

Department of Environmental Protection

Jeb Bush
Governor

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

David B. Struhs
Secretary

October 16, 2000

Mr. Douglas Cooper, President
Pendragon Technologies, Inc.
4 Semana Crescent
Vancouver, British Columbia V6N2E2

Re: **HCF-700**

Dear Mr. Cooper:

The Bureau of Petroleum Storage Systems hereby accepts HCF-700 as a product for both in situ and ex situ bioremediation of petroleum hydrocarbons in soil and groundwater at contaminated sites in Florida. The product is a proprietary mixture of non-pathogenic, naturally occurring bacteria, nutrients, and enzymes. A voucher for a confidential disclosure regarding the proprietary proportions of specific proprietary ingredients is provided as enclosure 1, and an analysis of chemical species and other information that may be of interest from either a technical or regulatory standpoint is provided as enclosure 2.

As indicated by Pendragon, its affiliates in regard to HCF-700, are: Micro Treatment Systems (MTS) of Walterboro, South Carolina; Applied Biotechnology Corporation (ABC) of Tucker, Georgia; and Global Environmental Management (GEM) Incorporated of Fort Lauderdale, Florida.

For in situ vadose remediation, when the underlying groundwater will not be affected by the leaching of this product, there are no special concerns beyond those which 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, Florida Administrative Code (F.A.C.). For ex situ groundwater treatment, when an aboveground treatment system produces effluent meeting the petroleum cleanup criteria of Chapter 62-777, F.A.C., as referenced by Chapter 62-770, F.A.C., and the drinking water standards of Chapter 62-550, F.A.C., for disposal via recharge gallery or NPDES permit, there are no special concerns. But for in situ groundwater remediation via injection of the product into an aquifer, there are underground injection control (UIC) regulations that must be observed. Since in situ aquifer remediation via injection 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.

Mr. Douglas Cooper
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The bureau recognizes HCF-700 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) all applicable and appropriate regulations are observed. Enclosure 3 includes a list and a discussion of regulations that apply.

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, safety, and welfare. Vendors must then market the products and processes on their own merits regarding performance, cost, and safety in comparison to competing alternatives in the marketplace.

Preparers of Remedial Action Plans are advised to 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 in regard to HCF-700. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 4.

The Department reserves the right to revoke its acceptance of any product or process if either the nature or composition of its ingredients, or its performance 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 850/487-3299 if there are any questions.

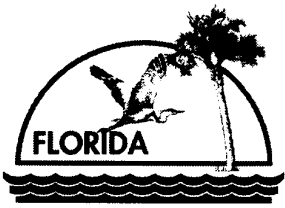
Sincerely,

Rick Ruscito, P.E.
Bureau of Petroleum Storage Systems

c: G. Heuler - FDEP/UIC/Tallahassee

T. Conrardy - FDEP/Tallahassee

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ENCLOSURE 1

HCF-700 PROPRIETARY INGREDIENTS VOUCHER

Department of Environmental Protection

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2600 Blair Stone Road
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Mr. Douglas Cooper, President
Pendragon Technologies, Inc.
4 Semana Crescent
Vancouver, British Columbia V6N2E2

Re: **HCF-700 Proprietary Ingredients Voucher**

Dear Mr. Cooper:

The Bureau of Petroleum Storage Systems hereby acknowledges receipt of a confidential disclosure dated October 3, 2000, from Pendragon Technologies Incorporated, regarding the proprietary proportions of specific ingredients for HCF-700, a naturally occurring, non-pathogenic bacteria product for the remediation of petroleum hydrocarbons. Having reviewed the confidential disclosure, we hereby vouch for its consistency with Pendragon's claims about the nature of the ingredients described on the Material Safety Data Sheet for HCF-700.

The bureau is reasonably assured that the product will not violate the underground injection control regulations set forth in Chapter 62-528, Florida Administrative Code (F.A.C.), or the minimum criteria for groundwater set forth in Section 62-520.400, F.A.C., which requires that the groundwaters of the state be free from substances which are harmful to plants, animals, and organisms, and free from substances that are carcinogenic, mutagenic, teratogenic or toxic to human beings. However, the obligation to comply with the minimum groundwater criteria, and all other applicable rules and regulations, ultimately rests with Pendragon Technologies and users of the product, not the Bureau of Petroleum Storage Systems. No ingredients, chemical species, or byproducts formed as a result of using HCF-700 shall result in a violation of any applicable and appropriate rules and regulations.

For underground injection control purposes, remediation plans prescribing the use of HCF-700 must disclose the volume and composition of the fluid to be injected into an aquifer. Since the composition with regard to specific ingredients is proprietary, it will suffice to indicate the overall concentration of the fluid to be injected, and then provide a footnote indicating that a one-time confidential disclosure regarding the composition has been submitted to the Department and accepted. Reference should be made to the original October 3, 2000

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disclosure, and a copy of this voucher should be included as an appendix of the plan. Remediation plan reviewers for petroleum contaminated site applications involving HCF-700 may contact Rick Ruscito at (850) 487-3299.

Sincerely,

Rick Ruscito, P.E.
Bureau of Petroleum Storage Systems

October 16, 2000

HCF-700 CHEMICAL ANALYSIS AND OTHER INFORMATION

<u>CHEMICAL SPECIES OR PARAMETER*</u>	<u>AMOUNT</u>	<u>DETECTION LIMIT</u>	<u>UNITS</u>
<u>Primary Drinking Water</u>			
<u>Contaminants</u>			
Nickel	BDL †	0.020	mg/L ‡
Sodium §	9.09	0.500	mg/L
Nitrate (as nitrogen)	0.39	0.05	mg/L
Nitrite (as nitrogen)	BDL	0.05	mg/L
<u>Secondary Drinking Water</u>			
<u>Contaminants</u>			
Chloride	9.2	1	mg/L
Copper	BDL	0.020	mg/L
Iron	BDL	0.100	mg/L
pH	6.9	0-14	standard units
Sulfate	10.2	1	mg/L
Total Dissolved Solids	115	5	mg/L
Zinc	BDL	0.020	mg/L
<u>Minimum Groundwater Criteria Contaminants of</u>			
<u>Chapter 62-777, Florida Administrative Code</u>			
Ammonia Nitrogen	BDL	0.75	mg/L
<u>Non-regulated Drinking Water</u>			
<u>Parameters</u>			
Total Kjeldahl Nitrogen ♁	3.5	1.0	mg/L

* Laboratory analysis of hydrated HCF-700, at the typical strength of one (1) pound dry powdered HCF-700 per 4,500 gallons of water (27 parts per million by weight) used for in situ treatment of hydrocarbon contaminants.

† BDL denotes below detection level.

‡ mg/L denotes milligrams per liter.

§ Sodium is a State of Florida primary drinking water contaminant with a maximum contaminant level of 160 mg/L set forth in Chapter 62-550, F.A.C., but not a federal primary drinking water contaminant.

♁ Total Kjeldahl Nitrogen (TKN) is the sum of free ammonia and organic nitrogen compounds, expressed as elemental nitrogen.

PHYSICAL PROPERTIES OF DRY, POWDERED HCF-700
(as indicated by the Material Safety Data Sheet)

<u>PARAMETER</u>	<u>VALUE</u>	<u>UNITS</u>
Solubility in Water	>90	%
Specific Gravity	0.66-0.77	
Appearance/Odor	Free-flowing, gray-colored powder with a yeast-like odor.	
Viabale Bacterial Cultures	60	% by weight, approx.
Nutrient Base	30	% by weight, approx.
<u>Crude Enzymes</u>	<u>10</u>	<u>% by weight, approx.</u>
Total	100.00	%

ENCLOSURE 3

HCF-700: ENVIRONMENTAL AND REGULATORY INFORMATION

For HCF-700, the major environmental and regulatory concerns are discussed below.

- a. Applicable rules and regulations: The onus shall be on Pendragon Technologies Incorporated and users of HCF-700 to comply with all applicable regulations, particularly those regarding underground injection control and groundwater quality. All applicable groundwater contaminant standards shall be met at the time of project completion for the contaminants of concern, any residuals associated with the ingredients of HCF-700, 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 as applicable but should not be construed as an exhaustive list: 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 wells; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., for contaminant 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 which 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 injection-type aquifer remediation constitutes the granting of a Class V injection well permit.
- c. Additional nutrients and additives: If either Pendragon Technologies Incorporated, its business affiliates, or a user of HCF-700 alters the composition of the product, or augments its injection with additional nutrients or other additives such as surfactants, then the Bureau of Petroleum Storage Systems should be notified and provided with a chemical analysis of the modified injection fluid, for comparison to underground injection criteria, to determine if an injection variance is required.

- 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 HCF-700. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling), shall be used to apply HCF-700. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not 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 petroleum monitoring: 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. Two noteworthy rules within that section are 62-770.700(3)(i), F.A.C., for frequency of sampling, and 62-770.700(5)(f), F.A.C., which requires a sampling schedule for bioremediation. If HCF-700 will be used for the cleanup of non-petroleum hydrocarbons, then the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 2. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring for petroleum contaminants of concern shall be conducted at a minimum of two (2) wells, one located in the area of maximum petroleum contamination, the other downgradient of the area of maximum petroleum contamination, pursuant to Section 62-770.750, F.A.C. If HCF-700 will be used for the cleanup of non-petroleum hydrocarbons, then the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 3. Underground injection control monitoring: Since no ingredient in HCF-700 exceeds a maximum contaminant level (MCL) allowed by the drinking water standards of Chapter 62-550, F.A.C., the department, pursuant to Rules 62-528.615(1)(b)1 and (2), F.A.C., has determined that the tracking of any particular ingredient shall not be mandatory for underground injection monitoring purposes.
- f. Operation:
1. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of HCF-700 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.

2. Underground injection control operating permit: Although an operating permit is not required for aquifer remediation wells pursuant to Rule 62-528.640(1)(b), and 62-528.640(1)(c), F.A.C., since no movement of the petroleum contamination plume is expected to accompany the HCF-700 treatment process, the Department requests that the information items listed in Rule 62-528.640(1)(b), F.A.C., be considered and included in Remedial Action Plan proposals as a matter of good and thorough design practice. Briefly summarized, they are: quality of water in the aquifer; quality of the injected fluid; existing and potential uses of the affected aquifer; and well construction details. Additionally, each Remedial Action Plan should clearly indicate the total volume of fluid and the overall concentration of HCF-700 that will be injected.
3. Operating parameter measurements: Petroleum cleanup Rule 62-770.700(9)(h), 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.
- g. 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.

ENCLOSURE 4

HCF-700: SUPPLEMENTAL INFORMATION

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

- a. Nature of the product: HCF-700 is a mixture of non-pathogenic, natural-occurring bacteria, nutrients, and enzymes. It is shipped in a dry state and must be re-hydrated prior to use.

For maximum effectiveness, the Bureau of Petroleum Storage Systems suggests that designers of remediation systems make sure the HCF-700 is applied in such a way that adequate vertical and horizontal coverage throughout the volume of soil and/or groundwater to be remediated is achieved. Additionally, if sufficient oxygen is not present in the aquifer at a site for aerobic biodegradation, then the bureau suggests it be added artificially, either by air sparging or other suitable means. In the case of soil remediation, ample soil moisture must also be present for the bacteria to be effective. It too, if necessary, may be introduced artificially.

- b. Department of Environmental Protection reviewers of in situ injection-type aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the enclosure 5 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 reviewers within the Department and its district offices may approve in situ injection-type remediation plans in which the approval constitutes the issuance of a Class V injection permit; local programs are not authorized to grant such approvals.

Reason: Although an arrangement between the US 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. Injection approval instructions to the local programs can be found in the Bureau of Petroleum Storage Systems guidance document BPSS-10 titled "In Situ Chemical Additives" at web page /www.dep.state.fl.us/dwm/programs/pcp/active.htm.

- c. Pilot study: For bioremediation, per rule 62-770.700(2), 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. In some cases, only a biotreatability test may suffice. In other cases, perhaps only a sampling of the site for parameters indicative of bioremediation could serve in lieu of a pilot test, to show that some bioremediation is already occurring naturally and that the site may be conducive to enhancements.

- d. Bioremediation indicator samples: Prior to preparation of a remedial action plan for full-scale in situ injection-type aquifer remediation of a site, the bureau recommends the sampling of monitoring wells that are upgradient, within, and downgradient of the groundwater contamination plume for bioremediation parameters, and then comparing the results in order to determine whether intrinsic bioremediation is already occurring across the plume. Paragraph *h* below lists some of the bioremediation parameters that may be sampled. This sampling suggestion is for technical, not regulatory purposes. It is not mandatory but is recommended as a matter of good practice.
- e. Underground injection control inventory: Remedial Action Plans prescribing in situ injection-type aquifer 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 5.
- f. 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. Naturally-occurring organic carbon at a site may also compete with the petroleum as a carbon source for bacteria. Depending on a 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.
- g. 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.

- h. 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 organic carbon. Preparers of bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site specific basis.
- i. Dosage and application rate: For rule-of-thumb purposes, per information about HCF-700 submitted to the bureau, one (1) pound of dry HCF-700 is re-hydrated with 4,500 gallons of water (27 parts per million by weight) for in situ treatment of hydrocarbons. And for the ex situ treatment of soil, one (1) pound of re-hydrated HCF-700 will treat approximately five (5) cubic yards of soil contaminated by up to 10,000 parts per million gasoline or diesel in 45 to 90 days.
- j. Operating conditions for HCF-700: As indicated by Pendragon Technologies Incorporated, the effective range and optimum range of operating conditions for HCF-700 are tabulated below.

<u>Parameter</u>	<u>Effective Range</u>	<u>Optimum Range</u>
pH	6.0-8.5	6.5-7.5
Temperature	55-95 deg. F	65-80 deg. F
Salinity	0-5%	<5%
Dissolved Oxygen	>0.5 ppm	1-3 ppm
Soil Moisture (when treating soil)		20%

Memorandum **Florida Department of
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): _____

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 follow the instructions in a March 16, 2000 memorandum to 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", and "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.

Richard Deuerling

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Date: _____

Site name: _____

FDEP facility no.: _____

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 exemption or variance has been granted.