



Department of Environmental Protection

Jeb Bush
Governor

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

Colleen M. Castille
Secretary

May 20, 2005

Gary M. Birk, P.E.
EOS Remediation Incorporated
3722 Benson Drive
Raleigh, North Carolina 27609

Re: **Edible Oil Substrate (EOS)**

Dear Mr. Birk:

The Florida Department of Environmental Protection hereby reaffirms and updates its acceptance of Edible Oil Substrate (EOS), a product for in situ anaerobic bioremediation of chlorinated hydrocarbons and other suitable contaminants in groundwater and soil. EOS is a U.S.-patented product containing soybean oil as the primary substrate, emulsifiers and surfactants.

This letter supersedes the original April 7, 2003 acceptance letter that was issued to EOS Remediation Incorporated in Raleigh, North Carolina, and contains four major revisions. The first is a correction that indicates a temporary injection zone of discharge is permitted by rule, not by variance, for soybean oil (total recoverable petroleum hydrocarbons), and polysorbate 80 (a surfactant). The second considers an analytical method for measuring the concentration of polysorbate 80 in groundwater samples. The third is an indication that lecithin is no longer an ingredient, and the fourth is a clarification that sodium bromide tracer is not one of the manufacturer's ingredients but rather added independently, later, by some but not all users.

Although this acceptance applies only to the regulatory jurisdiction and the remediation needs of this Department, other agencies and local governments may choose to recognize it if their needs are similar. This Department, however, is not responsible for applications beyond its own jurisdiction.

For in situ groundwater remediation, via direct injection of EOS into an aquifer, there are underground injection control 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 it.

The Department recognizes EOS as a viable product for the bioremediation of contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a site-specific Remedial Action Plan is approved by the Department; (c) the approved Remedial Action Plan complies with Rule 62-522.300(2)(c), Florida Administrative Code (F.A.C.), in order to permit a temporary injection zone of discharge for soybean oil's total recoverable petroleum hydrocarbons (TRPH); polysorbate 80 surfactant; sodium (depending on the amount of sodium lactate); total dissolved solids; and chloride (a contaminant degradation byproduct).

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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 a regulatory 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 performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance" and an approval. Products and processes are accepted but they are not approved.

Also, it is not a requirement that a particular remediation product or process have an official acceptance letter in order for it 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.

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 the environmental acceptability of EOS. To aid those reviewers, the Department provides environmental and regulatory information as Enclosure 1. Enclosure 2 contains supplemental information.

The Department reserves the right to revoke its acceptance of a product or process if it 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 a Remedial Action Plan. You may contact Rick Ruscito 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

enc: (1) Regulatory Information
(2) Supplemental Information

c: T. Conrardy - FDEP, Tallahassee/MS 4530

History:

4/7/03
ppl #214
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ppl #275
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ENCLOSURE 1

REGULATORY INFORMATION

- a. Groundwater cleanup standards: The onus shall be on users of EOS to ensure that all applicable groundwater standards will be met at the time of project completion for chlorinated hydrocarbons and any other contaminants of concern, any residuals associated with the ingredients of EOS, 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, and minimum criteria; 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; and Chapter 62-777, F.A.C., for cleanup criteria.

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, or by Chapter 62-777, F.A.C.

- b. Injection well permit: The issuance of a site-specific Remedial Action Plan Approval Order by the Florida Department of Environmental Protection, for remediation via injection of EOS into an aquifer, constitutes the granting of the state's permit for a Class V injection well.
- c. EOS ingredients: The Department will discuss the ingredients of EOS, a proprietary product, only to the extent necessary for users to comply with regulations. EOS contains soybean oil, polysorbate 80, glycerol monooleate, yeast extract, and sodium lactate in proprietary proportions. Those proportions were confidentially disclosed to the Department in August 2002, and the Department is safeguarding that disclosure in accordance with Florida Statutes that recognize the need to protect trade secrets. Update: Per telephone discussion on May 17, 2005, the Raleigh, North Carolina supplier of EOS indicated that it no longer uses lecithin as an ingredient, and that sodium bromide tracer is not one of the manufacturer's ingredients but rather added independently, later, by some but not all users.
- d. Glycerol monooleate: There is no minimum groundwater criterion for the glycerol monooleate component of EOS. In accordance with FDA regulations (21 CFR 184.1323) it can be used in food with no limitation, and is classified by the FDA as GRAS (Generally Regarded as Safe). For these reasons, the Department believes that glycerol monooleate does not have to be an ingredient of concern when EOS is used.
- e. Zone of discharge by Rule 62-522.300(2)(c), F.A.C.: In order for EOS to be used for in situ, injection-type aquifer remediation, it is necessary to first obtain permission for a temporary injection zone of discharge for the following EOS components: soybean oil's total recoverable petroleum hydrocarbons (TRPH); polysorbate 80 surfactant; sodium (depending on the

amount of sodium lactate used); total dissolved solids; and chloride (a contaminant degradation byproduct). If a user decides to independently augment EOS with sodium bromide tracer, then bromide should be included. The zone of discharge for all six (6) of these parameters is obtained by way of Rule 62-522.300(2)(c), F.A.C.

The indication above that a zone of discharge is permitted by rule for all six parameters (five if the user does not add a tracer) is a correction to the previous April 7, 2003 EOS acceptance letter, which erroneously indicated that a zone of discharge for TRPH and polysorbate 80 could only be obtained by way of a variance.

Explanation. The Department's Underground Injection Control Program indicated in correspondence to EOS on April 7, 2005, in regard to variance petition case number OGC 05-0356, that the soybean oil and polysorbate 80 components of EOS are prime constituents of the reagents needed to remediate site contaminants. Since Rule 62-522.300(2)(c), F.A.C., permits a zone of discharge for such constituents, there is no need to permit the zone by variance.

- f. Meeting the requirements of Rule 62-522.300(3)(c), F.A.C.: In order to comply with Rule 62-522.300(2)(c), F.A.C., a Department-approved Remedial Action Plan proposing the use of EOS must: **(a)** identify the chemical species and parameters in the fluid to be injected that do not meet their groundwater standards [TRPH, polysorbate 80, sodium (depending on the amount of sodium lactate used), total dissolved solids, chloride (if significant amounts of this degradation byproduct will be generated), and bromide (if a bromine-containing tracer is used)]; **(b)** indicate the size and duration of a temporary zone of discharge that is needed for these parameters; and **(c)** address groundwater monitoring of these parameters before and after injection.

For the duration (period of time) that a temporary zone of discharge is permitted for EOS parameters, a temporary departure from the groundwater standards established for those parameters by Chapters 62-520 and 62-777, F.A.C., will be tolerated. By the end of the period, the groundwater must once again meet the established standards for each of these parameters, or their natural-occurring background value, whichever is less stringent.

The current maximum allowable groundwater concentrations for these parameters are as follows: TRPH, 5 milligrams per liter (mg/L); polysorbate 80, 35 mg/L; total dissolved solids, 500 mg/L; sodium, 160 mg/L; and chloride, 250 mg/L. For bromide, if a tracer is used, the standard shall be 0.05 mg/L or less, which is the concentration of bromide in "source water" for drinking water systems, per 40 CFR (Code of Federal Regulations), Part 141, National Primary Drinking Water Regulations that qualify systems for reduced bromide monitoring. Although the monitoring for bromide per National Primary Drinking Water Regulations arises mainly as a concern for bromate (BrO_3^-) when ozone is used for disinfection, the Department reasons that the 0.05 mg/L concentration should be a suitable target level for remediation sites as well.

- g. Polysorbate 80: This is a nonionic surfactant of chemical composition $\text{C}_{64}\text{H}_{124}\text{O}_{26}$, Chemical Abstracts Service #9005-65-6. The Food and Drug Administration lists it as a food additive. The University of Florida's Center for Environmental and Human Toxicology, in correspondence dated September 24, 2001, indicated that a Department-calculated, maximum allowable groundwater concentration of 35 mg/L was reasonable.

For foaming agents (a group that includes surfactants) Chapter 62-550, F.A.C., indicates that Standard Method SM 5540 can be used for the analysis of drinking water samples. The Department, having reviewed SM 5540, believes it may be a viable method for the analysis of polysorbate 80 in groundwater samples from remediation sites as well. Method SM 5540-D applies to nonionic surfactants (and polysorbate 80 is a nonionic surfactant).

- h. 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 EOS. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply EOS. 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.
- i. Additional nutrients: If, in the future, either the manufacturer or a user decides to augment EOS with other nutrients and/or chemicals, the injection of such nutrients and other chemicals into an aquifer must also be in accordance with the underground injection control requirements of Chapter 62-528, F.A.C., which requires that injected substances meet the drinking water standards set forth Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C., which is now augmented by minimum groundwater criteria for specific chemicals listed in Chapter 62-777, F.A.C. If EOS is supplemented with commercially available microorganisms, then those microorganisms shall be non-pathogenic.
- j. Underground injection control inventory: Remedial Action Plans proposing injection-type, in situ 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 3. Only the Department, including its district offices, may approve injection-type, in situ aquifer remediation plans for which the approval constitutes a Class V injection permit; local programs are not authorized to grant such approvals.
- k. Operation:
 - 1. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of EOS 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 already 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 contamination plume is expected to accompany the EOS 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 EOS that will be injected.

1. Abandonment of wells: Upon issuance of a 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 2

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 3 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 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 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. Dosage and application rate: The theoretical dosage of soybean oil, the key component of EOS, is established by the electron demand of the contaminants to be dechlorinated. (EOS is 10-20 percent soybean oil.) An example is given for perchloroethylene (PCE). One(1) gram of soybean oil will support the biodegradation of 7.9 grams of PCE. The biodegradation of 1 gram of the oil provides approximately 0.38 electron equivalents. One mole of perchloroethylene requires 8 electron equivalents or 0.048 electron/g PCE. If all the electrons from the soybean oil were used for PCE dechlorination, then 1 gram of the oil would support the biodegradation of 7.9 grams of PCE. The same reasoning applies to other contaminants to be degraded. The Department, however, suggests that potential users of EOS consult the manufacturer about dosages for their site-specific conditions.

As for the application rate, a typical rate for EOS is in the range of 100 to 500 gallons per injection point. For rule-of-thumb purposes only, EOS applied to sand and gravel aquifers has had an observed radius of influence of at least 30 feet from the point of injection. The Department suggests that users take into account their own site-specific conditions to determine if the radius of influence for their cleanup project will be more or less than 30 feet.

- c. Degradation products: The long chain fatty acids in EOS are degraded to simpler compounds such as acetic acid, propionic acid, and butyric acid by anaerobic bacteria. These compounds are further degraded to release hydrogen and electrons that are used by dechlorinating bacteria to remove chlorides, resulting in the production of relatively innocuous products such as ethane and ethene.
- d. Cleanup time: Like any other product or process, the cleanup time for EOS depends on site-specific conditions. It has been indicated, however, that chlorinated solvent contaminants at one EOS site decreased to non-detect levels in 3 months, and that another had a 66% reduction 16 months.

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 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 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): _____

Richard Deuerling
Page Two
Date: _____

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 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 byproducts or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminants 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 remediation contractors may fill in all blanks except those labeled "FROM", "DATE", and "approval date", and "telephone number" blanks in the last paragraph. Only a state or local program reviewer should complete those blanks.

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 exemption or variance has been granted.