

Florida Department of Environmental Protection

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

Rick Scott
Governor

Jennifer Carroll
Lt. Governor

Herschel T. Vinyard Jr.
Secretary

July 8, 2011

Stephen D. Richardson, Ph.D.
EOS Remediation, LLC
1101 Nowell Road
Raleigh, North Carolina 27607

Re: EASTTM (Electron Acceptor Solution)

Dear Mr. Richardson:

The Bureau of Petroleum Storage Systems (Bureau) hereby accepts EASTTM (Electron Acceptor Solution), an aqueous solution of sulfate salts and nutrients that stimulate indigenous anaerobic bacteria to degrade petroleum hydrocarbon contaminants, in situ, in groundwater and soil. It is intended for use at cleanup sites where the conditions are already conducive to sulfate reduction. Enclosure 1 is a voucher for the confidential disclosure of EASTTM ingredients; Enclosure 2 contains regulatory information; Enclosure 3 contains supplemental information; and Enclosure 4 is an Underground Injection Control Notification.

The Bureau does not provide endorsement of specific or brand name remediation products or processes. It does, however, recognize the need to determine their acceptability in the context of environmental regulations, safety and the protection of public health. For that reason, the Bureau issues an "acceptance" letter, not an approval. In no way shall an acceptance be construed as a certification of performance. Additionally, vendors, upon receipt of an acceptance, must market their product or process on its own merits regarding performance, cost, and safety in comparison to competing alternatives in the marketplace.

Remedial Action Plans that propose the use of an accepted product or process should include a copy of the acceptance letter in the plan's appendix, and reference it in the text of the document. 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 rules and regulations.

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The Bureau reserves the right to revoke its acceptance of a product or process if it has been falsely represented. Additionally, Bureau 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 submitted for Department review and approval. If you have any questions, please contact Rick Ruscito below.

Sincerely,



Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Program Section 6 - MS 4590
rruscito@ene.com
(850)-877-1133, extension 3722



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

enc: (1) Proprietary Ingredients Voucher
(2) Regulatory Information
(3) Supplemental Information
(4) Underground Injection Control Notification

c: Tom Conrardy, P.E. - FDEP/Tallahassee

PROPRIETARY INGREDIENTS VOUCHER



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Environmental Protection

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Stephen D. Richardson, Ph.D.
EOS Remediation, LLC
1101 Nowell Road
Raleigh, North Carolina 27607

Re: **Proprietary Ingredients Voucher**

Dear Mr. Richardson:

The Bureau of Petroleum Storage Systems (Bureau) hereby acknowledges receipt of a confidential disclosure on June 13, 2011 describing the proprietary ingredients and their proportions in EAST™, an aqueous solution of sulfate salts and nutrients that stimulate indigenous anaerobic bacteria to degrade petroleum hydrocarbon contaminants, in situ, in groundwater and soil.

Having reviewed the confidential disclosure, the Bureau hereby vouches for its content, and provides advice in Enclosure 2 on how to comply with applicable regulations of the Florida Administrative Code (F.A.C.) when EAST™ is used for the cleanup of contamination in accordance with a Department-approved, site-specific Remedial Action Plan. The Department, in offering its advice, has been careful to mention only enough general information about the ionic species and parameters that must be monitored by users in order to comply with Underground Injection Control regulations, but not so much information as to compromise the identity of the proprietary molecular ingredients.

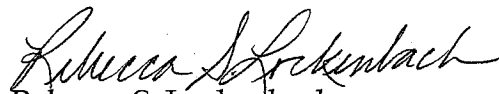
For Underground Injection Control purposes, injection-type aquifer remediation plans must specify both the volume and the complete chemical composition of the fluid to be injected. But since the details of the ingredients and their proportions in EAST™ are proprietary, it will suffice to indicate just the volume of the fluid to be injected, along with the overall concentration of EAST™ in that fluid, and then provide a note that a confidential disclosure of the proprietary details has already been submitted to the Department and accepted. Reference should be made to this voucher, and a copy of it

should be included as an appendix to the plan. If you have any questions, please contact Rick Ruscito below.

Sincerely,



Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Program Section 6 - MS 4590
rruscito@ene.com
(850)-877-1133, extension 3722



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

REGULATORY INFORMATION

- a. Regulations: Chapters of the Florida Administrative Code (F.A.C.) that may be applicable, either in part or in their entirety, include but are not necessarily limited to 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 groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for Underground Injection Control (UIC), particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapters 62-770, 62-780, 62-782, and 62-785 F.A.C., for cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels.

Users of EASTTM shall comply with all applicable regulations. This includes meeting applicable groundwater cleanup target levels for the contaminants of concern, the residual concentrations of ingredients, and any byproducts of concern produced by chemical and biological reactions induced by those ingredients during the timeframe of the cleanup project. For the ingredients of concern that are present in excess of their groundwater standards, the timeframe is that which is permitted for a temporary injection zone of discharge (ZOD) as described below.

- b. UIC and ZOD permits: Per Rule 62-528.630(2)(c), F.A.C., Class V injection-type aquifer remediation wells are exempt from the permitting requirements of Rule 62-528.635, F.A.C., when authorized by a Department-approved Remedial Action Plan or other enforceable mechanism, provided the requirements of the rules governing the remediation project, as well as the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. Per Rule 62-528.630(2)(c), F.A.C., the issuance of an enforceable, site-specific Remedial Action Plan Approval Order by the Department for injection-type aquifer remediation constitutes the granting of a Class V injection well construction/clearance permit. And per Rule 62-520.310(8)(c), F.A.C., if a temporary ZOD is necessary, and permissible by way of that rule, then the issuance of the site-specific Remedial Action Plan Approval Order also constitutes the granting of permission for the temporary ZOD.
- c. UIC notification: Remedial Action Plans proposing in-situ, injection-type aquifer remediation shall include information pursuant to Rules 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of the UIC program. Reviewers of those plans, upon issuance of an enforceable Remedial Action Plan Approval Order by the Department, must submit a completed copy of the Enclosure 4 UIC inventory notification form to the UIC program in Tallahassee.
- d. General information about temporary ZODs: For in-situ aquifer remediation, the composition of an injected material must meet the primary and secondary drinking water standards set forth in Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C., pursuant to UIC Rule 62-528.600(2)(d), F.A.C. Aquifer remediation products that do not meet these requirements must seek relief from water quality criteria by one of two mechanisms. Permission for a temporary

ZOD may be obtained by way of Rule 62-520.310(8)(c), F.A.C. If a ZOD cannot be obtained by rule, it will be necessary to seek a variance from Department rules in accordance with Section 120.542, Florida Statutes.

Rule 62-520.310(8)(c), F.A.C., allows for a temporary ZOD for closed-loop re-injection systems, for the prime constituents of the reagents used to remediate site contaminants, and for groundwater secondary standards. In order to obtain permission for a temporary ZOD by rule, a site-specific Remedial Action Plan must indicate: (a) the chemical ingredients of concern in the fluid to be injected that will be present in excess of groundwater standards; (b) the size of the ZOD that is needed; (c) the amount of time that the ZOD will be needed; and (d) a plan for monitoring the injected chemical ingredients of concern. The size of the temporary ZOD will usually be the injection well radius of influence when the treatment system is a single injection point. For a multiple point system, the ZOD can usually be expressed and illustrated as the total area of the cluster formed by all the injection points, located side-by-side with overlapping radii of influence.

- e. Specific ZOD information for EASTTM: EOS Remediation LLC anticipates that users will not be diluting EASTTM prior to use, but rather will be injecting the undiluted as-shipped product as a liquid of specific gravity 1.18 at pH 8.5. The Bureau of Petroleum Storage System, having reviewed the confidential disclosure of the ingredients and their proportions in the undiluted, as-shipped product, has determined that ZOD permission is needed for total dissolved solids (TDS), ammoniacal nitrogen, and sulfate. Permission can be obtained by way of Rule 62-520.310(8)(c), F.A.C., as described in paragraph d above. But in order to have information ready for the future, should there be a need to reduce the concentration of EASTTM in the fluid to be injected, the Bureau of Petroleum Storage Systems has done dilution calculations to identify the ZOD parameters that apply and summarizes them in Table 1 below.

<u>Table 1. ZOD Trigger Concentrations for EASTTM</u>						
<u>If the number of volumes of dilution water to be added to each volume of as-shipped EASTTM prior to injection is ...</u>				<u>then ZOD permission via Rule 62-520.310(8)(c), F.A.C., and groundwater monitoring is required for...</u>		
				<u>Total Dissolved Solids</u>	<u>Ammonia</u>	<u>Sulfate</u>
<i>equal to or greater than</i>	<i>0</i>	<i>but less than</i>	<i>660</i>	X	X	X
<i>equal to or greater than</i>	<i>660</i>	<i>but less than</i>	<i>892</i>		X	X
<i>equal to or greater than</i>	<i>892</i>	<i>but less than</i>	<i>1,050</i>			X
<i>equal to or greater than</i>	<i>1,050</i>	<i>(no ZOD required)</i>				

- f. ZOD monitoring notes for EASTTM: In most cases, quarterly monitoring of groundwater should suffice for the ZOD parameters listed in Table 1 above. The number of monitoring wells to be sampled should be representative of the EASTTM treatment area, and should include at least one monitoring well just beyond the downgradient edge of the treatment area. The current groundwater standards for the parameters listed in Table 1 are as follows: total dissolved solids, 500 milligrams per liter (mg/L); ammonia, 2.8 mg/L; and sulfate, 250 mg/L. Upon expiration of the time period granted for the ZOD, the concentration of each must meet its respective groundwater standard, or its natural-occurring background value at the specific cleanup site, whichever is less stringent.

Hydrogen sulfide is not an EASTTM ingredient and is not subject to UIC notification as such, but rather a byproduct of regulatory interest as indicated in paragraph a above. Chapter 62-777, F.A.C., regulates hydrogen sulfide as a minimum groundwater criteria contaminant with a maximum allowable groundwater concentration of 0.021 milligrams per liter (mg/L). Therefore, within the same timeframe that is permitted for a temporary ZOD for EASTTM, the concentration of residual hydrogen sulfide in the groundwater must meet its 0.021-mg/L criterion or return to its natural-occurring background level at the specific cleanup site, whichever is less stringent.

- g. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Bureau has no objection to the use of some wells for the application of EASTTM. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply EASTTM. This will avoid premature conclusion 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.
- h. Avoidance of migration: For injection-type, in-situ aquifer remediation projects, pursuant to Rule 62-528.630(3), F.A.C., injection of EASTTM shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the ingredients of concern, site contaminants, or remediation byproducts results.
- i. Abandonment of wells: Upon issuance of a Site Rehabilitation Completion Order, injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C., and the Underground Injection Control Section of the Department shall be notified so that the treatment wells can be removed from the injection well inventory-tracking list.
- j. Open-pit application: The direct application of EASTTM to an open pit in which the groundwater is exposed is not an injection, and notification of the UIC Section is not required, but the user must still be mindful of groundwater quality. Therefore, for open-pit applications, the groundwater in the application area should be monitored for the same parameters that would have required ZOD monitoring, had the application actually been an injection.

SUPPLEMENTAL INFORMATION

- a. How it works: EASTTM (Electron Acceptor Solution) is an aqueous solution of sulfate salts and nutrients that stimulate indigenous anaerobic bacteria to degrade petroleum hydrocarbons, in situ, in groundwater and soil. In order for it to work, the conditions of the cleanup site must already be conducive to sulfate reduction. The sulfate is chemically reduced when it serves as the electron acceptor in a degradation reaction whose byproducts include bicarbonate and hydrosulfide ions. At near neutral to slightly alkaline pH, the sulfide combines with natural-occurring dissolved metals already in the groundwater (e.g. iron, manganese, zinc, and others) to form immobile metal sulfides. The ultimate products of the degradation are the immobile metal sulfides, carbonates, water, and carbon dioxide.
- b. Hydrogen sulfide: EOS Remediation LLC indicates that hydrogen sulfide has not been detected in soil gas to date at sulfate cleanup sites, but nevertheless, as a prudent measure, recommends that consideration be given to hydrogen sulfide gas on a site-by-site basis. For example, if EASTTM will be used near a building or underground utilities, then consideration should be given to the amount of hydrogen sulfide gas that may be generated and the monitoring of it.
- c. Nearby wells and surface water bodies: EOS Remediation LLC indicates that consideration should be given to the location and distance of private water wells, high capacity municipal wells, and surface water bodies during EASTTM cleanups. Stay a safe distance away from the capture zone of these wells, and a safe distance from surface water bodies. Use monitoring wells at strategic locations to detect unwanted migration of EASTTM constituents and the cleanup site's contaminants of concern.
- d. Dosage and application rate: Each site-specific Remedial Action Plan proposing the use of EASTTM must indicate a dosage and application rate. EOS Remediation LLC anticipates that EASTTM will be applied at the as-shipped concentration, and that the frequency of application will be determined on a site-specific basis, taking into consideration the groundwater standard for sulfate and the potential for generation of hydrogen sulfide. If a situation should arise in which it is necessary to apply a reduced concentration of proprietary EASTTM, then the site-specific Remedial Action Plan may express the dosage as the number of volumes of water to be added to each volume of as-shipped EASTTM prior to injection, and Table 1 of Enclosure 1 should be used to identify the parameters that will need ZOD permission and groundwater monitoring at the reduced concentration.
- e. Limitations: EASTTM is not designed for free phase light non-aqueous phase liquid (free product) but it can be used at sites where just an oily sheen is present. It is also not suitable for sites that are not already conducive to sulfate reduction.

Florida Department of Environmental Protection

Memorandum

{This version of UIC Notice memo is for use by staff of the BPSS, BWC, and District offices}

TO: Cathy McCarty, P.G.
Florida Department of Environmental Protection
Bureau of Water Facilities Regulation
Underground Injection Control Section - MS 3530
2600 Blair Stone Road, Tallahassee, Florida 32399-2400

FROM: _____
(An employee of Div. of Waste Management or DEP District Office)

DATE: _____

SUBJECT: **Remediation Product Injection Well(s) for In Situ Aquifer
Remediation at a Contaminated Site**

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

Facility name: _____

Facility address: _____

City/County: _____

Latitude/Longitude: _____

FDEP Facility Number: _____

Facility owner's name: _____

Facility owner's address: _____

Well contractor's name: _____

Well contractor's address: _____

Reminder: This memorandum must be completed by an FDEP employee of the Bureau of Petroleum Storage Systems, the Bureau of Waste Cleanup, or an FDEP District Office. A person working for a consultant company preparing a RAP may complete some portions of this memo to expedite the FDEP's review but if so, the "From" and "Date" blanks and the date of RAP approval and phone number should be left blank for the FDEP technical reviewer to complete after verifying other information in the memo is accurate and conforms to applicable rules and procedures.

oOo

Please remove this message box prior to submittal of this memorandum to the Underground Injection Control Section.

AFFECTED AQUIFER

Name of aquifer: _____
Depth to groundwater (feet): _____
Aquifer thickness (feet): _____
Areal extent of contamination (square feet): _____

INJECTION WELLS

A site map showing the location and spacing of injection wells, the areal extent of the groundwater contamination plume, and associated monitoring wells is attached. 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, if applicable: _____ to _____ feet below land surface

Casing diameter, if applicable (inches): _____

Cased depth, if applicable: _____ to _____ feet below land surface

Casing material, if applicable: _____

If a remediation product will be injected as a DP rod is inserted, indicate injection interval: _____ to _____ feet below land surface.

PROJECT DESCRIPTION

The in situ, injection-type aquifer remediation product/process remediates contaminants by:
(check those that apply)

- ☐ use of a bioremediation product,
- ☐ use of a chemical oxidation product,
- ☐ recirculation of partially treated contaminated groundwater, or
- ☐ other (describe) _____

Brief description of the project: _____

Summary of major design considerations and features of the project:

Number of injection wells: _____

Injection volume per well (gallons): _____

Single or multiple injection events: _____

Injection volume total (all wells, all events): _____

For continuous recirculation of partially treated water, indicate total daily design flow rate: _____ gallons per day

FLUID TO BE INJECTED

Brand name of remediation product(s): _____

Has an innovative technology acceptance letter been issued for this product by the BPSS:
__ yes __ no (Note: it is not required that an innovative technology acceptance letter be issued for the technology or product to be proposed in a RAP)

If product formula is proprietary then non-disclosure of the formula to the PE reviewing the RAP for the Department is only acceptable if there is an innovative technology acceptance letter issued by the Department with an attached proprietary voucher of confidential disclosure and it is verified that the proposed application rates (dosage) is limited to the rates specified in the innovative technology acceptance letter.

Is product formulation proprietary? __ yes __ no.

If product formulation is proprietary are proposed application rates limited to that indicated in innovative technology acceptance correspondence? __ yes __ no __ N/A

Composition of injected fluid (e.g. ingredient, wt. %): _____

TEMPORARY INJECTION ZONE OF DISCHARGE (ZOD)

(check those that apply)

- ☐ No ZOD needed. The fluid to be injected meets the primary and secondary groundwater standards of Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapters 62-520 and 62-777, F.A.C. _____
- ☐ ZOD permission by rule 62-520.310(8)(c) †, F.A.C., for reagent chemical species and/or parameter(s) in the fluid to be injected (or re-injected) that exceed secondary groundwater standards. ZOD permission by this rule also applies to chemical species in the fluid to be injected that exceed primary groundwater standards or minimum groundwater criteria, provided those species are prime constituents of the reagents used to remediate site contaminants. The chemical species and parameters for which the approved Remedial Action Plan identifies zone size and duration, and addresses groundwater monitoring are summarized below.

Chemical species & parameters: _____

Zone size (sq. ft.) _____ Duration (mos.) _____ Yes, monitoring addressed. ☐

- ☐ ZOD permission by rule 62-520.310(8)(c) †, F.A.C., for the following contaminants of concern that exceed their groundwater standards in the fluid to be re-injected as part of a closed-loop re-injection system for which the approved Remedial Action Plan identifies zone size and duration, and groundwater monitoring:

Contaminants of concern: _____

Zone size (sq. ft.) _____ Duration (mos.) _____ Yes, monitoring addressed. ☐

- ☐ ZOD permission by variance because the fluid to be injected contains the following impurities that are not prime constituents of the reagents used to remediate the site's contaminants, and the concentrations of those impurities in the fluid to be injected are in excess of their primary groundwater standards:

Impurities regulated as primary groundwater contaminants: _____

Zone size (sq. ft.) _____ Duration (mos.) _____ Yes, monitoring addressed. ☐

- ☐ A variance needs to be granted before the remediation can be conducted.

- ☐ A variance has already been granted for the impurities listed above:

Date variance granted: _____

Zone size (sq.ft.): _____

Duration (mos.): _____

- ☐ If ZOD permission by rule 62-520.310(8)(c)†, F.A.C., or by variance is checked above, then a figure that delineates the ZOD is attached. (Use the lines below to more fully describe the ZOD if a figure alone will not suffice).

CLEANUP CRITERIA AND ENFORCEABLE APPROVAL ORDER

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 reactions induced by those ingredients or the contaminants of concern during their use. Applicable primary and secondary groundwater standards are set forth in Chapter 62-550, F.A.C., and minimum groundwater 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.

† Effective July 12, 2009, rule 62-522.300(2)(c), Florida Administrative Code (F.A.C.), was relocated to Chapter 62-520, F.A.C., and renumbered as rule 62-520.310(8)(c), F.A.C.