



# Department of Environmental Protection

Jeb Bush  
Governor

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

David B. Struhs  
Secretary

October 28, 2002

Mr. Greg Kruse, P.G.  
Deer Brook South  
5870 Eight Point Lane  
Lakeland, Florida 33811-4002

Re: **REM-3**

Dear Mr. Kruse:

The Bureau of Petroleum Storage Systems hereby reaffirms its original acceptance of REM-3 as a bioremediation product for both in situ and ex situ bioremediation of petroleum and other suitable hydrocarbon contaminants in groundwater or soil. This letter of reaffirmation supersedes all previous acceptance letters for REM-3, and it reflects the new address of your firm.

As indicated by the manufacturer, Microbes Research and Development Incorporated, of Big Spring, Texas, REM-3 is a non-toxic formulation of natural-occurring, non-pathogenic, non-opportunistic, aerobic bacteria. It is shipped in a dry form and is rehydrated by the user prior to application. For the remediation of subsurface contamination, the manufacturer recommends that REM-3 be used in conjunction with oxygen-supplying agents and third-party stimulants. Enclosure 1 is a brief summary of product information.

For vadose remediation where the underlying groundwater will not be affected by 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, where an aboveground treatment system produces effluent meeting the petroleum cleanup criteria of 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 direct injection of REM-3 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.

The bureau recognizes REM-3 as a viable product for the bioremediation of petroleum contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a Remedial Action Plan is approved by the Department; and (c) applicable and appropriate underground injection control regulations are observed when the product is used for in situ aquifer remediation via injection.

While the Department of Environmental Protection does not endorse 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. Vendor's 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 letter regarding regulatory acceptance (or the conditions of regulatory acceptance) be construed as certification of product or process performance. For REM-3, the major environmental and regulatory considerations are set forth in enclosure 2.

Preparers of 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 its environmental acceptability. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 3.

The Department reserves the right to revoke its acceptance of a product if the nature, composition, or proportions 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: Bill Burchett  
Microbes Research and  
Development, Inc.  
P.O. Box 2465  
Big Spring, Texas 79721

History:

inn\_039.doc - 3/1/00  
inn\_039a.doc - 7/10/01  
inn\_039b.doc - 10/28/02

ENCLOSURE 1

REM-3 PRODUCT INFORMATION\*

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<u>CHEMICAL SPECIES OR PARAMETER</u>	<u>AMOUNT</u>	<u>DETECTION LEVEL</u>	<u>UNITS</u>
<u>Primary Drinking Water Contaminants</u>			
Nitrate	ND †	0.5	mg/L ‡
<u>Non-regulated Drinking Water Parameters</u>			
Phosphate	ND	0.5	mg/L
<u>Secondary Drinking Water Contaminants</u>			
pH	7.1	n.a.	pH units

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\* REM-3 is bacteria that are shipped in a dried, dormant state. The information shown is for a sample that was rehydrated, with water whose pH was 7.2 prior to rehydration.

† ND denotes not detected at the indicated detection level.

‡ mg/L denotes milligrams per liter.

Notes:

1. Reactivation of the dormant bacteria occurs when REM-3 is rehydrated.
2. REM-3 contains a sugar source that aids in the reactivation of the bacteria.
3. REM-3 is a biodegradable, non-toxic formulation of natural-occurring, non-pathogenic, non-opportunistic bacteria. The microorganisms in the formulation are aerobic. The dominant species is *Bacillus subtilis*, whose hazard classification by the National Institute of Health is Risk Group 1 (RG1), meaning it is an agent not associated with disease in healthy adult humans.

ENCLOSURE 2

REM-3: ENVIRONMENTAL AND REGULATORY INFORMATION

For REM-3, the major environmental and regulatory concerns are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of REM-3 to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for the contaminants of concern, any residuals associated with the ingredients of REM-3, and any byproducts produced as a result of chemical or biochemical reactions involving those ingredients. The following chapters of the Florida Administrative Code are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; and Chapter 62-770, F.A.C., for petroleum 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 indiscriminate injection of a potentially harmful product in the event that any of its ingredients is not regulated as a specific primary or secondary drinking water contaminant.

- b. Injection well permit: The issuance of a site specific Remedial Action Plan Approval Order by either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup, for remediation via injection of REM-3 into an aquifer, 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.
- d. Nutrients option: If injection of REM-3 into an aquifer is to be augmented by nutrients or other substances, then the Remedial Action Plan for the project must provide a complete chemical analysis of the augmenting nutrient mixture. The injected mixture cannot exceed 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. Additionally, if the injected mixture contains substances not regulated as primary or secondary drinking water contaminants by Chapter 62-550, F.A.C., then none of them shall be harmful. For nutrient mixtures that do not meet the primary and secondary drinking water standards of Chapter 62-528, F.A.C., or the minimum groundwater criteria of Chapter 62-520, F.A.C., it is necessary to obtain a variance. Remedial Action Plans prescribing injection of nutrients, as augmentation to the

REM-3 formula, shall indicate which chemical species associated with the nutrients warrant tracking.

- 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 REM-3. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling), shall be used to apply REM-3. 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.
- f. Groundwater monitoring:
  - 1. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored 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. For non-petroleum cleanups, 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 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. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
  - 3. Underground injection control monitoring: Since no ingredient of REM-3 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.
- g. Background samples: Prior to commencement of in situ injection-type aquifer remediation projects, the Department recommends the sampling of at least one (1) monitoring well located upgradient of the petroleum contamination plume, or at least one (1) non-upgradient monitoring well, located beyond the edge of the plume, for the background concentration of selected key bioremediation parameters. If more than one well is sampled, then the average value of each parameter can be used as the background value for the site.

Since no ingredient of REM-3 exceeds an MCL set forth by the drinking water standards of Chapter 62-550, F.A.C., the measurement of background concentrations, for injection control purposes, shall not be mandatory. Such sampling, however, is recommended as a matter of good bioremediation practice.

- h. Underground injection control inventory: Remedial Action Plans prescribing in situ aquifer injection-type remediation shall include information pursuant to Rule 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of underground injection control. Per Rule 62-528.630(2)(c), F.A.C., aquifer remediation projects involving injection wells may be authorized under the provisions of a Remedial Action Plan, provided the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. A memorandum outlining the inventory information about injection-type aquifer remediation plans to be transmitted by Department reviewers to the Underground Injection Control Section is provided as enclosure 4. Only reviewers within the Department, including its district offices, may approve in situ injection-type remediation plans in which the approval constitutes a Class V injection permit; local programs are not authorized to grant such approvals. See enclosure 3.
- i. Operation:
1. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of REM-3 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 REM-3 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 and concentration of REM-3 that will be injected.
  3. Operating parameter measurements: 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.
- j. 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 list.

ENCLOSURE 3

REM-3: SUPPLEMENTAL INFORMATION

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

- a. Department of Environmental Protection reviewers of 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 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 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 for in situ chemical additives at web page [www.dep.state.fl.us/dwm/programs/pcp/geninfo/active.htm](http://www.dep.state.fl.us/dwm/programs/pcp/geninfo/active.htm).

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

REM-3 contains only microorganisms which are natural-occurring (not genetically engineered), non-pathogenic (do not cause disease), and non-opportunistic (will not cause disease in a compromised host).

- d. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of hydrocarbons. In the case of methanogenesis, an anaerobic process, carbon dioxide and methane are produced. The intermediate products of aerobic degradation may include simple acids, alcohols, and fatty acids. Aerobic processes use oxygen as an electron acceptor to produce carbon dioxide and water.
- e. Parameters: The following parameters may be useful in determining the potential for bioremediation at a site, or whether bioremediation is already occurring. They were selected from a list that appears in the publication "In Situ Treatment Technology" by E. Nyer et al., Lewis Publishers, 1996. The parameters are: dissolved oxygen; redox potential; pH; temperature; specific conductance; volatile organic compounds; nitrate; nitrite; ammonia nitrogen; manganese (total and dissolved); iron (total, dissolved, and ferrous); sulfate; sulfide; and total organic carbon. Gaseous parameters include: carbon dioxide, oxygen, nitrogen, and methane. Other parameters that may be helpful are chemical oxygen demand, biochemical oxygen demand, and total organic carbon. Preparers of bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site specific basis.
- f. Hydration: The information provided for this acceptability determination did not discuss the details of hydrating the dried dormant REM-3 bacteria. However, in 1999, the Department's Bureau of Waste Cleanup reviewed a site-specific Remedial Action Plan that included the use of REM-3, indicating that one (1) pound of REM-3 would be mixed with twenty (20) gallons of water.
- g. Dosage and application: The information provided for this acceptability determination did not discuss the details of dosage and application of the product. But regardless of whether or not general information has been provided for rule-of-thumb purposes, the exact dosage should be determined on a site by site basis, taking into account the site-specific conditions. For in situ aquifer remediation projects, it is assumed that injection wells and direct-push points will be the most common method of REM-3 application.

**Florida Department of  
Memorandum Environmental Protection**

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

FROM: \_\_\_\_\_ (Note 1.)  
\_\_\_\_\_  
\_\_\_\_\_

DATE: \_\_\_\_\_

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

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

Site name: \_\_\_\_\_

Site address: \_\_\_\_\_

City/County: \_\_\_\_\_

Latitude/Longitude: \_\_\_\_\_

FDEP Facility Number: \_\_\_\_\_

Site owner's name: \_\_\_\_\_

Site owner's address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Well contractor's name: \_\_\_\_\_ (Note 2.)

Well contractor's address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_

Summary of major design considerations and features of the project:

Areal extent of contamination (square feet): \_\_\_\_\_

Number of injection wells: \_\_\_\_\_

Composition of injected fluid (Note 3)  
(ingredient, wt. %): \_\_\_\_\_  
\_\_\_\_\_

Injection volume per well (gallons): \_\_\_\_\_

Single or multiple injection events: \_\_\_\_\_

Injection volume total (all wells, all  
events): \_\_\_\_\_

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 that 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.

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- 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. 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. Chapter 62-528, Florida Administrative Code, requires complete chemical analysis of injected fluid. 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