sufficient information about the product or process to show that it meets all applicable and appropriate rules and regulations, especially those of the Florida Administrative Code pertaining to groundwater and underground injection control.

The Department reserves the right to revoke its acceptance of a product or process if has been falsely represented. Additionally, Department acceptance of any product or process does not imply it has been deemed applicable for all cleanup situations, or that it is preferred over other treatment or cleanup techniques in any particular case. A site-specific evaluation of applicability and cost-effectiveness must be considered for any product or process, whether conventional or innovative, and adequate site-specific design details must be provided in Remedial Action Plans prescribing the product or process. You may contact me at (850) 877-1133, extension 29 if there are any questions.

Sincerely,

Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Rebecca S. Lockenbach
FDEP Section Leader
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

c: T. Conrardy - FDEP/Tallahassee

Regenesis
1011 Calle Sombra
San Clemente, California 92673

ENCLOSURE 1

ORC *ADVANCED* ™* CHEMICAL COMPOSITION †

(Hydrated) Calcium OxyHydroxide‡ [$CaO(OH)_2$] also known as (Hydrated) Calcium Oxide Peroxide (CAS no. 666235-17-2)	>60% by weight §
Other inorganic calcium compounds (Calcium Hydroxide [$Ca(OH)_2$], and Calcium Carbonate [$CaCO_3$])	>35% by weight §
Phosphates (to control oxygen release over approx. 12 months)	~3% by weight

† Information from Material Safety Data Sheet dated November 22, 2004 by Regenesis, San Clemente, California.

‡ Active ingredient.

§ Percent by weight for product as shipped by the manufacturer: dry, powder with a bulk density of 0.5 to 0.65 g/ml.

* For in situ injection-type remediation projects, generally, ORC *Advanced* will be applied as a 20%-40% aqueous slurry. For the pH and total dissolved solids content of the fluid to be injected, Rule 62-522.300(2)(c), Florida Administrative Code, allows an injection zone of discharge.

To comply with the rule, a Department-approved Remedial Action Plan proposing the use of ORC *Advanced* must: (a) indicate that the fluid to be injected will not meet the secondary drinking water standard of 6.5-8.5 for pH, and that it will not meet the 500 milligrams per liter secondary drinking water standard for total dissolved solids; (b) indicate a zone of discharge size (i.e. a radius of influence for each injection point); (c) indicate the period of time during which the injected fluid could temporarily exceed the secondary drinking water standards for pH and total dissolved solids; and (d) propose adequate groundwater monitoring of pH and total dissolved solids.

ENCLOSURE 2

ENVIRONMENTAL AND REGULATORY INFORMATION

For ORC *Advanced*, the major environmental and regulatory concerns are listed below.

a. Groundwater cleanup standards: The onus shall be on users of ORC *Advanced* to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for the contaminants of concern, any residuals associated with the ingredients of ORC *Advanced*, and any byproducts produced as a result of chemical or biochemical reactions involving those ingredients. The following chapters of the Florida Administrative Code are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels.

   A noteworthy aspect of the minimum criteria set forth in Chapter 62-520, F.A.C., is that it requires groundwater to be free from substances that are harmful to plants, animals, and organisms, and free from substances that are carcinogenic, mutagenic, teratogenic or toxic to human beings. In effect, these "free from" requirements form a catchall. They close what would otherwise be a loophole in the regulations by preventing injection of a potentially harmful product in the event that any of its ingredients is not regulated as a specific primary or secondary drinking water contaminant.

b. Injection well permit: The issuance of a site-specific Remedial Action Plan Approval Order by either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup, for remediation via injection of ORC *Advanced* into an aquifer, constitutes the granting of a Class V injection well permit. [62-528.630(2)(c) and 62-528.640(1)(c), F.A.C.]

c. Groundwater injection standards: For in situ aquifer remediation, pursuant to Chapter 62-528, F.A.C., the composition of an injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., and the minimum groundwater criteria described in Chapter 62-520, F.A.C. The minimum groundwater criteria set forth in Chapter 62-777, F.A.C., also apply. The Bureau of Petroleum Storage Systems is aware that the chemical analysis of enclosure 1 for ORC *Advanced* will not meet the secondary drinking water standards of 500 mg/L for total dissolved solids and the 6.5 to 8.5 range for pH. Therefore, in order to use ORC *Advanced* for injection-type in situ aquifer remediation, rule 62-522.300(2)(c), F.A.C., must be applied to these secondary drinking water parameters that do not meet injection requirements.

   Rule 62-522.300(2)(c), F.A.C., effective August 27, 2001, allows a temporary zone of discharge for aquifer remediation purposes, within which a temporary exceedance of the primary and secondary drinking water parameters is tolerated when ORC *Advanced* is injected. In order to comply with the rule, a Department-approved site-specific remediation plan proposing ORC *Advanced* must: (a) identify the secondary parameters pH and total dissolved solids, whose standards are exceeded by the composition of the fluid to be injected; (b) indicate the size and duration of the temporary zone of discharge; and (c) propose groundwater

monitoring of the secondary parameters in the fluid that do not meet injection requirements.

The manufacturer indicates, as a rule of thumb, that a one (1)-year zone of discharge period should suffice in most cases, and that a zone size of not much more that 1 foot, radially from the point of injection is sufficient for pH, since it decreases rapidly with distance. The Bureau of Petroleum Storage Systems does not dispute the claim in regard to the pH, but instead would like to encourage those who prepare Remedial Action Plans to use a site-specific zone duration time and size whenever possible. Historically, for Florida applications, most injection-type aquifer remediation products have used a zone size in the range of 10 to 50 feet radially from each injection point, which the Bureau believes is reasonable, since this is neither too small nor too large, yet leaving enough room for some variation to occur at a site without causing a violation of the zone size that was permitted as part of the Remedial Action Plan approval process, pursuant to Rule 62-522.300(2)(c), F.A.C.

d. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells for the application of ORC *Advanced*. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply ORC *Advanced*. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not also used for treatment, there will be more assurance that the treatment process has permeated the entire site and that it did not remain localized to the area immediately surrounding each injection well.

e. Groundwater monitoring:

1. Active remediation monitoring of petroleum: During the period of active remediation, groundwater shall be monitored for petroleum contaminants of concern in accordance with the requirements set forth in Section 62-770.700, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.

2. Post remediation monitoring of petroleum: During the period of post active remediation, groundwater monitoring for petroleum contaminants of concern shall be conducted in accordance with the requirements set forth in Section 62-770.750, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.

3. Monitoring for underground injection control purposes: Pursuant to rule 62-522.300(2)(c), F.A.C., groundwater monitoring of the primary and secondary drinking parameters set forth in Chapter 62-550, F.A.C., that are not met by a fluid injected for aquifer remediation must be addressed in a Department-approved Remedial Action Plan. Additionally, if an injected fluid does not meet the minimum groundwater criteria of Chapters 62-520 and 62-777, F.A.C., then groundwater monitoring must be conducted for the specific parameters associated with the necessary temporary zone of discharge variance for the injection of such a fluid. In the case of ORC *Advanced*, only the secondary drinking water parameters for pH and total dissolved solids are not met by the fluid to be injected, so the groundwater monitoring of those two parameters must be addressed in a Department-approved Remedial Action Plan.

f. Underground injection control inventory: Remedial Action Plans prescribing in situ aquifer injection-type remediation shall include information pursuant to Rule 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of underground injection control. Per Rule 62-528.630(2)(c), F.A.C., aquifer remediation projects involving injection wells may be authorized under the provisions of a Remedial Action Plan, provided the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. A memorandum outlining the inventory information about injection-type aquifer remediation plans, to be transmitted by Department reviewers, to the Underground Injection Control Section is provided as enclosure 4.

g. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of ORC *Advanced* shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the product's ingredients or the contaminants of concern in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.

h. Operating parameters: Section 62-770.700, F.A.C., sets forth frequency requirements for the measurement of bioremediation operating parameters such as dissolved oxygen levels, rates of nutrient addition, temperature, etc. It also includes an option for reduction in the frequency or discontinuation of some measurements in situations when appropriate.

i. Abandonment of wells: Upon issuance of a petroleum Site Rehabilitation Completion Order, or a declaration of "No Further Action", injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C. The Underground Injection Control Section of the Department shall be notified so that the injection wells can be removed from the inventory-tracking list.

j. Surface waters: The Bureau anticipates that most applications of ORC *Advanced* Oxygen Release Compound will be at petroleum cleanup sites where groundwater is in need of remediation, but surface waters will not be nearby, or at least not affected by the groundwater or remediation activities to clean up the groundwater. Therefore, the small amount of phosphate present in the ORC *Advanced* Oxygen Release Compound should not be of great concern in these cases.

   If surface waters, however, happen to be present, and could be affected by the chemicals used to clean up the groundwater, then sufficient consideration should be given to the phosphate and its potential to affect the surface water. Given that the amount of phosphate in ORC *Advanced* is relatively small, and not likely to be highly mobile, the potential threat to surface waters should be very small, if any at all. And if for some reason a question or a concern should arise, then background or upstream surface water samples could be taken for analysis of phosphate prior to the use of the ORC, in order to establish a baseline phosphate concentration. The Bureau suggests that judgment and common sense be used when surface waters are nearby, and that phosphate be handled as an issue when necessary, but not necessarily as a routine matter that always requires surface water sampling.

k. Open pit applications: The application of ORC *Advanced* to an open excavation pit prior to backfilling, for the purpose of remediating groundwater, is not an injection. In such cases, it is not necessary to notify the Underground Injection Control Section by using the notification memorandum in enclosure 4. However, this does not release the user from the responsibility of making sure that no long-term negative groundwater impacts occur as a result of the chemicals added to

the pit. In the case of ORC *Advanced*, it may be prudent to measure the pH and total dissolved solids concentration of the groundwater in the pit area prior to application, and to measure them again some time after the application, in order to demonstrate that the groundwater meets the 6.5 to 8.5 standard for pH and the 500 mg/L maximum standard for total dissolved solids, or their natural-occurring background levels, whichever is less stringent. Additionally, it may be helpful to know that drinking water regulations will tolerate a total dissolved solids concentration greater than 500 mg/L, but only if no other parameter's standard is exceeded.

ENCLOSURE 3

SUPPLEMENTAL INFORMATION

The information below, compiled from several sources, may be helpful to reviewers of Remedial Action Plans prescribing bioremediation.

a. Department of Environmental Protection reviewers of injection-type in situ aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the enclosure 4 memorandum, whose subject is "Proposed Injection Well(s) for In situ Aquifer Remediation at a Petroleum Remedial Action Site". The completed form must be submitted to the Underground Injection Control Section at 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

   Only the appropriate bureau chiefs and division directors within the Department and its district offices may sign in situ injection-type remediation plan approval orders that constitute the granting of a Class V injection permit. Local program staff may review such plans but are not authorized to sign the approval orders. Reason: Although an arrangement between the Environmental Protection Agency and the Department delegates underground injection control authority to the Department, it does not allow the Department to delegate that authority any further. This includes delegation to the Department's contracted remediation review agencies such as those operated by the counties and other local governments.

b. Pilot study: For bioremediation, per Section 62-770.700, F.A.C., a pilot study proposal shall be submitted for review, and a pilot test shall be performed prior to designing a treatment system. If conditions or the situation at a site do not warrant a pilot study, then a proposal explaining the rationale for the decision not to perform a pilot study shall be submitted for review. The state's technical reviewers are encouraged to use judgment in balancing cost and the need for technical information to be obtained from a pilot study.

c. Bacteria: It is generally reported (on a total weight basis) that bacteria are approximately 70 to 80 percent water. On a dry weight basis, approximately 95 percent of the composition is represented by 5 elements: carbon, oxygen, nitrogen, hydrogen, and phosphorus. At a petroleum remediation site, it is intended that the source of carbon for the growth of bacteria will come from the petroleum hydrocarbons themselves. Natural-occurring organic carbon at a site can also serve as a carbon source for bacteria. Depending on site's specific conditions, the remaining four elements must either be available naturally, or added as macronutrients in order to stimulate bioremediation. Micronutrients must also be present for bacteria to grow.

d. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of hydrocarbons. In the case of methanogenesis, an anaerobic process, carbon dioxide and methane are produced. The intermediate products of aerobic degradation may include simple acids, alcohols, and fatty acids. Aerobic processes use oxygen as an electron acceptor to produce carbon dioxide and water.

e. Parameters: The following parameters may be useful in determining the potential for bioremediation at a site, or whether bioremediation is already occurring. They were selected from a list that appears in the publication "In situ Treatment Technology" by E. Nyer et al., Lewis Publishers, 1996. The parameters are dissolved oxygen; redox potential; pH; temperature; specific conductance; volatile organic compounds; nitrate; nitrite; ammonia nitrogen; manganese (total and dissolved); iron

(total, dissolved, and ferrous); sulfate; sulfide; and total organic carbon. Gaseous parameters include carbon dioxide, oxygen, nitrogen, and methane. Other parameters that may be helpful are chemical oxygen demand, biochemical oxygen demand, and total inorganic carbon. Those who prepare bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site-specific basis.

f. Vendor information: Below is some of the information included in the submittal by Regenesis for ORC *Advanced* that the Bureau of Petroleum Storage Systems would like to pass along to readers of this letter.

(Hydrated) Calcium Oxide Peroxide [$CaO(OH)_2$] (white powder)	60% by weight, minimum
Other inorganic calcium compounds Calcium Hydroxide[$Ca(OH)_2$] Calcium Carbonate [$CaCO_3$]	35% by weight, minimum
Active Oxygen	17%
Solubility	1.65 g/l at 68 ^oF (for calcium hydroxide) [$Ca(OH)_2$]
pH	11 to 13 (saturated solution)
Loose Bulk Density	0.5 to 0.65 g/ml
Theoretical weight ratio of oxygen to BTEX for aerobic degradation	3:1
Application Rate (typical, examples) (tailor to site-specific conditions)	Sands: 15 lbs per vertical ft. (max.) Silts & clays: 10 lbs per ft. Minimum: 4 lbs per ft.
Application strength	20% to 40% aqueous slurry

g. Limitations: Not recommended for free product.

Florida Department of

Memorandum **Environmental Protection**

TO: Richard Deuerling, Mail Station 3530
Division of Water Facilities
Underground Injection Control Section
Florida Department of Environmental Protection
2600 Blair Stone Road, Tallahassee, FL 32399-2400

FROM: _____ (Note 1.)

_____

_____

DATE: _____

SUBJ: **Proposed Injection Well(s) for In situ Aquifer Remediation at a Petroleum Remedial Action Site**

Pursuant to Rule 62-528.630(2)(c), F.A.C, inventory information is hereby provided regarding the proposed construction of temporary injection well(s) for the purpose of in situ aquifer remediation at a petroleum-contaminated site.

Site name: _____
Site address: _____
City/County: _____
Latitude/Longitude: _____
FDEP Facility Number: _____

Site owner's name: _____
Site owner's address: _____
_____
_____
_____

Well contractor's name: _____ (Note 2.)
Well contractor's address: _____
_____
_____
_____

Brief description of the in situ injection-type aquifer remediation project:

_____

_____

Summary of major design considerations and features of the project:

Areal extent of contamination (square feet): _____
Number of injection wells: _____
Composition of injected fluid (Note 3)
(ingredient, wt. %): _____

_____

Injection volume per well (gallons): _____
Single or multiple injection events: _____
Injection volume total (all wells, all events): _____

Site name: _____
FDEP facility no.: _____

A site map showing the areal extent of the groundwater contamination plume, and the location and spacing of injection wells and associated monitoring wells is attached.

The following is a summary description of the affected aquifer:

Name of aquifer: _____
Depth to groundwater (feet): _____
Aquifer thickness (feet): _____

The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or Conventional *(circle the appropriate well type)*
Diameter of well(s) (i.e., riser pipe & screen)(inches): ____
Total depth of well(s) (feet): _____
Screened interval: _____ to _____ feet below surface
Grouted interval: _____ to _____ feet below surface
Casing diameter, if applicable (inches): _____
Cased depth, if applic.: _____ to _____ feet below surface
Casing material, if applic.: _____

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is intended to meet the groundwater petroleum cleanup criteria set forth in Chapter 62-770, F.A.C. Additionally, all other groundwater standards will be met at the time of project completion for any residuals associated with the ingredients of the injected remediation products, and any by-products or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminating petroleum during their use. Applicable primary and secondary drinking water standards are set forth in Chapter 62-550, F.A.C., and additional groundwater quality criteria are set forth in Chapter 62-520, F.A.C.

The remediation plan estimates that site remediation will take _____ months. We will notify you if there are any modifications to the remediation strategy, which will affect the injection well design or the chemical composition and volume of the injected remediation product(s).

The proposed remediation plan was approved on _____ by an enforceable approval order. A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.

Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: Per agreement with EPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should arrange for Department headquarters' execution of an approval order, and then complete this form. This form is primarily for use by state and local program technical reviewers, but petroleum remediation contractors may fill in all blanks except those labeled "FROM", "DATE", "approval date", and "telephone number" blanks in the last paragraph. Those blanks should be completed only by a state or local program reviewer.

Note 2. If an injection well installation contractor has not yet been selected, then indicate the name and address of the project's general remediation contractor/consultant.

Note 3. Complete chemical analysis of injected fluid is required by Chapter 62-528, Florida Administrative Code. Proprietary formulations shall make confidential disclosure. Injected fluids must meet drinking water standards of Chapter 62-550, F.A.C., unless an injection zone of discharge has been permitted by Rule 62-522.300(2)(c), F.A.C., or by variance.