



Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

August 22, 2007

Hugh Russell, Ph.D.
AR Environmental Services, Inc.
P.O. Box 711
Cushing, Oklahoma 74023

Re: **Enhanced Bioremediation for
Soil and Groundwater**

Dear Mr. Russell:

The Bureau of Petroleum Storage Systems hereby accepts the process known as Enhanced Bioremediation for Soil and Groundwater (EBSG) for in situ remediation of petroleum and other suitable contaminants. As AR Environmental Services Incorporated has indicated, EBSG uses nutrients and oxygen to increase the population of indigenous microorganisms already present at a contaminated site that are capable of destroying the contaminants. The source of the oxygen is low concentration hydrogen peroxide. EBSG itself does not contain microorganisms.

EBSG is not new to the Florida Department of Environmental Protection (the Department). It was granted a variance by the Department for a temporary injection zone of discharge on September 7, 2001. An official acceptance letter, however, was not issued at that time to augment the variance. Although such a letter is not required, in order to propose the use of a product or process in a site-specific Remedial Action Plan, it can still serve as a useful source of information to potential users of the product or process, and also to regulators and reviewers of Remedial Action Plans throughout the state. For that reason, this acceptance letter is hereby issued for EBSG.

There are no objections to the use of EBSG provided the considerations of this letter are taken into account and a site-specific Remedial Action Plan is approved prior to its application. The September 7, 2001 variance granting permission for a temporary injection zone of discharge is still valid. Users of the process, however, now have an additional means by which to obtain such permission: Rule 62-522.300(2)(c), Florida Administrative Code (F.A.C.).

Information about the chemical composition of EBSG, as reported in the September 7, 2001 variance, is presented in Enclosure 1, and regulatory considerations applicable to EBSG are presented in Enclosure 2. Since injection-type, in situ aquifer remediation is likely to be the most common application of EBSG, the bulk of the regulatory requirements discussed in Enclosure 2 will be directed to that topic.

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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 in comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory acceptance be construed as certification of product or process performance.


Those who prepare Remedial Action Plans are advised to include a copy of this letter in the appendix, 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 EBSG. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as Enclosure 3.

The Department reserves the right to revoke acceptance of any product or process if it has been falsely represented. Additionally, Department acceptance of a 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 a Remedial Action Plan.

Questions regarding this acceptance of EBSG should be directed to Rick Ruscito at 850-877-1133, extension 3722.

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

Enclosures: (1) Chemical Composition
(2) Regulatory Information
(3) Supplemental Information
(4) Underground Injection Control Notification

c: T. Conrardy - FDEP/Tallahassee

ENCLOSURE 1
CHEMICAL COMPOSITION

EBSG
August 22, 2007

ENHANCED BIOREMEDIATION FOR SOIL AND GROUNDWATER (EBSG) CHEMICAL COMPOSITION

<u>Parameter</u>	<u>Percent by Weight⁽¹⁾</u>	<u>Milligrams per Liter (mg/L)⁽¹⁾</u>	<u>Current Florida Standard (mg/L)</u>
<u>Primary Drinking Water Contaminants</u>			
Nitrate		0.00197	10 (as N)
<u>Secondary Drinking Water Contaminants</u>			
Copper		0.005	1
Iron		0.01	0.3
Manganese		0.005	0.05
Zinc		0.005	5
<u>Specific Minimum Groundwater Criteria Contaminants</u>			
Boron		0.002	1.4
Molybdenum		0.00005	.035
<u>Other</u>			
Ammonium Chloride ⁽²⁾⁽⁵⁾	0.1		
Hydrogen Peroxide ⁽³⁾	1.5		
Magnesium		0.05	
Sodium Tripolyphosphate ⁽⁴⁾	0.1		
Urea ⁽⁵⁾		0.018	

Notes:

- (1) Maximum amount that may be present in EBSG.
- (2) The secondary drinking water standard for chloride is 250 mg/L (max.).
- (3) The secondary drinking water standard for pH is range 6.5 to 8.5.
- (4) Sodium is classified as a primary drinking water contaminant in Florida with a standard of 160 mg/L (max.).
- (5) The minimum groundwater criteria for ammonia is 2.8 mg/L (max.).
- (6) Existing variance granted on September 7, 2001 or Rule 62-522.300(2)(c), F.A.C., applies. If EBSG is used for in situ remediation of groundwater, or in situ remediation of soil above the water table, from which EBSG ingredients could percolate or leach into the underlying groundwater, then monitoring of the groundwater for the following is necessary: ammonia, chloride, pH, sodium, and total dissolved solids.

ENCLOSURE 2

REGULATORY INFORMATION

- a. Applicable rules and regulations: The onus shall be on AR Environmental Services and users of EBSG 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 EBSG, 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; 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 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 for injection-type aquifer remediation constitutes the granting of a Class V injection well permit.
- c. Groundwater injection standards: For in situ aquifer remediation, the composition of an injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., pursuant to underground injection control Rule 62-528.600(2)(d), F.A.C., and the minimum groundwater criteria set forth in Chapter 62-520, F.A.C. If the manufacturer of EBSG makes any changes to its formulation in the future, then the Bureau should be notified and provided with a complete chemical analysis of the reformulated product.
- d. Temporary Injection Zone of Discharge: The chemical composition of EBSG shown in Enclosure 1 does not meet Florida's underground injection control and groundwater standards for ammonia, chloride, pH, sodium, and total dissolved solids. It is therefore necessary to obtain permission for a temporary injection zone of discharge for these parameters. In the case of EBSG, there are two options.

Option 1: Users of EBSG, in their proposed site-specific Remedial Action Plans, may cite the existing variance granted by the Department on September 7, 2001 as permission for a zone size of 50 feet from each injection point for the temporary period of 1 year. By the end of the 1-year period, the Florida groundwater standards for each of the parameters must be met, or their values must be no worse than their pre-injection, natural-occurring background values at the remediation site, whichever is less stringent. A note of interest: At approximately the same time the variance

was granted, giving permission for a temporary injection zone of discharge for EBSG, a change in the Florida Administrative Code eliminated the need to seek such permission by way of a variance in most cases . Permission now, in most cases, including that of EBSG, can be obtained by way of rule. The variance granted for EBSG, however, is still valid, and users of EBSG may continue to cite it as permission for a temporary injection zone of discharge.

Option 2: As of August 21, 2001, permission for a temporary zone of discharge, in most cases, including EBSG, can readily be obtained by way of Rule 62-522.300(2)(c), F.A.C., for each site-specific Remedial Action Plan, provided the plan meets the requirements of the rule. In order to obtain permission by rule for EBSG, a Remedial Action Plan proposing its injection must: (a) specify the size of the zone of discharge that is requested; (b) specify the amount of time that a temporary zone of discharge is needed; (c) indicate that the EBSG parameters of concern in regard to the zone of discharge are ammonia, chloride, pH, sodium, and total dissolved solids; and (d) propose groundwater monitoring for the parameters of concern. Monitoring on a quarterly basis should suffice. Approval issued for a site-specific Remedial Action Plan that meets the requirements of Rule 62-522.300(2)(c), F.A.C., also constitutes the granting of permission for the requested temporary injection zone of discharge.

- e. 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 EBSG. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply EBSG. 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.
- f. 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. If EBSG is 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 in accordance with Section 62-770.750, F.A.C. If EBSG is 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: Regardless of whether the September 7, 2001 variance or Rule 62-522.300(2)(c), F.A.C., is the permission vehicle for a temporary injection zone of discharge for EBSG's ammonia, chloride, pH, sodium and total dissolved solids, it is necessary to monitor the groundwater for these parameters for underground injection control purposes. The frequency of the monitoring shall be that which was specified in the approved Remedial Action Plan. In most cases, monitoring on a quarterly basis should suffice.

g. Operation:

1. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of EBSG 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. [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 EBSG 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 concentration of EBSG that will be injected.
 3. Operating parameter measurements: 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.
- h. 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.
- i. Open excavation applications: The addition of EBSG to the groundwater exposed by an open excavation is not an injection. For this reason, it is not necessary to use the Underground Injection Control Notification of Enclosure 4 to notify the Underground Injection Control Section about this type of application. This does not, however, relieve the user of the product from an obligation to be mindful of groundwater quality standards and any toxicological effects that the ingredients of EBSG may have on the groundwater.

A simple way of handling the addition of EBSG to the exposed groundwater in an open excavation (or to a dry pit, from whose bottom the EBSG could percolate down to the water table) is to monitor the groundwater for the same EBSG "parameters of concern" as if the application had actually been an injection. A well installed in the excavation area after it is backfilled should be monitored for those parameters, which are ammonia, chloride, pH, sodium and total dissolved solids. In most cases, a quarterly sampling frequency should suffice.

ENCLOSURE 3

SUPPLEMENTAL INFORMATION

- a. Application methods: AR Environmental Services Incorporated indicates that EBSG can be applied in a number of ways, including but not necessarily limited to direct injection via permanent injection well or direct-push techniques, recirculation/re-injection, recirculation/re-infiltration, or to an open excavation pit prior to backfilling.
- 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 4 memorandum, whose subject is "Proposed Injection Well(s) for In Situ Aquifer Remediation at a 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. These local programs, however, can arrange to have enforceable, Department-issued approval orders for their injection-type projects signed by the chief of the Bureau of Petroleum Storage Systems at the Department's headquarters in Tallahassee. The procedure is the same as it would be for the issuance of any other approval order that is processed by the Bureau for a local program cleanup project.

- c. Pilot study: For innovative technologies and 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.
- d. Underground injection control inventory: Remedial Action Plans proposing 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 4.
- e. 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 may also compete with the petroleum or other contaminants being remediated 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.

- f. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of hydrocarbons. 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. When chlorinated organic compounds are biodegraded, the degradation products will include chloride.
- g. Dosage and application rate: Site-specific. Users of EBSG are instructed to contact AR Environmental Services for advice on the recommended dosage and application rate.

**Florida Department of
Environmental Protection**

Memorandum

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

FROM: _____ [see Note 1.]

DATE: _____

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

Pursuant to paragraph 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 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: _____ [see 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 [see 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 HSA/Mud rotary (*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 land surface
Grouted interval: _____ to _____ feet below land surface
Casing diameter, if applicable (inches): _____
Cased depth, if applicable: _____ to _____ feet below land surface
Casing material, if applicable: _____

The in situ injection-type aquifer remediation plan for this contaminated site is intended to meet the groundwater cleanup criteria set forth in Chapter 62-777, 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 contaminants of concern 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 the USEPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should prepare the Approval Order and route it to Tallahassee for Bureau Chief's signature, and then complete this form. This form is primarily for use by state and local program technical reviewers, but remediation contractors may fill in all blanks except those labeled "FROM" and "DATE" on page 1, and the 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, F.A.C. Proprietary formulations shall make confidential disclosure. Injected fluids must meet drinking water standards of Chapter 62-550, F.A.C., unless a zone of discharge is permitted by way of rule 62-522.300(2)(c), F.A.C., or a variance.