



California Regional Water Quality Control Board Central Valley Region

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Arnold
Schwarzenegger
Governor

16 November 2009

Lloyd O. and Elsie V.M. Gotthold Support Trust B
1306 Leo Way
Woodland, CA 95776

Paratransit, Inc.,
c/o Aaron Gundzik
Cotton and Gundzik, LLP
624 Soluth Grand Avenue, 22nd Floor
Los Angeles, CA 90017

NOTICE OF APPLICABILITY OF GENERAL ORDER NO. R5-2008-0149 – LLOYD O. AND ELSIE V.M. GOTTHOLD SUPPORT TRUST B, PARATRANSIT INC., FAVERO PROPERTY, 1931 30TH STREET, SACRAMENTO, IN-SITU REMEDIATION OF PETROLEUM HYDROCARBONS, SACRAMENTO COUNTY

Lloyd and Elsie Gotthold and Paratransit, Inc. (Dischargers) submitted a Notice of Intent, dated 28 July 2009, requesting coverage under General Order No. R5-2008-0149, General Waste Discharge Requirements for In-situ Groundwater Remediation at Sites with Volatile Organic Compounds, Nitrogen Compounds, Perchlorate, Pesticides, Semi-Volatile Compounds and/or Petroleum Compounds. Based on information in your submittal, it is our determination that this project meets the required conditions to be approved under Order No. 2008-0149. All of the requirements contained in the general order are applicable to your project. You are assigned Order No. R5-2008-0149-004.

Project Location:

The project is in the City of Sacramento in Sacramento County, Section 7, T 8N R5E, Sacramento East Quad, Assessor's Parcel No. 010-0062-019. See Figure 1.

Project Description:

Operations at a former gasoline service station and subsequent vehicle fueling station at the property at 1931 30th Street in Sacramento caused pollution of the soil and groundwater. The primary pollutants of concern are total petroleum hydrocarbons (TPH) in the gasoline range and its associated components such as benzene, toluene and xylenes. In 1989 the fuel tanks and piping were removed from the site. Commencing in 1999, an SVE system was operated at the site to remove the pollutants from the soil column and a groundwater extraction and treatment system was operated to address groundwater pollution. Subsequently, air sparging and dual phase extraction were used to promote remediation of the groundwater pollution. The dual phase system was discontinued in 2007. Despite these activities, groundwater pollution still remains at unacceptable levels with concentrations of TPH being greater than 50,000 micrograms per liter ($\mu\text{g/L}$). It has been estimated that approximately 14,500 to 19,000 pounds of TPH, from the initial estimate of 130,000 to 170,000 pounds, remain in the soil and groundwater.

California Environmental Protection Agency

The Dischargers conducted an in-situ push-pull test to determine if enhanced bioremediation is viable and estimate nutrient and electron donor consumption the site. The consultants conducting the test concluded that the test demonstrated that the addition of oxygen and nutrients stimulated microbial degradation of the subsurface petroleum pollutants and that the site is electron acceptor limited. Based on these results the Dischargers presented an Interim Remedial Action Plan, 26 March 2009 (Interim RAP) to the Sacramento County Environmental Management Department overseeing the cleanup at the site.

The Interim RAP and Notice of Intent propose using 14 injection wells and 4 extraction wells, combined with a treatment system using granular activated carbon, to create a biologically active zone beneath the site to reduce the highest concentrations of TPH. The extracted groundwater, estimated to be approximately 10 gallons per minute, is sent to the treatment system to remove the pollutants of concern. Periodically the treated water is amended with a bacterial consortium, nutrients and dissolved oxygen to enhance the biological activity. The nutrient amendment consists primarily of nitrate and ammonia. Oxygen is added on a continuous basis. If necessary to assure capture by the extraction wells, the amount of water injected will be less than that extracted with the excess water discharged to the sanitary sewer. On as-needed basis to maintain the wells, hydrochloric acid with a surfactant and dispersant will be added. Following addition, the wells will be surged and developed to remove the added chemicals and restore flow through the well. It is estimated that the system will be operational for up to 3 years.

If the project causes exceedances of the limits contained in the General Order, the Dischargers' contingency plan calls for increased extraction within the treatment zone and extraction from downgradient well EW-1 to capture the pollutants that above the allowable concentrations that have migrated off-site.

No comments were received on the draft Notice of Applicability and Monitoring and Reporting Program during the 30-day public comment period ending 3 November 2009.

General Information:

1. The project will be operated in accordance with the requirements contained in the General Order attached to this Notice of Applicability in accordance with the information submitted in the Notice of Intent.
2. The required annual fee (as specified in the annual billing you will receive from the State Water Resources Control Board) shall be submitted until this Notice of Applicability is officially revoked.
3. Injection of materials other than dissolved oxygen, EZT-A2 Bacterial Consortium, EXT-EA Enzyme Accelerator, CBN-Nutrimax nutrient amendment, hydrochloric acid, Johnson Screens' NW-310 Bioacid Dispersant, and Johnson's Screens' NW-400 Non-Ionic Surfactant into the subsurface is prohibited.
4. Failure to abide by the conditions of the General Order could result in an enforcement action as authorized by provisions of the California Water Code.

5. The project will implement the final contingency plan included as part of the Notice of Intent within 30-days of it being triggered.
6. The Dischargers' shall comply with the attached Monitoring and Reporting Program, Order No. R5-2008-0149-004, and any revisions thereto as ordered by the Executive Officer.

If you have any questions regarding this matter, please call Alexander MacDonald at (916) 464-4625 or contact him by e-mail at amacdonald@waterboards.ca.gov.

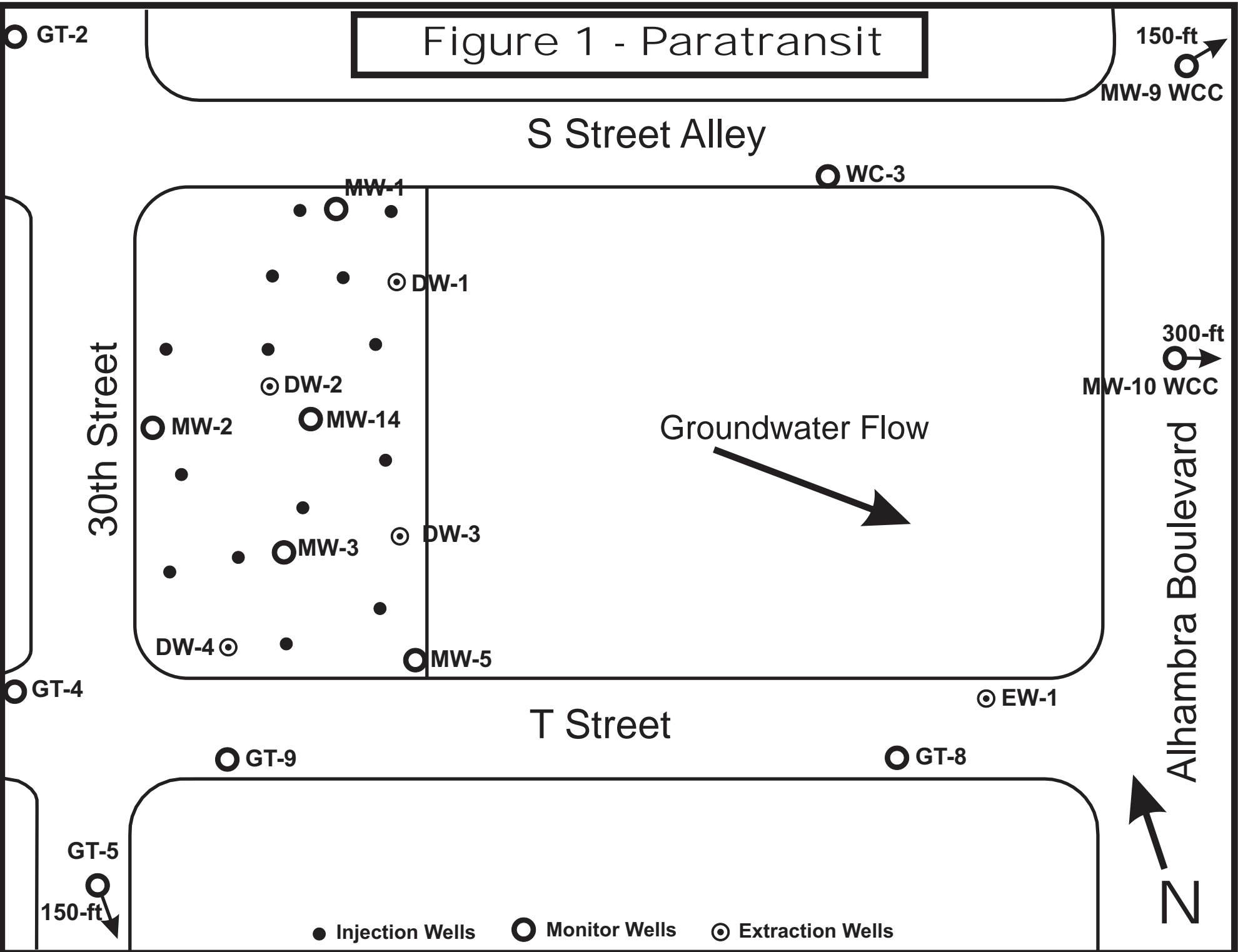
Original Signed by:

PAMELA C. CREEDON
Executive Officer

Attachments

cc: Della Kramer, Regional Water Quality Control Board, Sacramento
Barry Marcus, Sacramento County Environmental Health Department, Sacramento
Aaron Gundzik, Cotton and Gundzik, LLP, Los Angeles
Ed Childers, Kennedy/Jenks Consultants, Rancho Cordova

Figure 1 - Paratransit



CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. R5-2008-0149

WASTE DISCHARGE REQUIREMENTS
GENERAL ORDER FOR
IN-SITU GROUNDWATER REMEDIATION AT SITES WITH VOLATILE ORGANIC
COMPOUNDS, NITROGEN COMPOUNDS, PERCHLORATE, PESTICIDES,
SEMI-VOLATILE COMPOUNDS, HEXAVALENT CHROMIUM
AND/OR PETROLEUM HYDROCARBONS

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Regional Water Board) finds that:

1. Pursuant to Section 13263, subdivision (i) of the California Water Code (CWC), the Regional Water Board may prescribe general waste discharge requirements (WDRs) for discharges produced by similar operations, involving similar types of wastes, and requiring similar treatment standards.
2. Discharges of volatile organic compounds (VOCs), perchlorate, pesticides, semi-volatile compounds, hexavalent chromium and petroleum hydrocarbons have degraded groundwater at numerous sites within the Central Valley Region and cause or threaten to cause pollution or nuisance and adversely affect existing and potential beneficial uses of groundwater resources. Remediation of groundwater at these sites includes the use and application of in-situ biological, chemical, and physical treatments. These processes include oxygen enhancement, chemical oxidation, biostimulation (addition of nutrients and bacteria to enhance biodegradation), bioaugmentation (introducing appropriate bacteria) and groundwater extraction and sometimes treatment, with return of treated groundwater to the area in the aquifer undergoing treatment. The application of the amendments can be done actively with hydraulic control of the treatment zone as the amendments are added to the extracted groundwater and injected upgradient into the treatment area. The application is also done at times in a passive mode where the amendments are injected into the treatment zone and there is no nearby hydraulic control of the treatment zone. Additional details are supplied in the Information Sheet, attached to this Order.
3. Adoption of general WDRs for the these processes would: a) simplify the application process for dischargers, b) prevent regulatory delays to groundwater remediation activities, c) reduce time needed for Regional Water Board staff to prepare and the Regional Water Board to adopt WDRs for common remedial activities in the Central Valley Region, d) enhance protection of surface water quality by eliminating some discharges of treated groundwater to surface water, and e) provide a comparable level of water quality protection to individual, site-specific WDRs.
4. This Order regulates the use and application of in-situ biological, chemical, and physical treatments to clean up waste constituents in groundwater. The dischargers regulated by this Order are more appropriately regulated by general WDRs than individual WDRs because the Regional Water Board regulates many sites using this type of process, the cleanup of these type of sites is of high priority and the issuance of individual WDRs is

time-consuming without providing additional benefit, and the types of treatment used have similar effects that can reasonably be regulated with general WDRs. This Order does not preclude the adoption of individual WDRs where appropriate.

5. The materials that can be used to remediate groundwater pollution at a site in the Central Valley Region under this Order are limited to those listed in the CONDITIONS OF ELIGIBILITY, listed below. This Order is not intended for use and application of other materials to remediate groundwater pollution or for remediation of waste constituents in groundwater other than VOCs, perchlorate, nitrogen compounds (nitrate, ammonia, etc.), some selected pesticides and semi-volatile organic compounds, and petroleum hydrocarbons.
6. The application of any material to groundwater may result in unintended adverse effects to groundwater quality. To comply with this Order, any potential adverse water quality effects that may occur must be localized, of short-term duration, and may not affect existing or potential beneficial uses of groundwater. Groundwater quality will be monitored before and after addition of any materials to verify both the effectiveness of the remediation and that no long-term adverse affect on beneficial uses of groundwater has occurred.
7. The addition of materials to remediate groundwater may require bench-scale and/or small-scale pilot testing prior to design and implementation of full-scale remediation. The addition of amendments to conduct pilot studies is also covered under this Order.

REGULATORY CONSIDERATIONS

8. *The Water Quality Control Plan, Fourth Edition, for the Sacramento and San Joaquin River Basins, Fourth Edition* (hereafter Basin Plan) designates beneficial uses, establishes water quality objectives (WQOs), contains prohibitions, contains implementation plans and policies for protecting waters of the basin, and incorporates by reference plans and policies adopted by the State Water Resources Control Board (State Water Board). Pursuant to ¶ 13263(a) of the California Water Code (CWC), waste discharge requirements must implement the Basin Plan.
9. The designated beneficial uses of underlying groundwater include, but are not limited to:
 - a. Municipal and domestic water supply (MUN);
 - b. Agricultural water supply (AGR);
 - c. Industrial service supply (IND); and
 - d. Industrial process supply (PRO).
10. The Basin Plan establishes numerical and narrative water quality objectives for surface water and groundwater within the basin, and recognizes that water quality objectives are achieved primarily through the Board's adoption of waste discharge requirements and enforcement orders. Where numerical water quality objectives are listed, these are limits necessary for the reasonable protection of beneficial uses of the water. Where compliance with narrative water quality objectives is required, the Board will, on a case-by-case basis,

adopt numerical limits in orders, which will implement the narrative objectives to protect beneficial uses of the waters of the state. Finding No. 15 lists those numerical limits for compliance with the narrative objectives for this Order.

11. The Basin Plan identifies numerical water quality objectives for waters designated as municipal supply. These are the maximum contaminant levels (MCLs) specified in the following provisions of Title 22, California Code of Regulations: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Table 64449-A (Secondary Maximum Contaminant Levels-Consumer Acceptance Limits) of Section 64449. The Basin Plan's incorporation of these provisions by reference is prospective, and includes future changes to the incorporated provisions as the changes take effect. The Basin Plan recognizes that the Board may apply limits more stringent than MCLs to ensure that waters do not contain chemical constituents in concentrations that adversely affect beneficial uses.
12. The Basin Plan contains narrative water quality objectives for chemical constituents, tastes and odors, and toxicity. The toxicity objective requires that groundwater be maintained free of toxic substances in concentrations that produce detrimental physiological responses in humans, plants or animals. The chemical constituent objective requires that groundwater shall not contain chemical constituents in concentrations that adversely affect beneficial uses. The tastes and odors objective requires that groundwater shall not contain tastes or odors producing substances in concentrations that cause nuisance or adversely affect beneficial uses.
13. State Water Board Resolution No. 92-49 (hereafter Resolution No. 92-49) requires the Regional Board to require actions for cleanup and abatement of discharges that cause or threaten to cause pollution or nuisance to conform to the provisions of State Water Board Resolution No. 68-16 (hereafter Resolution No. 68-16) and the Basin Plan. Pursuant to Resolution No. 92-49, the Regional Board shall ensure that dischargers are required to clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality, or if background levels of water quality cannot be restored, the best water quality which is reasonable and which complies with the Basin Plan including applicable WQOs.
14. Resolution No. 68-16 requires the Board in regulating discharges to maintain high quality waters of the State until it is demonstrated that any change in quality will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and potential beneficial uses, and will not result in water quality less than that described in plans and policies (e.g., quality that exceeds WQOs). Temporal degradation of groundwater may occur at sites subject to this Order within the defined treatment zone due to the amended groundwater injection. The temporary degradation allowed by this Order is consistent with Resolution No. 68-16 since (1) the purpose is to accelerate and enhance remediation of groundwater pollution and such remediation will benefit the people of the State; (2) the discharge facilitates a project to evaluate the effectiveness of cleanup technology in accord with Resolution No. 92-49; (3) the degradation is limited in scope and

duration; (4) best practicable treatment and control, including adequate monitoring and hydraulic control to assure protection of water quality, are required; and (5) the discharge will not cause WQOs to be exceeded beyond the treatment zone and it is expected that increases in concentrations above WQOs caused by the treatment will be reduced over time. A slight residual increase in salts may occur at some sites subject to this Order but will be limited to a maximum 10 percent increase over background and less than the WQO listed below in Finding No. 15. See Groundwater Limitation E.3.

15. This Order addresses water quality as it relates to the chemicals being injected, as well as the byproducts and breakdown products produced by the reactions of the injectants, chemicals being treated and geological materials. Cleanup criteria for groundwater are established in an appropriate enforcement document – Record of Decision, Cleanup and Abatement Order, or Remedial Action Plan and are not discussed further as a part of this Order. As discussed above, chemicals are injected to stimulate reduction in concentrations of the target waste constituent and the target waste constituent may undergo a series of transformations to other constituents as it degrades. The injected chemical itself may leave residuals of its components, as well as cause changes in groundwater chemistry that liberate metals found in the formation materials. Background/baseline concentrations of metals and total dissolved solids will be established pursuant to the attached Monitoring and Reporting Program. The applicable WQOs are the narrative toxicity objective, Primary and Secondary Maximum Contaminant Levels, and the narrative taste and odor objective as found in the Basin Plan. Numerical limits in this Order implement those WQOs. The following Table presents the numerical WQOs for potential waste constituents of concern at the site:

Constituent	WQO	Reference
trichloroethene	0.8 µg/L	California Public Health Goal
tetrachlorethene	0.06 µg/L	California Public Health Goal
vinyl chloride	0.05 µg/L	California Public Health Goal
cis 1,2-dichlorethene	6 µg/L	Primary Maximum Contaminant Level
1,2-dichlorethene	10 µg/L	Primary Maximum Contaminant Level
1,2-dichloroethane	0.4 µg/L	California Public Health Goal
1,1-dichloroethene	6 µg/L	Primary Maximum Contaminant Level
1,1-dichloroethane	3 µg/L	California Public Health Goal
1,2,3-trichloropropane	0.0007µg/L	Draft California Public Health Goal
1,2-dichloropropane	0.5 µg/L	California Public Health Goal
1-chloropropane	280 µg/L	IRIS
propene	28 µg/L	Taste and Odor
iron	300 µg/L	Secondary Maximum Contaminant Level
manganese	50 µg/L	Secondary Maximum Contaminant Level
hexavalent chromium	2 µg/L	Draft PHG
total chromium	50 µg/L	Primary Maximum Contaminant Level
total dissolved solids	450 mg/L	Food and Agricultural Organization
sulfate	250,000 µg/L	Secondary Maximum Contaminant Level
sodium	20,000 µg/L	USEPA Health Advisory
bromate	10 µg/L	Primary Maximum Contaminant Level
chloride	106,000 µg/L	Agricultural Water Quality Goal – Food and Ag

16. Some amendments used to stimulate degradation of waste constituents in groundwater have a salt component (generally sodium or potassium). Upon completion of the intended degradation process, the salt component remains. The groundwater in the Central Valley is severely degraded by salts and the Regional Board is intent on minimizing the discharge of salts to the groundwater. The use of non salt-containing injectants is preferred, and the Discharger is required to demonstrate that there are no non salt-containing injectant alternatives that will cost-effectively promote the degradation of the target constituent before being allowed to use a salt-containing injectant. See Discharge Specification D.1. Furthermore, the Discharger is required to establish background salt concentrations and monitor the groundwater for changes in salt concentrations during the life of the project. Increases in salt concentrations in ground water are restricted by Groundwater Limitation E.3, below.
17. The action to adopt these Waste Discharge Requirements is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21000, et seq.) (CEQA) because it: (1) authorizes activity that will result in a minor modification to land pursuant to Title 14, California Code of Regulations, Section 15304; (2) consists of an action by a regulatory agency authorizing actions for the protection of the environment pursuant to Title 14, California Code of Regulations, Section 15308; and (3) authorizes minor cleanup actions costing \$1.5 million or less that are taken to prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a hazardous waste or substance pursuant to Title 14, California Code of Regulations, Section 15330.
18. The discharge is exempt from the requirements of *Consolidated Regulations for Treatment, Storage, Processing, or Disposal of Solid Waste*, set forth in the Title 27, California Code of Regulations (CCR), section 20005 et seq. (hereafter Title 27), which allows a conditional exemption from some or all of the provisions of Title 27. The exemption, pursuant to Title 27 CCR Section 20090(b), is based on the following:
 - a. The Regional Water Board is issuing waste discharge requirements.
 - b. The discharge is in compliance with the applicable Basin Plan.
 - c. The wastewater does not need to be managed according to Title 22CCR, Division 4.5 and Chapter 11 as a hazardous waste.

Section 20090(d) allows exemption for a project to cleanup a condition of pollution that resulted from an unauthorized discharge of waste based on the following:

- d. The application of amendments to groundwater is at the direction of the Regional Water Board to cleanup and abates conditions of pollution or nuisance resulting from the unauthorized discharge of waste.
- e. Wastes removed from the immediate place of release must be discharged according to the Title 27 regulations; and
- f. The cleanup actions intended to contain wastes at the place of release shall implement the Title 27 regulations to the extent feasible.

19. Section 13267(b) of the California Water Code provides that:

“In conducting an investigation specified in subdivision (a), the Regional Board may require that any person who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge within its region, or any citizen or domiciliary, or political agency or entity of this state who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge waste outside of its region that could affect the quality of the waters of the state within its region shall furnish under penalty of perjury, technical or monitoring program reports which the Regional Board requires. The burden, including costs of these reports, shall bear a reasonable relationship to the need for the reports and the benefits to be obtained from the reports. In requiring these reports, the Regional Board shall provide the person with a written explanation with regard to the need for the reports, and shall identify the evidence that supports requiring that person to provide the reports.”

The technical reports required by this Order and the attached Monitoring and Reporting Program are necessary to assure compliance with this Order. The Discharger operates the facility that discharges the waste subject to this Order.

20. The California Department of Water Resources sets standards for the construction and destruction of groundwater wells, as described in *California Well Standards Bulletin No. 74-90* (June 1991) and *Water Well Standards: State of California Bulletin No. 94-81* (December 1981). These standards, and any more stringent standards implemented by the Regional Water Board or adopted by the local county where the site is located pursuant to California Water Code Section 13801 apply to all monitoring and injection wells.
21. Section 3020(b)(2) of the Resource Conservation and Recovery Act (RCRA) states that prior to injection into or above an underground source of drinking water, contaminated groundwater shall be “...treated to substantially reduce hazardous constituents prior to such injection.” In a letter dated 10 December 1999, the United States Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER) states, “if extracted groundwater is amended at the surface (i.e., “treated”) before reinjection, and the subsequent in-situ bioremediation achieves a substantial reduction of hazardous constituents the remedy would satisfy Section 3020(b)(2).” The injection of groundwater within the treatment zone in compliance with this Order, with or without the treatment for the constituents of concern, complies with Section 3020(2)(b) of RCRA.
22. Section 13304.1(b) of the California Water Code requires that the Regional Board shall consult with the affected groundwater management entity, if any, affected public water systems, and the State Department of Public Health prior to setting applicable water quality standards to be achieved at groundwater cleanup sites that are associated with an aquifer that is used as a drinking water source. Prior to issuing a Notice of Applicability under this Order for a specified project, the Regional Board will consult with the appropriate interested agencies.

23. Section 13307.5 of the California Water Code requires specific public participation actions if the site cleanup is being undertaken pursuant to a cleanup and abatement order. When applying this Order to sites subject to a cleanup and abatement order, the required public participation will be adhered to.

Other

24. Pursuant to California Water Code Section 13263(g), discharge is a privilege, not a right, and adoption of this Order does not create a vested right to continue the discharge.
25. All the above and the supplemental data and information and details in the attached Information Sheet, which is incorporated by reference herein, were considered in establishing the following conditions of discharge.
26. The Discharger and interested agencies and persons were notified of the intent to prescribe waste discharge requirements for this discharge and provided with an opportunity for a public hearing and an opportunity to submit written comments.
27. In a public meeting, all comments pertaining to this Order were heard and considered.

IT IS HEREBY ORDERED that, pursuant to Sections 13263 and 13267 of the California Water Code, Dischargers, in order to meet the provisions contained in Division 7 of the California Water Code, and regulations and guidelines adopted thereunder, shall comply with the following:

A. CONDITIONS OF ELIGIBILITY

1. A discharger may seek coverage under this Order to:
 - a. Add specific amendments directly to groundwater or indirectly through the soil column for the purpose of facilitating in situ remediation of waste constituents. The Discharger must demonstrate the effectiveness of the selected amendment(s), and demonstrate control of side reactions and breakdown products under site conditions.
2. To be covered under this Order, a discharger must provide the following:
 - a. A Notice of Intent (Attachment A), including additional information as required in Attachment B (Report of Waste Discharge);
 - b. A Regional Board approved Work Plan, Work Plan Addendums (if applicable), and/or a Remedial Action Plan or Cleanup Plan which includes application of an amendment that qualifies for coverage under this Order (The approval for the

- Work Plan or Remedial Action Plan needs to be dated within 12 months of the date of the Notice of Intent);
- c. A proposed Monitoring and Reporting Program, based on Attachment C, incorporated herein by reference; and
 - d. The first annual fee in accordance with the current version of the California Code of Regulation, Title 23, Division 7, Chapter 9, Waste Discharge Report and Requirements Article 1 fees for a discharge. The check or money order shall be made payable to the "State Water Resources Control Board".
 - e. A Contingency Plan to be implemented to correct unacceptable water quality effects.
3. This Order covers the following actions:
- a. Pilot studies of limited extent and duration:
 - i. When the amendments have previously been demonstrated (previous pilot tests or full-scale operations) to achieve the desired results and side reactions, byproducts, breakdown products, and residuals are understood.
 - ii. When processes to remove byproducts, breakdown products, and residuals are identified and discussed in the Remedial Action Work Plan or Report of Waste Discharge.
 - b. Full-scale applications:
 - i. When it has been demonstrated in a pilot study, or full-scale application at this site or a similar site, that the desired results can be achieved and side reactions, breakdown products, and residuals do not result in long-term adverse water quality effects.
4. Coverage under this Order applies to the following groups of amendments, except as specifically excluded in A5 below, provided the conditions in A1, A2, and A3 are satisfied:
- a. Amendments that create reducing conditions (i.e., amendments that provide carbon, energy, electrons and/or macronutrients). Examples include:
 - i. Zero valent iron
 - ii. Easily degradable carbon sources such as glucose, acetate, citric acid, acetic acid, ethanol, methanol and others
 - iii. Slowly degradable carbon sources such as edible oils, poly-lactate, and other hydrogen release compounds
 - iv. Polysulfides
 - v. Macro nutrients such as nitrate, phosphate, and potassium

- vi. Microorganisms cultured on site materials
 - b. Amendments that create oxidizing conditions (i.e., amendments that provide oxygen or otherwise gain electrons). Examples include:
 - i. Air
 - ii. Oxygen
 - iii. Ozone
 - iv. Potassium or sodium permanganate
 - v. Oxygen release compounds
 - vi. Hydrogen peroxide
 - c. Multiple amendments (includes application of reducing agents or oxidizing agents or both applied concurrently or over time as proposed in an approved Work Plan and the Notice of Intent). Examples include:
 - i. Establishing a reducing zone immediately downgradient of an oxidizing zone to reduce hexavalent chromium that may be produced under oxidizing conditions
 - ii. Providing a slowly degradable carbon source along with polysulfides to precipitate sulfates as metal sulfides.
 - d. Tracer compounds as discussed in Attachment A (Notice of Intent/Report of Waste Discharge).
 - e. Biofouling control agents such as chlorine dioxide, chlorine and bleach.
5. Amendments specifically excluded from coverage under this Order:
- a. Amendments that may cause violent exothermic reactions.

B. NOTIFICATION OF COVERAGE

Project coverage under this Order shall not take effect until the Executive Officer notifies the Discharger in writing, by issuance of a Notice of Applicability which shall be a part of this Order, that coverage has been issued. The Executive Officer will not issue notification of project coverage under this Order prior to providing notice and a 30-day public comment period on the proposed issuance of coverage. Notification of project coverage under this Order shall not be issued if the Executive Officer finds that there may be significant effects on water quality, or finds that significant public controversy has arisen or will likely arise from the issuance of project coverage by this Order and that individual Waste Discharge Requirements should be considered at a regularly scheduled Regional Water Board meeting.

C. DISCHARGE PROHIBITIONS

1. The discharge of any amendment or other materials not specifically regulated by this Order is prohibited. These amendments and materials are those listed in the approved Work Plan required in A.2.b and the Notice of Applicability, as listed above.
2. Creation of a pollution, contamination, or nuisance, as defined by Section 13050 of the California Water Code (CWC), is prohibited.
3. The discharge of amendments or wastes to surface water or surface water drainage courses is prohibited.
4. The discharge of amendments or wastes to land or groundwater in areas other than that proposed for remediation is prohibited.
5. The discharge of amendments to property that is not under the control of the Discharger is prohibited. The "area under the control" of the Discharger is considered to be at the horizontal borders of the waste plume and owned by the Discharger and/or where the Discharger holds an agreement with the property owner for purposes of investigation and remediation.
6. The migration of any byproducts produced as part of the treatment process beyond the boundaries of the property owned or controlled by the discharger or to surface waters is prohibited.

D. DISCHARGE SPECIFICATIONS

1. The Discharger shall not inject any amendments into the aquifer prior to receiving the Notice of Applicability nor prior to the construction of all necessary monitor wells listed in the Monitoring and Reporting Program.
2. The groundwater shall not be amended with materials other than those approved in the Notice of Applicability.
3. The Discharger will minimize the amount of amendments injected to the extent practicable.

E. GROUNDWATER LIMITATIONS

1. The discharge shall not cause the pH of the groundwater at the compliance points, downgradient and outside the treatment zone, to shift outside the range of 6.5 to 8.5.
2. The release, injection, discharge or addition of constituents from a remediation system shall not cause the groundwater at the compliance wells listed in Table 1 of the Monitoring and Reporting Program attached to the Notice of Applicability, and any revisions thereto, to contain concentrations of chemical constituents, including the

amendments and by-products of the in-situ treatment process, in amounts that exceed the Water Quality Objectives listed in Finding No. 15.

3. The release, injection, discharge or addition of constituents from a remediation system shall not cause the groundwater at the compliance wells listed in Table 1 of the Monitoring and Reporting Program attached to the Notice of Applicability, and any revisions thereto, to contain concentrations of metals, total dissolved solids, or electrical conductivity that are more than 20% greater than their respective background concentrations, as established by the Monitoring and Reporting Program attached to the Notice of Applicability, and any revisions thereto.
4. The release, injection, discharge or addition of constituents from a remediation system shall not cause the groundwater to contain taste or odor producing substances that cause nuisance or adversely affect beneficial uses at the compliance monitor points designated in Table 1 of the Monitoring and Reporting Program attached to the Notice of Applicability, and any revisions thereto.

F. PROVISIONS

1. The Discharger shall comply with all applicable Standard Provisions and Reporting Requirements for Waste Discharge Requirements, dated 1 March 1991, which are attached hereto and by reference a part of this Order. This attachment and its individual paragraphs are commonly referenced as Standard Provisions.
2. The Discharger shall comply with the Monitoring and Reporting Program, attached to the Notice of Applicability, and any revisions thereto, as ordered by the Executive Officer.
3. The Discharger may be required to submit technical reports pursuant to California Water Code Section 13267 as directed by the Executive Officer. The technical reports required by this Order are necessary to assure compliance with this Order.
4. All technical reports required herein that involve planning, investigation, evaluation, or design or other work requiring interpretation or proper application of engineering or geologic sciences, shall be prepared by, or under the direction of, persons registered to practice in California pursuant to California Business and Professions Code, sections 6735, 7835 and 7835.1. To demonstrate compliance with Title 16, CCR, Sections 415 and 3065, all technical reports must contain a statement of the qualifications of the responsible registered professional(s). As required by these laws, completed technical reports must bear the signature(s) and seal(s) of the registered professional(s) in a manner such that all work can be clearly attributed to the professional responsible for the work.
5. A copy of this Order shall be maintained at the project site and be available at all times to operating personnel.

6. Provisions of this Order are severable. If any provision of these requirements is found invalid, the remainder of this Order shall not be affected.
7. The Discharger shall maintain in good working order and operate as efficiently as possible any facility or control system installed by the discharger to achieve compliance with this Order.
8. In the event of a violation of the order, or any material change in the character, location, or volume of the discharge, or if the Discharger is unable to comply with any of the conditions of this Order due to:
 - a. breakdown of any facility or control system or monitoring equipment installed by the Discharger to achieve compliance with this Order;
 - b. migration or application of amendments, pollutants or byproducts outside the specified treatment area;
 - c. accidents caused by human error or negligence; or
 - d. other causes such as acts of nature;

the Discharger shall notify the Regional Water Board by telephone within 24-hours after he or his agents have knowledge of the incident and confirm this notification in writing within two weeks of the telephone notification. The written notification shall include pertinent information explaining reasons for the noncompliance and shall indicate the steps taken to correct the problem and the dates thereof, and the steps being taken to prevent the problem from recurring. The reporting of migration or application of amendments, waste constituents or byproducts outside the specified treatment area shall include an assessment of and schedule for implementation of the contingency plans required in the Notice of Applicability.

9. The Discharger shall report within 48-hours to the Regional Water Board any violation of this Order, and any material change in the character, location, or volume of the discharge.
10. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the discharger, the discharger shall notify the succeeding owner or operator of the following items by letter, in advance of the transfer of ownership or control, a copy of the notice must be forwarded to the Regional Water Board:
 - a. existence of this Order; and
 - b. the status of the discharger's annual fee account
11. This Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act

causing injury to persons or property, nor protect the discharger from his liability under Federal, State, or Local laws, nor create a vested right for the discharger to continue the waste discharge.

12. Chemical, bacteriological, and bioassay analyses must be conducted at a laboratory certified for such analyses by the State Department of Public Health.
13. All reports, Notice of Intent, or other documents required by this Order, and other information requested by the Regional Board shall be signed by a person described below or by a duly authorized representative of that person.
 - a. for a corporation: by a responsible corporate officer such as: (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function; (b) any other person who performs similar policy or decision making functions for the corporation; or (c) the manager of one or more manufacturing, production, or operating facilities if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
 - b. Reports required by this Order, other information requested by the Regional Water Board, and Notices of Intent may be signed by a duly authorized representative provided:
 - i. the authorization is made in writing by a person described in paragraph (a) of this provision;
 - ii. the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company; and
 - iii. the written authorization is submitted to the Regional Water Board prior to or together with any reports, information, or applications signed by the authorized representative.
 - c. Any person signing a document under paragraph (a) or (b) of this provision shall make the following certification: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine

and imprisonment for knowing violations."

14. The Discharger shall permit authorized staff of the Regional Water Board:
 - a. entry to the project site covered by this Order or in which any required records are kept;
 - b. access to copy any records required to be kept under terms and conditions of this Order;
 - c. inspection of monitoring equipment or records; and
 - d. sampling of any discharge.
15. The Regional Water Board may review this Order periodically and may revise requirements when necessary. In addition, the discharger shall file a report of waste discharge with the Executive Officer at least 120 days before making any material change or proposed change in the character, location, or volume of the discharge.
16. This Order is in effect until terminated by the Executive Officer. Project coverage under this Order may be terminated, by the Executive Officer at any time upon giving reasonable notice to the discharger.

I, Pamela C. Creedon, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 11 September 2008.

original signed by:
PAMELA C. CREEDON, Executive Officer

ATTACHMENT A

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. R5-2008-0149-004

FOR
LLOYD O. AND ELSIE V.M. GOTTHOLD SUPPORT TRUST B, PARATRANSIT INC.,
FAVERO PROPERTY ,
1931 30TH STREET, SACRAMENTO
IN-SITU REMEDIATION OF PETROLEUM HYDROCARBONS
SACRAMENTO COUNTY

This Monitoring and Reporting Program (MRP) describes requirements for monitoring a groundwater extraction and treatment system. This MRP is issued pursuant to Water Code Section 13267. The Discharger shall not implement any changes to this MRP unless and until a revised MRP is issued by the Executive Officer. As appropriate, Regional Board staff shall approve specific sample station locations prior to implementation of sampling activities.

All samples should be representative of the volume and nature of the discharge or matrix of material sampled. The time, date, and location of each grab sample shall be recorded on the sample chain of custody form.

GROUNDWATER MONITORING

As shown on Figure 1, there are 23 monitor wells, 5 extraction wells, and 14 injection wells associated with this site, not all of which will be monitored under this program. The groundwater monitoring program for these wells and any treatment system wells installed subsequent to the issuance of this MRP, shall follow the schedule below. Monitor wells with free phase petroleum product or visible sheen shall be monitored, at a minimum, for product thickness and depth to water. The volume of extracted groundwater, if applicable, shall also be provided in quarterly monitoring reports. Sample collection and analysis shall follow standard EPA protocol.

The monitor wells, extraction wells and/or injection wells shall be sampled according to the schedule in Table 1 and the samples analyzed by the methods in Table 2, as follows:

Table 1: Sampling Frequency and Constituent Suite

Well Number¹	Frequency²	Constituent Suite(s)³	Monitoring Objective
GT-8, GT-9, WC-3	Quarterly	Suites B and C	Compliance ⁴
DW-1, DW-2, DW-3, DW-4 DW-5 though DW-8 ⁷	Quarterly	Suites A and B	Treatment Zone ⁵
MW-1, MW-2, MW-3, MW-5, MW-14	Quarterly	Suite B	Transition Zone
GT-2, GT-4, GT-5, MW-9 WCC, MW-10 WCC	Quarterly	Suite C and D	Background ⁶

- 1 Well numbers as shown on Figure 1.
- 2 Prior to startup and stated frequency thereafter.
- 3 Constituent suite components listed in Table 2.
- 4 Wells used to determine compliance with water groundwater limitations.
- 5 Wells sampled to evaluate in-situ bioremediation progress inside the treatment zone.
- 6 Wells used to develop background concentrations
- 7 Only sampling of wells being used during the quarter is required as not all of these wells will be used at the same time.

Table 2: Analytical Methods

Constituent	Method ¹	Maximum Practical Quantitation Limit (µg/L) ²
Suite A		
Benzene, toluene, total xylenes, ethylbenzene	EPA Method 8260B	0.5
Total Petroleum Hydrocarbons	EPA Method 8015M	50
Suite B		
Nitrate	EPA Method 6500	300
Sulfate	EPAM Method 6500	200
Ammonia	EPA Method 350.1	1
Nitrite	EPA Method 6500	300
Phosphorous, orthophosphate	EPA Method 365	1,000
Potassium	EPA Method 200.7	100
Iron, Total and Dissolved	EPA Method 200.7	100
Manganese, Total and Dissolved	EPA Method 200.7	25
Suite C		
Total Dissolved Solids	EPA 160.1	10,000
Suite D		
Iron, Total and Dissolved	EPA Method 200.7	100
Manganese, Total and Dissolved	EPA Method 200.7	50
Nitrate	EPA Method 6500	300

- ¹ Or an equivalent EPA Method that achieves the maximum Practical Quantitation Limit.
- ² All concentrations between the Method Detection Limit and the Practical Quantitation Limit shall be reported as an estimated value.
- ³ Metals include barium cadmium, calcium, total chromium, copper, lead, magnesium, manganese, mercury, molybdenum, nickel and silica.

FIELD SAMPLING

In addition to the above sampling and analysis, field sampling and analysis shall be conducted each time a monitor well or extraction well is sampled. The sampling and analysis of field parameters shall be as specified in Table 3.

Table 3: Field Sampling Requirements

Parameters	Units	Type of Sample
Groundwater Elevation	Feet, Mean Sea Level	Measurement
Oxidation-Reduction Potential	millivolts	Grab
Electrical Conductivity	uhmos/cm	Grab
Dissolved Oxygen	mg/L	Grab
pH	pH Units (to 0.1 units)	Grab

Field test instruments (such as those used to test pH and dissolved oxygen) may be used provided that:

1. The operator is trained in proper use and maintenance of the instruments;
2. The instruments are calibrated prior to each monitoring event;
3. Instruments are serviced and/or calibrated by the manufacturer at the recommended frequency; and
4. Field calibration reports are submitted as described in item (b) of the "Reporting" section of this MRP.

DISCHARGE MONITORING

The Discharger shall monitor daily the discharge of water and amendments that are injected into the groundwater according to the requirements specified in Table 4. Each amendment addition shall be recorded individually, along with information regarding the time period over which the amendment was injected into the aquifer.

Table 4: Discharge Monitoring Requirements

Parameters	Units	Type of Sample
Injected Volume	gallons per day	Meter
Amendment(s) Added	kilograms per day	Measured
Biocide Added	kilograms per day	Measured

AMENDMENT ANALYSIS

Amendments shall be analyzed for the constituents listed in Table 5. The analysis should be done on the pure amendment and on a mixture of the amendment and deionized water at the estimated concentration that would be injected during the pilot project.

Table 5: Amendment Analytical Requirements

Constituent	Method ¹	Maximum Practical Quantitation Limit ($\mu\text{g/L}$) ²
Volatile Organic Compounds	EPA 8020 or 8260B	0.5
General Minerals ³		
Metals, Total and Dissolved ⁴	EPA 200.7, 200.8	Various

Constituent	Method ¹	Maximum Practical Quantitation Limit (µg/L) ²
Semi-Volatile Organic Compounds	EPA Method 8270	5.0
Total Dissolved Solids	EPA 160.1	10,000
pH	meter	NA
Electrical Conductivity	meter	NA

- ¹ Or an equivalent EPA Method that achieves the maximum Practical Quantitation Limit.
- ² All concentrations between the Method Detection Limit and the Practical Quantitation Limit shall be reported, and reported as an estimated value.
- ³ Alkalinity, bicarbonate, potassium, chloride, sulfate, total hardness, nitrate, nitrite, ammonia.
- ⁴ Metals include arsenic, barium, cadmium, calcium, total chromium, copper, iron, lead, manganese, magnesium, mercury, molybdenum, nickel, selenium and silica.

ESTABLISHMENT OF BACKGROUND CONCENTRATION VALUES

The Discharger shall develop background values for concentrations of nitrate, dissolved iron, dissolved manganese and total dissolved solids in groundwater following the procedures found in CCR Section 20415(e)(10). The Discharger shall submit a proposal to develop the background concentrations by **15 November 2009**.

REPORTING

When reporting the data, the Discharger shall arrange the information in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner as to illustrate clearly the compliance with this Order. In addition, the Discharger shall notify the Regional Board within 48 hours of any unscheduled shutdown of any soil vapor and/or groundwater extraction system. The results of any monitoring done more frequently than required at the locations specified in the Monitoring and Reporting Program shall also be reported to the Regional Board.

As required by the California Business and Professions Code Sections 6735, 7835, and 7835.1, all reports shall be prepared by a registered professional or their subordinate and signed by the registered professional.

The Discharger shall submit quarterly electronic data reports, which conform to the requirements of the California Code of Regulations, Title 23, Division 3, Chapter 30. The quarterly reports shall be submitted electronically over the internet to the Geotracker database system by the 1st day of the second month following the end of each calendar quarter by **1 February, 1 May, 1 August, and 1 November** until such time as the Executive Officer determines that the reports are no longer necessary.

Hard copies of quarterly reports shall be submitted to the Regional Board by the **1st day of the second month following the end of each calendar quarter (i.e., by 1 February, 1 May, 1 August, and 1 November)**. Each quarterly report shall include the following minimum information:

LLOYD O. AND ELSIE V.M. GOTTHOLD SUPORT TRUST B, PARATRANSIT INC., FAVERO PROPERTY,
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SACRAMENTO COUNTY

- (a) a description and discussion of the groundwater sampling event and results, including trends in the concentrations of pollutants and groundwater elevations in the wells, how and when samples were collected, and whether the pollutant plume(s) is delineated;
- (b) field logs that contain, at a minimum, water quality parameters measured before, during, and after purging, method of purging, depth of water, volume of water purged, etc.;
- (c) groundwater contour maps for all groundwater zones, if applicable;
- (d) pollutant concentration maps for all groundwater zones, if applicable;
- (e) a table showing well construction details such as well number, groundwater zone being monitored, coordinates (longitude and latitude), ground surface elevation, reference elevation, elevation of screen, elevation of bentonite, elevation of filter pack, and elevation of well bottom;
- (f) a table showing historical lateral and vertical (if applicable) flow directions and gradients;
- (g) cumulative data tables containing the water quality analytical results and depth to groundwater;
- (h) a copy of the laboratory analytical data report, which may be submitted in an electronic format;
- (i) the status of any ongoing remediation, including an estimate of the cumulative mass of pollutant removed from the subsurface, system operating time, the effectiveness of the remediation system, and any field notes pertaining to the operation and maintenance of the system; and
- (j) if applicable, the reasons for and duration of all interruptions in the operation of any remediation system, and actions planned or taken to correct and prevent interruptions.

If requested, an Annual Report shall be submitted to the Regional Board by **1 February** of each year. This report shall contain an evaluation of the effectiveness and progress of the investigation and remediation, and may be substituted for the fourth quarter (**or second semi-annual**) monitoring report. The Annual Report shall contain the following minimum information:

- (a) both tabular and graphical summaries of all data obtained during the year;
- (b) groundwater contour maps and pollutant concentration maps containing all data obtained during the previous year;

- (c) a discussion of the long-term trends in the concentrations of the pollutants in the groundwater monitoring wells;
- (d) an analysis of whether the pollutant plume is being effectively treated;
- (e) a description of all remedial activities conducted during the year, an analysis of their effectiveness in removing the pollutants, and plans to improve remediation system effectiveness;
- (f) an identification of any data gaps and potential deficiencies/redundancies in the monitoring system or reporting program; and
- (g) if desired, a proposal and rationale for any revisions to the groundwater sampling plan frequency and/or list of analytes.

A letter transmitting the monitoring reports shall accompany each report. Such a letter shall include a discussion of requirement violations found during the reporting period, and actions taken or planned for correcting noted violations, such as operation or facility modifications. If the Discharger has previously submitted a report describing corrective actions and/or a time schedule for implementing the corrective actions, reference to the previous correspondence will be satisfactory. The transmittal letter shall contain the penalty of perjury statement by the Discharger, or the Discharger's authorized agent, as described in the Standard Provisions General Reporting Requirements Section B.3.

The Discharger shall implement the above monitoring program on the first day of the month following adoption of this Order.

Original Signed by:

Ordered by: _____
PAMELA C. CREEDON Executive Officer

10 November 2009
(Date)

Volatile organic compounds (VOCs), petroleum hydrocarbons, perchlorate and fumigants have impacted groundwater at numerous sites within the Central Valley Region and cause or threaten adverse impacts to existing and potential beneficial uses of groundwater resources. Those sites are being required to clean up the pollution and restore the beneficial uses of the groundwater. This cleanup can take many forms. The two most common methods of cleanup of groundwater pollution are pump and treat, and in-situ remediation. The operation and discharge of a pump and treat system is generally regulated under site-specific or general waste discharge requirements. Prior to this General Order, in-situ groundwater remediation projects have had site-specific waste discharge requirements issued. The process to develop and adopt site-specific waste discharge requirements can be lengthy. Many in-situ treatment processes have common components and issues that can be regulated under general waste discharge requirements.

In-situ remediation of groundwater pollution at most sites includes the use and application of biological, chemical, and/or physical treatment processes. These processes include addition of oxygen, chemical oxidation/reduction, and the addition of nutrients, carbon and/or bacteria to enhance biodegradation. The method of delivery can be via injection to soil or groundwater insitu, or via groundwater recirculation (extraction and treatment with return of treated groundwater to the impacted aquifer zone). In most instances the in-situ remediation processes will cause reducing or oxidizing conditions within the aquifer in order to either reduce or oxidize the target pollutant. The remediation processes can result in exceedances of water quality objectives that are generally limited in duration and/or in a relatively small portion of the aquifer. These waste discharge requirements allow exceedances of water quality objectives to occur while oxidation/reduction processes are taking place, but only within the treatment zone.

Oxidation/reduction reactions take place when an electron is transferred from one compound to another. The electron donor becomes oxidized, and the electron receptor becomes reduced. These are always coupled reactions. If a compound is reduced, another must necessarily be oxidized to provide the electron. Reducing environments are typified by the absence of oxygen and are also referred to as anaerobic environments. Oxidative environments contain oxygen and are also referred to as aerobic environments.

Reducing Environment Processes

The primary reduction processes that are effective on perchlorate and VOCs are anaerobic in nature as aerobic processes are generally not effective on most highly chlorinated VOCs. Aerobic dechlorination or aerobic cometabolism of perchloroethylene (PCE) and trichloroethylene (TCE) has not been successful at

most sites. Therefore, reductive dechlorination of VOCs requires development of anaerobic conditions within the groundwater contaminant plume. PCE can be sequentially reduced to TCE, thence to cis-1,2-dichloroethylene, vinyl chloride and finally to ethane. Along the way the rate of reduction, consortium of bacteria involved in the process, and groundwater conditions may change. Reduction of VOCs may even stall at a stage if the correct conditions and bacteria are not present. Perchlorate reduction appears to occur more readily than VOCs and stalling at a particular stage in the dechlorination process does not occur

In order to develop a reducing environment to achieve reduction of chlorinated hydrocarbons and perchlorate, concentrations of oxygen and nitrate need to be significantly depleted. Oxygen and nitrate are more easily reduced than the chlorinated compounds and will utilize the electrons preferentially over the chlorinated compounds. Elevated concentrations of dissolved iron and manganese may also inhibit reduction of the chlorinated hydrocarbons by being electron acceptors.

There are three types of anaerobic reduction that may be occurring:

- **Direct Anaerobic Reductive Dechlorination** is a biological reaction in which bacteria gain energy and grow as one or more chlorine atoms on the chlorinated hydrocarbon molecule are replaced with hydrogen. In this reaction, the chlorinated compound serves as the electron acceptor, and the hydrogen serves directly as the electron donor (USEPA, 2000a).
- **Cometabolic Anaerobic Reductive Dechlorination** is a reaction in which a chlorinated compound is reduced by a non-specific enzyme or co-factor produced during microbial metabolism of another compound (i.e., the primary substrate) in an anaerobic environment. For the cometabolic process to be sustained, sufficient primary substrate is required to support growth of the transforming microorganisms.
- **Abiotic Reductive Dechlorination** is a chemical degradation reaction, not associated with biological activity in which a chlorinated hydrocarbon is reduced by a reactive compound. Addition of an organic substrate and creation of an anaerobic environment may create reactive compounds, such as metal sulfides, that can degrade chlorinated aromatic hydrocarbons (ITRC, 2007).

Of those three, direct anaerobic reductive dechlorination is the primary process for biological reduction of VOCs. In order to accomplish the complete reduction to ethane, the appropriate species of bacteria must be present. Lacking the complete consortium of bacteria could cause the process to stall at cis-1,2-DCE and vinyl chloride. If this condition occurs, adding bacteria that are known to

effectively reduce cis-1,2-DCE and vinyl chloride is an option to correct the problem.

Hydrogen has a lead role as a direct electron donor in the anaerobic dechlorination of chlorinated aromatic hydrocarbons. Hydrogen is generated by fermentation of non-chlorinated organic substrates, including naturally occurring organic carbon, accidental releases of anthropogenic carbon (fuel), or introduced substrates such as carbohydrates (sugars), alcohols, and low-molecular-weight fatty acids (lactates, acetates, etc.). As hydrogen is produced by fermentative organisms, it is rapidly consumed by other bacteria, including denitrifiers, iron-reducers, sulfate-reducers, methanogens, and dechlorinating microorganisms. For anaerobic reductive dechlorination to occur, dechlorinators must successfully compete against other microorganisms that also utilize hydrogen (ITRC, 2007).

Generally, there are not sufficient numbers of bacteria naturally present to conduct an effective anaerobic dehalogenation process. To increase the concentration of bacteria biostimulation is implemented by injecting a carbon source or substrate into the groundwater. For the degradation of chlorinated ethenes, the injected carbon source provides for cell growth and ferments to produce products like hydrogen, providing an electron donor for the reductive dechlorination process. By adding electron donors, methanogenic and/or sulfate-reducing conditions can be achieved at a site, which can be used to dechlorinate cis-1,2-DCE and vinyl chloride. Complete reductive dechlorination to ethene without the accumulation of cis-1,2-DCE and vinyl chloride is most likely to occur under these strongly-reducing conditions (ITRC, 2007).

Biostimulation also may include injecting limiting nutrients, such as phosphorus or nitrogen. The advantage of biostimulation is that native populations present in the subsurface are already acclimated to the site, so enhancements such as the addition of nutrients will increase their biodegradation capacity. The disadvantage is that subsurface geology of a site may interfere with the introduction of nutrients, including the formation of preferential flow patterns due to fractures and impermeable lithology affecting the distribution of additives. Important subsurface characteristics to consider for biostimulation include velocity of the groundwater, and hydraulic conductivity of the soil. Pilot studies are usually conducted to provide additional site-specific information before full-scale implementation (ITRC, 2007).

Substrates added to promote reductive dechlorination come in many forms and may be soluble, low viscosity, high viscosity or solid. Soluble substrates, such as sugars, citric acid and lactic acid, may be applied in an aqueous phase offering uniform distribution throughout the aquifer. These dissolved substrates travel with advective groundwater flow and are typically applied continuously or

periodically. The soluble substrates are consumed rather quickly and must be frequently replenished.

Substrates that are viscous are less mobile than soluble substrates, but they tend to last longer in the subsurface. Slow release materials such as vegetable oil or HRC™, which are intended to be long lasting, may require a single or limited number of injections. The low mobility of viscous substrates may lead to non-uniform distribution and require different application mechanisms to achieve the desired distributions. These substrates are relatively immobile and rely on advective and dispersive qualities of soluble compounds (lactic acid for the HRC and metabolic acids for the oil) to deliver them throughout the subsurface (ITRC, 2007).

Moderate viscosity fluids such as emulsions of vegetable oil have a relatively high mobility as compared to solid or highly viscous materials that allows more uniform distribution within the aquifer. Emulsified oils slowly release hydrogen through fermentation of fatty acids. Other moderate viscosity substrates that could be used include, chitin, whey and oleate.

Oxidative Environment Processes

As with reductive processes, oxidation processes can be either chemically or biologically induced. A chemical oxidant removes electrons from constituents in the vicinity of the oxidant and the oxidant becomes reduced. In a biological oxidation process, one compound is the electron donor and another compound is the electron acceptor. An example of biological oxidation happens with fuel contaminants in groundwater. In an aerobic environment, fuel can provide the carbon and the electrons for microbial metabolism, and the oxidizing agent is oxygen, which is the electron acceptor. In the absence of oxygen, nitrate also serves as an electron acceptor. The fuel becomes degraded as it is oxidized.

Remediation of groundwater pollution, including VOCs, benzene, toluene, ethylbenzene, xylenes, organic pesticides, munitions (i.e., HMX, RDX), petroleum hydrocarbons or MTBE can potentially be achieved using chemical or biological oxidation processes. This involves injecting oxidants directly into the source and the downgradient plume, or delivering oxidants by means of a groundwater recirculation system. The oxidant reacts with the pollutants, producing innocuous substances such as carbon dioxide, water, and chloride. The four main chemical oxidants used are permanganate, peroxide, persulfate and ozone.

The ability of the oxidant to react with a certain contaminant in the field depends on kinetics, stoichiometry, thermodynamics and delivery of the oxidant. On a microscale, kinetics or reaction rates are the most important. The rates of

oxidation reactions are dependent on many variables, such as, pH, temperature, concentration of the reactants, catalysts, reaction by-products, and impurities (oxidant scavengers, organic matter, etc.) that all must be taken into consideration.

The oxidant needs to be delivered in such a manner that the oxidant comes into the contact with the pollutant to be oxidized. The delivery goal is to ensure that the oxidant is dispersed evenly throughout the groundwater needing to be remediated. The solubility and rate of reaction of the oxidant need to be considered when developing the method of delivery of the oxidant.

Treatment Zone

The treatment zone is the area where the oxidation/reduction processes take place. During oxidation, several changes in water quality parameters can occur. The oxidation process can cause trivalent chromium present in formation materials and dissolved in the aquifer to be converted to hexavalent chromium, a much more toxic form of chromium. In addition, chlorides will be liberated if the pollutants being oxidized are chlorinated compounds. Increases in salts can occur if the oxidant being used has a salt component such as sodium or potassium.

Reduction processes have similar concerns with chlorides and salts. Reducing conditions will remove dissolved oxygen from the water, and can liberate excess concentrations of dissolved iron and manganese from formation materials, and generate methane, causing secondary water quality problems. These waste discharge requirements recognize that water quality objectives for some parameters may be exceeded within the treatment zone. However, water quality objectives are not allowed to be exceeded outside of the treatment zone. Monitor wells are established downgradient of the treatment zone for use as compliance wells. The monitor wells are used to measure compliance with water quality objectives and groundwater limitations.

The size of the treatment zone should be made as small as feasible, but in most cases will be driven by the plume configuration and design of the treatment system. The treatment zone could include a transition zone where ambient groundwater mixes with the treatment zone, reestablishing ambient oxidative conditions. In contact with the oxygen of ambient groundwater, the elevated concentrations of ferrous iron and dissolved manganese are oxidized, removing them from solution. Methane concentrations return to ambient concentrations much more slowly, and travel further than other reduced species. Therefore, the formation of methane should be avoided to the extent practicable by minimizing the degree of reducing conditions generated by the project. It is not appropriate

to significantly increase the size of the treatment zone to simply allow for methane concentrations to reduce back to ambient levels.

Amendment Delivery

The in-situ treatment system is usually one of three types. One type utilizes a groundwater recirculation consisting of extraction and injection wells and provides control of the injectants and treatment zone. The extracted groundwater is amended aboveground and the amended water recharged upgradient of the extraction well. The second type injects the amendments into the groundwater and allows the groundwater to flow through the treatment zone. The third type uses extraction and injection wells to create a barrier with the treatment zone being established within and downgradient of the capture zone of the injection well(s). In this type of system the injection tends to occur downgradient of the extraction wells. The use of extraction and recharge systems is preferred as it provides greater flexibility and control of the treatment zone, and can be operated to help restore the treatment zone to pre-project conditions after remediation of the initial pollution has been completed.

Amendments

These waste discharge requirements require that the injectant materials be analyzed to determine the suitability of the materials to be used for in-situ remediation. Past analyses of various amendments, including corn syrup, molasses, HRC™ and edible oils have shown elevated concentrations of sodium and other salts, and trace metals in some of them. As the groundwater in the Central Valley is in many places adversely impacted by salts, the use of salt-containing amendments is discouraged. A project that proposes using a salt-containing amendment is required to demonstrate that there is no cost-effective, salt-free amendment that can be utilized to achieve adequate remediation of the pollution before allowing the salt-containing amendment to be used. In addition, amendments containing other pollutants such as metals could contribute to exceedances of water quality objectives and/or degradation of the groundwater.

Basin Plan, Beneficial Uses, Background Groundwater Quality and Water Quality Objectives

The *Water Quality Control Plan for the California Regional Water Quality Control Board Central Valley Region, Fourth Edition* (Basin Plan), designates beneficial uses, establishes water quality objectives, and contains implementation plans and policies for all waters of the Basin. Beneficial uses often determine the water quality objectives that apply to a water body. For example, waters designated as municipal and domestic supply must meet the maximum contaminant levels (MCLs) for drinking waters. The Basin Plan sets forth the applicable beneficial

uses (industrial, agricultural, and domestic supply in this instance) of groundwater, procedure for application of water quality objectives, and the process for and factors to consider in allocating waste assimilation capacity.

The antidegradation directives of Section 13000 of the California Water Code require that waters of the State that are better in quality than established water quality objectives be maintained "consistent with the maximum benefit to the people of the State." Waters can be of high quality for some constituents or beneficial uses and not others. Policies and procedures for complying with this directive are set forth in the Basin Plan (including by reference State Water Board Resolution No. 68-16, "Statement of Policy With Respect to Maintaining High Quality Waters in California," or "Antidegradation" Policy).

Resolution 68-16 is applied on a case-by-case, constituent-by-constituent basis in determining whether a certain degree of degradation can be justified. It is incumbent upon the Discharger to provide technical information for the Board to evaluate that fully characterizes:

- All waste constituents to be discharged;
- The background quality of the uppermost layer of the uppermost aquifer;
- The background quality of other waters that may be affected;
- The underlying hydrogeologic conditions;
- Waste treatment and control measures;
- How treatment and control measures are justified as best practicable treatment and control;
- The extent the discharge will impact the quality of each aquifer; and
- The expected degradation to water quality objectives.

In allowing a discharge, the Board must comply with CWC section 13263 in setting appropriate conditions. The Board is required, relative to the groundwater that may be affected by the discharge, to implement the Basin Plan and consider the beneficial uses to be protected along with the water quality objectives essential for that purpose. The Board need not authorize the full utilization of the waste assimilation capacity of the groundwater (CWC 13263(b)) and must consider other waste discharges and factors that affect that capacity.

The project proponent is required to determine background groundwater quality. The background data is used to determine compliance with water quality limitations at the points of compliance downgradient from the treatment zone. As stated above, salts can increase due to the dehalogenation of volatile organics or other pollutants or from salts present in amendments. Metals can be solubilized

from aquifer materials by the reduction process, be released from amendments during reactions, or change to more toxic states during the oxidation process. These waste discharge requirements allow a slight increase (20% over background) in metals and salts, as long as water quality objectives are met. A value of less than 20% would be within the error of duplicate analysis comparability criteria and an exceedance not always verifiable. Water quality objectives for the anticipated pollutants that are found at these remediation projects are established in the Findings. The water quality objectives are established based on the numerical and narrative standards found in the Basin Plan.

Coverage Under the Order

To obtain coverage under the order, the project proponent must submit a Notice of Intent (NOI) and supplemental information listed in Attachment A. The information requirements are significant as these projects are complex and require a great deal of knowledge about the project site and remediation processes. Though the requirement for submittal of information is substantial, it should be information that has already been developed by the project in order to justify the remediation project to the appropriate regulatory agency.

In order for coverage to occur, the project proponent needs to demonstrate through laboratory-scale tests that the proposed project will adequately promote remediation of the pollution. The laboratory-scale tests will also be used to identify potential adverse water quality impacts with the project and help establish monitoring parameters. If there are data from projects sufficiently similar to the proposed project, the proponent can use that information in lieu performing the laboratory-scale testing, as appropriate. Once the project is completed, the project proponent will file for termination of coverage under the general order.

AMMAST\MLP