



Department of Environmental Protection

Jeb Bush
Governor

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

David B. Struhs
Secretary

July 1, 1999

Mr. Frank Hughes
National Resource Protection Corporation
2133 North Dixie Highway
Fort Lauderdale, Florida 33305

Re: **PX-700**

Dear Mr. Hughes:

The Bureau of Petroleum Storage Systems hereby reaffirms its July 21, 1998 acceptance of PX-700 as an innovative product for the remediation of petroleum contaminated sites. This reaffirmation is issued in response to a request by National Resource Protection Corporation that it be listed in the innovative product schedule as both the manufacturer and Florida agent, at the address shown above.

Our understanding is that PX-700 is a biodegradable, non-toxic plant extract that stimulates the activity of indigenous aerobic and anaerobic bacteria, and that it may be used in groundwater or soil, in situ or ex situ. The results of a chemical analysis performed on the full-strength product, prior to dilution for use, are presented in enclosure 1.

If sufficient oxygen is not available for aerobic applications of this product, then an artificial supply can be introduced via air sparging, oxygen release compounds or other suitable methods. In the case of soil remediation, the bureau assumes that ample moisture must be present, and that it too, if necessary, may be introduced artificially.

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

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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 PX-700 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 PX-700 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 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. 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. For PX-700, 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 or composition of either or any

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of its principal and proprietary 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

cc: T. Conrardy - FDEP/Tallahassee

W. Evans - FDEP/Tallahassee

History:

inn_018.doc, 7/21/98
ppl_014, 7/21/98

inn_018a.doc, 7/1/99
ppl #054, 7/1/99

ENCLOSURE 1

FULL-STRENGTH PX-700 CHEMICAL ANALYSIS *

<u>CHEMICAL SPECIES OR PARAMETER</u>	<u>AMOUNT</u>	<u>UNITS</u>
<u>Primary Drinking Water Contaminants</u>		
Antimony	BDL <	mg/L >
Arsenic	0.31	mg/L
Barium	0.28	mg/L
Beryllium	BDL	mg/L
Cadmium	BDL	mg/L
Chromium	BDL	mg/L
Lead	BDL	mg/L
Mercury	BDL	mg/L
Nickel	BDL	mg/L
Selenium	BDL	mg/L
Sodium §	940	mg/L
Thallium	BDL	mg/L
Total Cyanide	BDL	mg/L
Nitrate (as nitrogen)	BDL	mg/L
Nitrite (as nitrogen)	0.97	mg/L
<u>Non-regulated Drinking Water Parameters</u>		
Total Nitrogen	798	mg/L
Total Kjeldahl Nitrogen %	797	mg/L
Salmonella	BDL	cells/10 milliliters
<u>Secondary Drinking Water Contaminants</u>		
Aluminum	0.77	mg/L
Chloride	540	mg/L
Color	3,000	color units
Copper	BDL	mg/L
Fluoride ¶	85	mg/L
Foaming Agents	3.0	mg/L
Iron	21.0	mg/L
Manganese	0.24	mg/L
Odor	100	threshold odor number
pH **	3.6	standard units
Silver	BDL	mg/L
Sulfate	10.0	mg/L
Total Dissolved Solids	15,700	mg/L
Zinc	0.42	mg/L

- * Prior to aquifer injection applications, full-strength PX-700 will be diluted to a total dissolved solids concentration of 100 mg/L or less, by combining at least 157 parts water with 1 part PX-700 (by volume). At such a dilution ratio, no primary or secondary drinking water contaminant listed exceeds its maximum contaminant level (MCL) set forth in the June 24, 1997 issue of Chapter 62-550, F.A.C.
- < BDL denotes below detection level of 0.10 milligrams per liter (mg/L), except in the cases of mercury, for which the analytical detection level is 0.0005 mg/L; cyanide, 0.01 mg/L; nitrate and nitrite, each of which is 0.02 mg/L; and salmonella, which is 3 cells per 10 milliliters.
- > mg/L denotes milligrams per liter.
- S Sodium is a State of Florida primary drinking water contaminant with an MCL of 160 mg/L set forth in Chapter 62-550, F.A.C., but not a federal primary drinking water contaminant.
- % Total Kjeldahl Nitrogen (TKN) is the sum of free ammonia and organic nitrogen compounds, expressed as elemental nitrogen.
- ¶ Fluoride appears in Chapter 62-550, F.A.C., as both a primary drinking water contaminant with an MCL of 4 mg/L, and a secondary drinking water contaminant with an MCL of 2 mg/L.
- ** For aquifer injection applications of PX-700 at concentrations of 100 mg/L or less, as described above, the pH will be in the acceptable 6.5 to 8.5 range set forth in Chapter 62-550, F.A.C. This was demonstrated in an actual test in which a sample of full-strength PX-700, from a batch having a pH of 3.91, was diluted to 100 mg/L using municipal tap water of pH 6.88. The resulting pH of the mixture was 6.55.

PHYSICAL PROPERTIES DATA FOR FULL-STRENGTH PX-700

<u>PARAMETER</u>	<u>VALUE</u>	<u>UNITS</u>
Boiling Point	188	°F
Solubility in Water	100	%
Vapor Density	1.1	Relative to air (1.0)
Specific Gravity	1.01	
Freezing Point	29	°F
pH	3.5-4.5	S.U.
% Volatile by Volume	97.4	%
Appearance/Odor	Brown liquid, slight marine odor	

ENCLOSURE 2

PX-700: ENVIRONMENTAL AND REGULATORY INFORMATION

For PX-700 formulations, the major environmental and regulatory concerns are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of PX-700 formulations 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 PX-700, 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 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 PX-700 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. Enclosure 1

provides indication that the ingredients of PX-700, when diluted to 100 mg/L or less prior to injection, meet this requirement.

- 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 PX-700. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling), shall be used to apply PX-700. 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. Bioaugmentation option: PX-700 does not contain microorganisms. For projects in which bioaugmentation will accompany the use of PX-700, only microorganisms that are naturally occurring (not genetically engineered), non-pathogenic (do not cause disease), and non-opportunistic (will not cause disease in a compromised host) shall be used.
- 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.
 - 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: Since no ingredient in PX-700 (when diluted to 100 mg/L or less prior to application) 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 in PX-700 formulations 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 PX-700 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 PX-700 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 PX-700 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 tracking list.
- k. Increased injection concentrations: If aquifer injection concentrations of greater than 100 mg/L of PX-700 are desired, then it may be necessary to seek a variance for the temporary exceedance of state secondary drinking water standards for those PX-700 ingredients which are regulated as secondary contaminants, and no longer in compliance at the higher concentration. Such a variance may require that each remediation site's background concentration of the affected secondary parameters be established, as baseline, prior to remediation, and establishment of a zone of discharge,

within whose dimensions a temporary exceedance is sought, and the maximum amount of time that a temporary exceedance may be tolerated. By the time the cleanup project is completed, all parameters covered by the variance must meet their maximum allowable secondary drinking water concentrations, or the site's naturally occurring background concentrations, whichever is less stringent.

The Department, however, does not recommend contemplation of PX-700 injection at any concentration that will cause exceedance of a federal primary drinking water standard, since such an exceedance cannot be granted under a state variance, and obtaining a federal exemption may be impractical and/or expensive.

ENCLOSURE 3

PX-700: 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. In some cases, it may be possible that a only a biotreatability test will suffice.
- 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. Aerobic processes use oxygen as an electron acceptor to produce carbon dioxide and water. In the case of methanogenesis, an anaerobic process, carbon dioxide and methane are produced.

For some of the other major anaerobic hydrocarbon degradation processes, the byproducts (fate of chemical species involved) also include: the generation of nitrogen (N_2) when nitrate serves as the electron acceptor in nitrate reduction processes; the formation of ferrous (Fe^{+2}) forms of iron in ferric iron (Fe^{+3}) reduction processes; the formation of (S^{-2}) forms of sulfur when sulfate serves as the electron acceptor in sulfate reduction processes; and the formation of Mn^{-2} forms of manganese when manganese dioxide is reduced.

- 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. Dosage and application: It is expected that PX-700 will usually be applied as an aqueous solution whose concentration is 100 mg/L or less. Exact dosages will depend on site conditions, total organic carbon, and an assessment of nutrients already available for bioremediation. For in situ treatment, PX-700 may be applied using injection wells or direct push methods.
- g. Operating parameters: Some key bioremediation parameters are listed below, along with their typical ranges and optimum values. They 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

ENCLOSURE 4

Memorandum

**Florida Department of
Environmental Protection**

TO: Richard Deuerling, Mail Station 3530
Division of Water Facilities
Bureau of Resource Protection
Underground Injection Control Section

FROM: _____ (Local programs
_____ see Note 1.)

DATE: _____

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

This is to notify you of proposed injection well(s) construction for the in situ remediation of groundwater at a petroleum contaminated site. The following is a description of the site location.

Name: _____
Address: _____
City/County: _____
Latitude/Longitude: _____
FDEP Facility Number: _____

The design of the injection-type aquifer remediation system consists of the following:

Areal extent of contamination (square feet): _____
Number of injection wells: _____
Composition of injected fluid (See note 2)
(ingredient, wt. %): _____

Injection volume per well (gallons): _____
Single or multiple injection events: _____
Injection volume total (all wells, all
events): _____

Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: The Department, per agreement with EPA, has been delegated this authority but is not allowed to delegate it any further. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should follow instructions in a January 12, 1998 memorandum to arrange for Department headquarters approval.

Note 2. Complete chemical analysis of injected fluid is required by Chapter 62-528, Florida Administrative Code (no exceptions). 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.

Richard Deuerling
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Date:_____

A site map showing the areal extent of the groundwater contamination plume and the location and spacing of injection wells is attached.

Excerpts from the remediation plan which describe the site lithology are attached. The following is a summary description of the affected aquifer:

Name of aquifer:_____
Depth to groundwater (feet):_____
Aquifer thickness (feet):_____

A schematic of the injection well(s) is attached. The following is a summary:

Depth of well (feet):_____
Screened interval:_____ to _____ feet below surface
Well casing diameter (inches):_____
Bore hole diameter:_____
If direct-push type well(s), indicate
diameter (inches):_____ and depth (feet):_____

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 byproducts 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 a Remedial Action Plan Approval Order (or other enforceable document). A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.