



Department of Environmental Protection

Jeb Bush
Governor

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

David B. Struhs
Secretary

March 6, 2002

Mr. Joseph Gaudet
Bio-Tech 2000
420 Clematis Street
West Palm Beach, Florida 33401

Re: Oppenheimer Formula

Dear Mr. Gaudet:

The Bureau of Petroleum Storage Systems hereby reaffirms its acceptance of the Oppenheimer formula microbiological product, produced by Oppenheimer Biotechnology Incorporated of Austin, Texas, as an innovative product for the remediation of petroleum contamination in groundwater and soil, both in situ and ex situ. Per chemical analysis shown in enclosure 1 and your indication, the product contains only natural-occurring non-pathogenic bacteria, which have been dried and mixed with an inert preparation of natural clay for rehydration prior to use. [This reaffirmation supersedes the original March 6, 1998 acceptance letter, which is hereby updated, including the removal of all references to the American Type Culture Collection \(ATCC\) at the request of the ATCC.](#)

For soil remediation, in situations where groundwater will not be affected by the use of the 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 Oppenheimer formula 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 a common application of this product, the bulk of the regulatory requirements discussed herein will be directed to that topic.

The Bureau recognizes the Oppenheimer formula as a viable bioaugmentation product for the remediation 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 provide endorsement of specific or brand name remediation products or processes, it does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health, safety and welfare. Vendors must then market the products and processes on their own merits regarding performance, cost, and safety in

comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory acceptance letter be construed as Department certification of product or process performance. Additionally, the Department emphasizes a distinction between a regulatory "acceptance" and an approval. Products and processes are accepted; they are not approved. For the Oppenheimer formula, the major environmental and regulatory considerations are set forth in enclosure 2.

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 this product or process. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information in enclosure 3.

The Department reserves the right to revoke its acceptance of a product or process if its nature or 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: T. Conrardy - FDEP/Tallahassee

History:

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ENCLOSURE 1

CHEMICAL ANALYSIS OF THE OPPENHEIMER FORMULA (Notes 1 & 3)

PARAMETER	RESULT	UNITS
Total phosphorus (as P)	2.5	mg/L
Nitrite Nitrogen (as N)	0.073	mg/L
Nitrate Nitrogen (as N)	0.288	mg/L
Ammonia Nitrogen (as N)	0.163	mg/L
Total Nitrogen (as N)	3.45	mg/L
Total Kjeldahl Nitrogen [TKN] (as N)	3.09	mg/L
pH (Note 2)	5.05	SU
Total Dissolved Solids [TDS]	124	mg/L
Potassium [K]	3.239	mg/L
Sodium [Na]	15.81	mg/L
Calcium [Ca]	7.344	mg/L
Magnesium [Mg]	2.713	mg/L
Iron [Fe]	0.089	mg/L

Notes:

1. All results are for a sample of Oppenheimer dry product, which was hydrated in a 10:1 water to product ratio prior to analysis by a third party laboratory. The dry product consisted of bacteria in an inert preparation of natural clay.
2. Bio-Tech 2000 has indicated in February 26, 1998 correspondence that pH will be adjusted to approximately 7.5 in the field, prior to injection, in order to meet a requirement that the pH of fluids injected into an aquifer be in the range of 6.5 to 8.5. Actual field dilution will be greater than the 10:1 water to product ratio used for laboratory analysis.
3. Chemical analysis was conducted February 1998.
4. Abbreviations: mg/L denotes milligrams per liter.

ENCLOSURE 2

ENVIRONMENTAL AND REGULATORY INFORMATION

For the Oppenheimer formula, the major environmental and regulatory concerns are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of the Oppenheimer formula to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for petroleum and any residuals associated with the ingredients of the Oppenheimer formula, and any byproducts produced as a result of chemical or biochemical reactions. 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; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels.
- b. Groundwater injection standards: For in situ aquifer remediation, the composition of the 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.
- c. Nutrients option: The Oppenheimer formula, as sold by the manufacturer, already contains nutrients. If, however, the groundwater at an in situ aquifer remediation site is found to be in need of additional nutrients, and injection of the Oppenheimer formula 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. [If the composition of the injected mixture exceeds the drinking water standards set forth in Chapter 62-550, F.A.C., then the Remedial Action Plan, pursuant to Rule 62-522.300\(2\)\(c\), F.A.C., must address the size and duration of a zone of discharge, and groundwater monitoring of parameters that do not meet those drinking water standards.](#) 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 [exceed the minimum groundwater criteria of Chapters 62-520 and 62-777, F.A.C., without first obtaining a zone of discharge variance.](#)
- d. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells for the application of Oppenheimer formula. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply Oppenheimer formula. 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.
- e. 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.

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.
 3. Underground injection control monitoring: The Department, for the sake of prudence, in its original March 6, 1998 acceptance of the Oppenheimer Formula, required underground injection control monitoring of some primary and secondary groundwater parameters pursuant to Rule 62-528.615(2), F.A.C., even though none of these parameters were exceeded by the composition of the injected formula. It will no longer require monitoring of those parameters for underground injection control purposes for Oppenheimer.
- f. 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.
- g. Operation:
1. Avoidance of migration: For in situ injection type aquifer remediation projects, injection of the Oppenheimer formula 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 petroleum contaminants 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 Oppenheimer 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 amount of Oppenheimer formula 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.

- 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.

ENCLOSURE 3

OPPENHEIMER FORMULA: 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.

- 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. For state funded projects, reviewers are encouraged to use judgment in balancing cost and the need for technical information to be obtained from a pilot study.
- 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. Naturally 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.
- d. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of petroleum hydrocarbons. The intermediate products may include simple acids, alcohols, and fatty acids.
- e. Oxygen: The aerobic microorganisms in the Oppenheimer formula require oxygen, which serves as an electron acceptor in the biodegradation of petroleum hydrocarbons. If sufficient oxygen is not present at a remediation site, then it may be added artificially, e.g., via air

sparging or oxygen generating compounds such as magnesium peroxide or hydrogen peroxide.

- f. 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.
- g. Dosage: For in situ hydrocarbon remediations, the manufacturer indicates that one (1) pound of the Oppenheimer formula (prior to rehydration) per five (5) cubic yards of contaminated soil may be used as a rough rule of thumb dosage. The precise dose to be used will depend on a site specific evaluation of the type of contaminants present, the concentration of the contaminants, and the nutritional sources available at the site for the bacteria. (The Department assumes that the 1 pound per 5 cubic yards of soil rule of thumb may also be used to roughly estimate the quantity and cost of Oppenheimer formula required to remediate a given volume of soil, whether it is located above or below the water table.)
- h. Operating parameters: The bioremediation parameters listed below, compiled from various sources, are provided as guidance only, and should not be construed as absolute, or used as the sole criteria for approval or disapproval of proposed Remedial Action Plans or remediation status reports.

Total nitrogen:	50-100 mg/L
Total phosphorus:	50-100 mg/L
Temperature:	10-40 deg. C
	30 deg. C, optimum
Moisture content (for soil):	15-20%
pH:	4.5-9.0
	7.0, optimum
Dissolved oxygen:	2 ppm minimum
	> 3 ppm, optimum
Carbon/nitrogen ratio:	20 to 1, maximum
	10 to 1, optimum

For the Oppenheimer formula, the operating ranges for several parameters are consistent with the above, and are as follows: temperature, 0-49 deg. C; pH, 5-10; and dissolved oxygen must be greater than 1% of saturation.

- i. Cleanup time: Case history summaries presented for the Oppenheimer formula, for the cleanup of soils contaminated by diesel, oil, and tars, indicate that TRPH reductions of 98% or greater in a matter of 1 to 4 months are possible. The longest period of time cited in a case history was for the cleanup of a high concentration of crude oil, in soil, which took approximately 18 months. Groundwater applications can be as quick as a matter of days.

**Florida Department of
Environmental Protection**

Memorandum

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): _____

Richard Deuerling
Page Two
Date: _____

Site name: _____
FDEP facility no.: _____

The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or Conventional (*circle the appropriate well type*)
Diameter of well(s) (i.e., riser pipe & screen)(inches): _____
Total depth of well(s) (feet): _____
Screened interval: _____ to _____ feet below surface
Grouted interval: _____ to _____ feet below surface
Casing diameter, if applicable (inches): _____
Cased depth, if applic.: _____ to _____ feet below surface
Casing material, if applic.: _____

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is intended to meet the groundwater petroleum cleanup criteria set forth in Chapter 62-770, F.A.C. Additionally, all other groundwater standards will be met at the time of project completion for any residuals associated with the ingredients of the injected remediation products, and any by-products or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminating petroleum during their use. Applicable primary and secondary drinking water standards are set forth in Chapter 62-550, F.A.C., and additional groundwater quality criteria are set forth in Chapter 62-520, F.A.C.

The remediation plan estimates that site remediation will take _____ months. We will notify you if there are any modifications to the remediation strategy which will affect the injection well design or the chemical composition and volume of the injected remediation product(s).

The proposed remediation plan was approved on _____ by an enforceable approval order. A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.

- Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: Per agreement with EPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should follow the instructions in a March 16, 2000 memorandum to arrange for Department headquarters' execution of an approval order, and then complete this form. This form is primarily for use by state and local program technical reviewers, but petroleum remediation contractors may fill in all blanks except those labeled "FROM", "DATE", and "approval date", and "telephone number" blanks in the last paragraph. Those blanks should be completed only by a state or local program reviewer.
- Note 2. If an injection well installation contractor has not yet been selected, then indicate the name and address of the project's general remediation contractor/consultant.
- 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.